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University–Industry Linkages in Egypt: A Political Economy Approach

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ABSTRACT

The Egyptian Science, Technology and Innovation (STI) sector has witnessed several institutional changes in the last ten years. It is slowly becoming more oriented toward satisfying the industrial Research and Development (R&D) needs with a more competitive approach to R&D expenditure. Meanwhile, the state has been in political turbulence since 2011 with a subsequent economic/financial crisis. In this thesis, we ask how the institutional changes that seek to stimulate Technology Transfer (TT) from the R&D institutions to the industrial sector can be understood within a broader political economy context. We break down our question into four main investigations. The first is concerning the economic rents and governance mechanisms as dictated by the state's industrial policy. The second investigates the relationship between the state and the industrialists given the distribution of power among economic factions while considering changes, if any, in the Political Settlements (PS) before and after 2011. The third question describes the innovation patterns in the manufacturing sector and the financial and knowledge flows within the National System of Innovation (NSI). Finally, we present a case study for the TT Offices (TTOs), providing a narration of their institutional weaknesses.

For our analysis, we use a hybrid framework by merging the PS and the NSI approaches. The former is used to check for the compatibility of the industrial policy in Egypt with the prevailing distribution of power among the state factions while the second provides a framework for analyzing financial and knowledge linkages in the Egyptian NSI as well as the University-Industry Linkages (UILs). The research methodology adopted in this thesis is mixed and involves literature review and qualitative analysis of data from conducted interviews. The methodology first relies on analyzing the available literature on the industrial policies and political economy in Egypt. The investigation then proceeds to give a descriptive account of the Egyptian NSI from which we move forward to present the case for TT from university to industry by conducting five semi-structured interviews with officials from TTOs belonging to R&D institutions.

Results of our investigation reveal that the variation in manufacturing sector performance is linked with the distribution of economic rents by the state to the capitalists, in return of political support provided by the latter to the former. Hence, in line with the predictions of the PS theory, the industrial policy failed to realize higher competitiveness of the Egyptian manufacturing sector in the international market as the supporting industrial faction (capitalists) had accumulated enough power to weaken the state's capacity of implementing its active industrial policy. We note that the variation in sector performance reflects not only growth but also innovation rates. While sectors receiving higher economic rents show less rates of innovation, except for beverage industry, those with less rents show the highest

innovation rates. The core contribution of the thesis comes with presenting the case for TTOs in Egypt which were recently established to induce UILs. Conducted interviews reveal that the STI policy is still in an early phase of formulation and that the organizational capacity of the STI actors remains low and constricted by various institutional and legal barriers.

We infer, from other country experiences, that the PS in Egypt, which has persisted for a long time and without significant changes after 2011, does not indicate substantial changes in the power distribution among its state factions and hence, in the incentives structure and governance mechanisms towards a successful implementation of an industrial policy. Hence, we conclude that while the STI institutions are being reformed slowly, the prevailing PS and the associated inclination towards neoliberal economic policies in which the STI sector is being shaped in Egypt do not allow for an efficient TT through the free-market mechanisms, as perceived by the state.

Keywords: National System of Innovation – Technology Transfer – University-Industry Linkages - Political Settlements

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List of Acronyms and Abbreviations

ALEXU	Alexandria University
AUC	American University in Cairo
BERD	Business Expenditure on R&D
CU	Cairo University
EGP	Egyptian Pound
EPO	Egyptian Patent Office
ESTIO	Egyptian Science, Technology and Innovation Observatory
EU	European Union
FY	Fiscal Year
GDP	Gross Domestic Product
GERD	Gross Expenditure on R&D
HC	Head Count
HCST	Higher Council for Science and Technology
ICT	Information and Computer Technology
IPR	Intellectual Property Right
ISI	Import-Substitution Industrialization
MB	Muslim Brotherhood
MNC	Multinational Corporation
MOF	Ministry of Finance
MOHESR	Ministry of Higher Education and Scientific Research
MOI	Ministry of Investment
MTI	Ministry of Trade and Industry
NIS	National Innovation Survey
NRC	National Research Center
NSI	National System of Innovation
NU	Nile University
PS	Political Settlement(s)
R&D	Research and Development
RDI	Research Development and Innovation
SME	Small and Medium Enterprise
SRTA-City	City of Scientific Research and Technology Applications
STI	Science, Technology and Innovation
TICO	Technology, Innovation and Commercialization Office
TT	Technology Transfer
TTO	Technology Transfer Office
UIL	University-Industry Linkage
UIS	UNESCO Institute of Statistics

Chapter 1: Introduction

Technology production, transfer and adoption are becoming an increasingly decisive factor for successful industrial policies that drive economic growth and technological catch-up processes in developing countries. In this thesis, we present the case of the recently established TTOs in Egypt and seek to investigate how they are institutionally organized to foster UILs by examining their functions through the NSI and PS approaches.

The NSI approach is concerned with the linkages among producers and consumers of knowledge and technology to assess the innovation capacity of an economy. The approach, therefore, encompasses the analysis of a wide range of institutions and linkages among actors, including the private sector, universities and R&D institutions, among others (OECD, 1997). However, in developing countries, informal institutions play an important role in their political economy and therefore we seek to accommodate the PS approach so as to avoid a narrow definition of the NSI which focuses solely on formal STI institutions. In that sense, the PS approach refers to the particular distribution of economic and political power through formal and informal institutions in an economy that either strengthens or weakens the state capacity to enforce a developmental industrial policy (Khan, 2010).

The question sought after by the thesis is relevant to the current Egyptian economy set in a political transition period after 2011 revolution for two reasons. First, while the government continues to implement financial and trade liberalization policies, accompanied by tighter fiscal policies to reduce the fiscal budget deficit, an active industrial policy is crucial to increase domestic production, close trade deficits, and raise the manufacturing sector's competitiveness. Second, one of the main lessons learned from the historical economic paths of late industrializers of South East Asia is that technological upgrade of domestic manufacturing industries is an essential component of a successful industrial policy. Technology might be transferred from abroad through, for example, Foreign Direct Investment (FDI) or joint ventures, or it can be domestically developed in and transferred from their production institutions. In cases where the state does not possess the sufficient bargaining power to impose TT from Multinational Corporations (MNCs), domestic production and transfer of knowledge becomes inevitable for achieving industrial growth and competitiveness.

The research methodology adopted in this thesis is mixed and first relies on analyzing the available literature on the industrial policies and political economy in Egypt within the PS framework. The analysis allows us to draw a conclusion regarding the effectiveness of the industrial policy given the prevailing distribution of power among the different political and economic factions. The investigation

then moves to give a descriptive account of the Egyptian NSI from which we proceed to a present the case for TTOs using semi-structured interviews.

The thesis is composed of six chapters including an introduction and a conclusion. Chapter two provides the theoretical framework explaining both the PS and NSI theories to come up with a combined hybrid approach to tackle the research questions. A literature review on industrial policies in developing countries and late industrializers comes next, followed by a reflection on their NSIs and role of R&D institutions in TT. We follow by posing our research questions in the case of Egypt. Chapter three provides a short background of the Egyptian economy and a detailed methodology for the next two chapters. Chapter four describes the economic rents as created/distributed through the industrial policies and the prevailing PS in Egypt before and after 2011 revolution to conclude on the effectiveness of these policies. Lastly, chapter five provides a description of the NSI in Egypt based on literature and statistics then presents the case for TTOs to understand the patterns of their funding and TT collaboration with industrial sectors, ending the thesis with a concluding chapter on the UILs in Egypt within a political economy context.

Chapter 2: Theoretical Framework, Literature Review and Research Questions

This chapter is composed of three main sections. We begin with the theoretical framework presenting detailed definitions and propose a hybrid analysis framework that combines both the PS and NSI approaches. We then move to a literature review on the industrialization policies of some selected economies and a reflection on the historical specificity of their NSIs and UILs. Lastly, we pose the relevant thesis questions in the case of Egypt.

2.1 Theoretical Framework

The section provides a conceptual framework for answering the research questions by combining the PS and NSI approaches in order to understand the broader political economy context of the UILs in Egypt.

2.1.1 The Political Settlements Approach

The PS approach is particularly useful in the context of developing countries to explain the effectiveness of industrial policies arising from the interactions of economic and political factions given their balance of power. We start by introducing some essential definitions of the PS terminology used throughout the research.

- a. **Distribution of power:** *“the relative holding power of different groups and organizations contesting the distribution of resources”* (Khan, 2010, p. 1).
- b. **Institutions:** any rule accepted by a society that gives a specific agent the right to own or do something. There are two major types of institutions: (a) formal institutions: the ones which are publicly defined through written laws and, enforced by official organizations and characterized by being impersonal (i.e. unrestrictedly applied within a defined space-time horizon), and (b) informal institutions, representing any other type of socially accepted rules. They might be enforced through recognized organizations with informal power such as those formed in what Khan calls *“patron-client structures”*. These are combinations of organizations and informal institutions through which an agent acquires (economic) benefits to maintain their informal power and they can incur the societies high costs otherwise. Patron-client networks are especially important in analyzing institutions in developing countries in which many organizations (political factions) rely on informal institutions for acquiring and maintaining their power (Khan, 2010, p. 26). Khan (ibid, p. 54) asserts that these networks characterize the developing countries which are passing through (long) stable transitional periods towards modern and advanced economies, when economies are productive and sometimes with strong growth.

- c. **Political settlement:** *“an interdependent combination of a structure of power and institutions at the level of a society that is mutually ‘compatible’ and also ‘sustainable’ in terms of economic and political viability”* which means they are able to reproduce themselves without significant changes in the power distributions (Khan, 2010, p. 20).
- d. **Rents:** Economic rents take several forms such as preferential treatment in terms of subsidies or protection measures. In Khan’s words (Khan, 2013, p. 248), rents are *“incomes higher than the minimum a person or organization would have accepted, the minimum usually being defined as the income in the next-best opportunity available to that individual or organization”*. In mainstream economics, rents are normally associated with deadweight loss and cause harm to fair competition as benefits accrue to private agents at the expense of the society (Krueger, 1974). However, rents that are associated with positive net social benefit are desirable, such as in case of protection of Intellectual Property Rights (IPRs). The PS analysis requires a successful industrial policy to identify specific firms or sectors that are strongly networked with the ruling coalition in which these sectors get a special attention in the policy design; imposing conditions on rent distribution through **“governance mechanisms”**. Governance mechanisms represent a system of punishment or the withdrawal of these rents if adequate performance standards, as dictated by the industrial policy, are not met.

Khan (2010) distinguishes between advanced and developing economies with respect to the source of power of their organizations. While the formal institutions (such as incomes or wealth accruing from formal jobs or capital ownership) constitute the main channel through which power accumulates in developed countries, informal institutions prevail in most developing countries. The power distribution in the latter stems from historical roots and evolution of informal institutions over time.

In developing countries, an industrial policy addresses contracting failures of domestic firms to adopt or implement new technologies through the generation or redistribution of economic rents (such as subsidies) among different political factions. As an example of a contracting failure facing TT is the enforcement of the IPRs. A particularly important failure that needs to be pre-addressed before any other is the **“organizational capability”** as Khan (2013, p. 47) calls it. It is similar to what Mazzoleni and Nelson (2009) call “social technologies” as opposed to “physical” ones, referring to the set of practices and knowledge that enable the firms to effectively use the existing technologies or adopt new ones, requiring the long process of learning by doing. Incorporating such organizational capabilities in our analysis allows us to stay away from a narrow perspective of the NSI encompassing only science and

technology aspects to a broader one putting stronger emphasis on the political and (informal) institutional aspects (Scerri, 2013a, p. 81)

There are two essential conditions for a successful industrial policy, according to Khan. First, it adequately addresses the specific contracting failure facing the domestic firms. Second, it is effectively implemented using the governance mechanisms as mentioned before (Khan, 2013, p. 243). Industrial policies that combine both rent distribution coordinated over selected firms or sectors and accompanied by monitoring frameworks usually result in strong growth and technological catch-up such as in the case of the late Asian industrializers. This is in contrast to the sole provision of protection measures to infant industries in other developing countries which did not necessarily yield enhanced productivity or competitiveness. Hence, effectiveness of an industrial policy depends the state's capacity to implement it given the particular power distribution among organizations affected by the policy. Organizations tend to either fortify the policy if they are receiving rents or to weaken it if the policy directs the rents away from them (Khan, 2013, p. 252).

Understanding the PS within a country requires the examination of two dimensions: (a) power distribution among the ruling coalition and its supporting factions and (b) the relationship between the ruling coalition and the production sectors (capitalists). In the first dimension, we draw a map of the power distribution among the ruling coalition, its supporting factions and the excluded faction. Politically excluded factions tend to weaken the power of the ruling coalition while the magnitude of the supporting factions power determines the ruling coalition's capability of enforcing governance mechanisms. The more powerful the supporting factions are, the less likely the ruling coalition is able to enforce institutions that redistribute rents among different political and economic agents. In the second dimension, the production sector has a combination of technological capabilities and political power. The outcome of an industrial policy depends on the configuration of these two dimensions (Khan, 2010, pp. 8–9). Figures 1 and 2 depict the analytical framework of both dimensions, as presented by Khan (2010).

Figure 1: Patron-client structures and ruling coalition

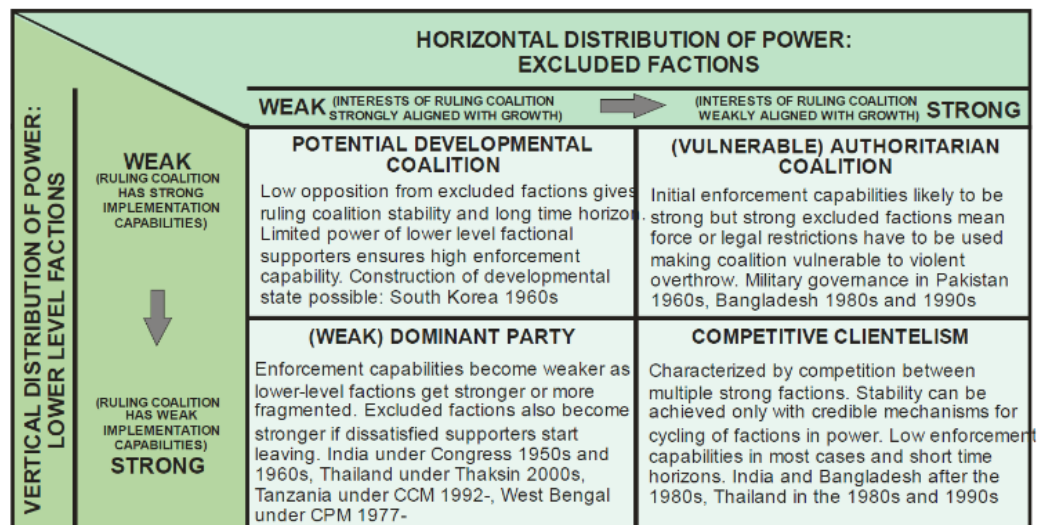
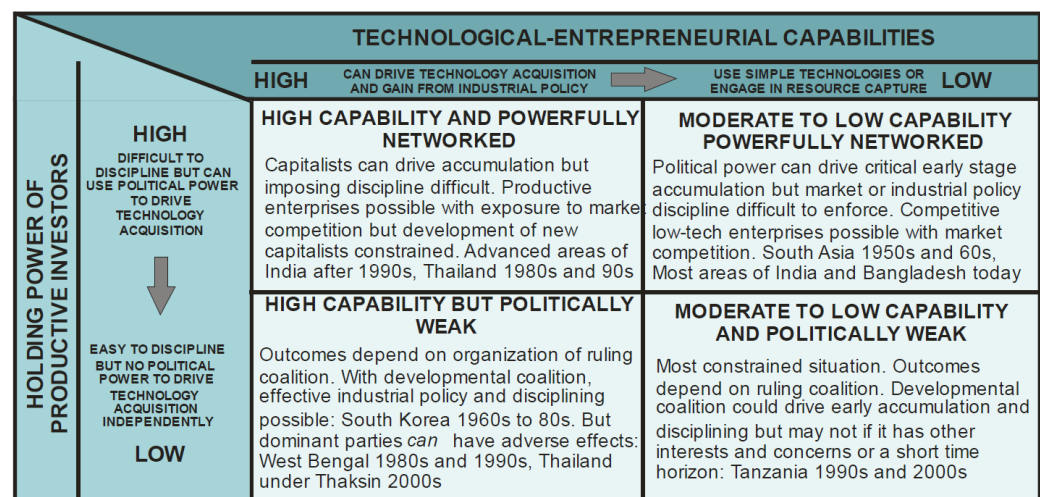


Figure 2: Patron-client structures and production sectors



Source: Khan, 2010, p. 65

2.1.2 National System of Innovation

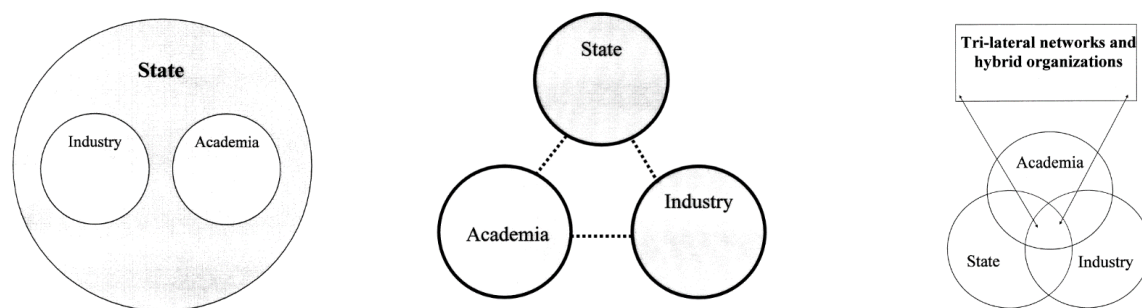
The notion of “innovation” has been much attributed to Joseph Schumpeter and his theory of economic development depicted in his seminal work “Theory of Economic Development” (Schumpeter and Opie, 1934) in the early twentieth century. Since then, the role of innovation has become central in explaining economic growth and social development associated with technical change. In 1987, Christopher Freeman linked the economic catch-up process in Japan to innovation while Lundvall in 1992 tackled the importance of learning process in knowledge accumulation. Another notable contribution by Nelson in 1993 provided a distinction between innovation that results from active R&D activities and what is called “organizational innovation”. The former results from the economic

valorization of knowledge in the form of, for example, a commercialized invention, i.e. an idea with an economic value, while the latter is based on learning by doing and training (Lundvall, 2005). We have already shown in the previous sub-section that the same concept is a core one in the PS approach where addressing the “organizational capacity” of an industry is one of the contracting failures that a successful industrial policy should address.

By centralizing the role of innovation, the NSI approach perceives it as a product of complex interactions among the system’s players (Fagerberg, 2004). The main contribution of the NSI is its ability to comprehensively and systematically analyze economic systems from an “innovation” perspective, i.e. where technical and organizational skills drive the economy’s evolution. Moreover, its focus on the institutional, cultural and even geographical dimensions of the economy allows it to take into account the historical specificity of the system’s evolution and how it reflects on the economic path of nations (Fagerberg and Sapprasert, 2011).

To discuss the characteristics of a particular NSI, studies may focus on specific actors and the linkages among them. The most important and formally recognized actors are government, industry and university, with the industry (firm) as the cornerstone of the system. Although several other actors may be added, a basic discussion of NSI would at least involve conferring the linkages among these three. For example, the Triple Helix approach (figure 3), inspired by the NSI, focuses exclusively on the preceding three. Etzkowitz and Leydesdorff, (2000) present three different models of the State-Industry-Academia relationships where in the first, the state controls both resulting in a system failure and is seen in contrast with the “laissez-faire” model. The third model represents a hybrid configuration where the state actively engages with the two other actors to facilitate their collaboration. However, the TH approach can easily be extended to n-tuple of helices to include other actors as proposed by Leydesdorff, (2012).

Figure 3: Triple Helix model versus other models of Government-Industry-University Relationships



Source: Etzkowitz and Leydesdorff, 2000

Niosi et al. (1993) list a number of linkages that exist among the system's actors including: (a) financial flows where public finance plays a significant role beside the private investment, (b) social flows where individuals who own knowledge move among actors and (c) STI flows such as the output of the R&D (e.g. patents and licenses). The authors also add the legal and policy links; however, we may rather need to embed the whole NSI within an institutional framework where both formal (laws and regulations) and informal institutions (culture and norms) interact with the system. The NSI approach entails several assumptions regarding its actors and their linkages (figure 4).

Figure 4: Assumptions of National Systems of Innovation as presented by Lundvall (2005)

A first assumption is that elements of knowledge important for economic performance are localized and cannot easily moved from one place to another.

A second assumption is that important elements of knowledge are embodied in the minds and bodies of agents, in routines of firms and in relationships between people and organizations.

A third assumption is that learning and innovation is best understood as the outcome of *interaction*. Perhaps the most basic characteristic of the innovation system approach is that it is '*interactionist*'.

A fourth assumption is that interactive learning is a socially embedded process and that therefore a purely economic analysis is insufficient.

A fifth assumption is that learning and innovation are strongly interconnected (but not identical) processes.

A sixth assumption is that national systems differ in terms of specialization both in production and trade and in terms of knowledge base.

A seventh assumption is that national systems are systemic in the sense that the different elements are interdependent and that interrelationships matter for innovation performance.

Source: Lundvall (2005)

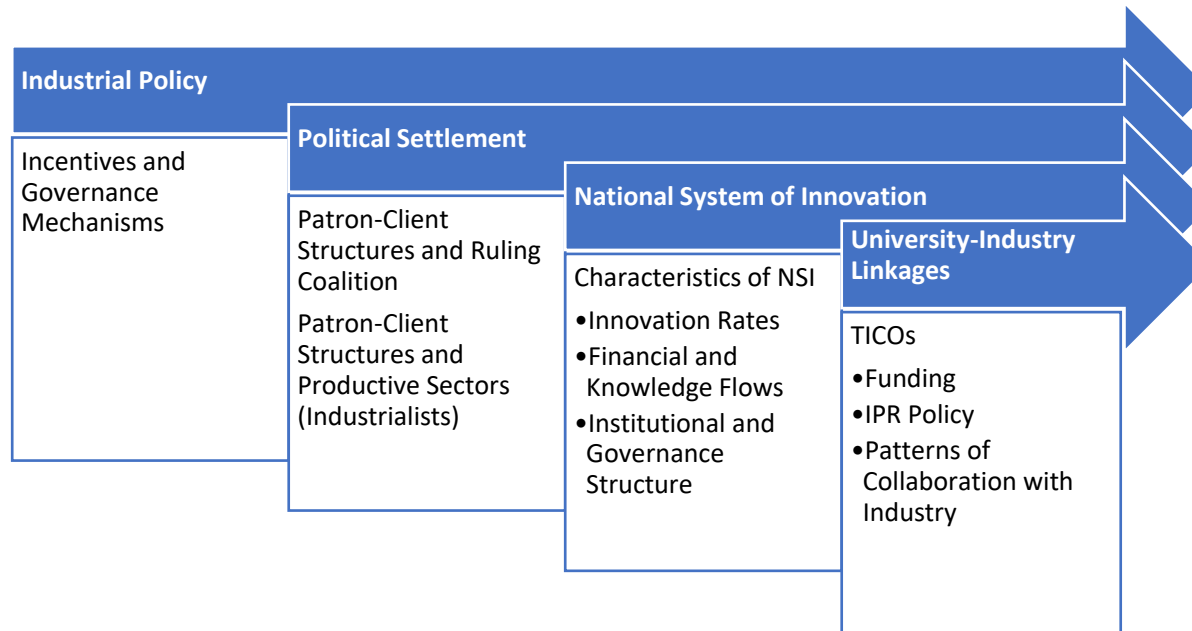
Measuring Metrics of NSI

There are several approaches that were developed in an attempt to quantify the NSI. Innovation surveys are an important tool to gather data at the firm-level. Nowadays they mostly incorporate data on four types of innovation: product, process, marketing and organizational. In addition, they gather data on expenditure on innovation, sources of information and the cooperation partners, among others. These surveys were firstly initiated in Europe but are now getting popular in developing countries. Another approach is to use the "cluster analysis" which studies knowledge and technology flows among industry within clusters. Geographical proximity creates knowledge externalities and therefore has been the basis for the modern industrial clusters and science parks where collaborations occurring among firms and between firms and R&D institutions are assumed (and empirically sought after) to create positive externalities evident in higher innovation rates. Lastly, a macro-level measurement approach is the technological balance of payments where flows of knowledge and technology among countries are measured including IPRs and technology diffused in physical capital (OECD, 1997).

2.1.3 A Hybrid Approach

Studies on developing countries needed to tailor the NSI approach to accommodate their historical socio-economic specificities. There have been several shifts in the literature focus to include, for example, an emphasis on the political dimension or the role of MNCs affecting the interactions among the system's actors (Watkins et al., 2014). In this thesis we study the UILs in Egypt by providing a case study of the recently established Technology Innovation Commercialization Offices (TICOs). As Khan does, we acknowledge the technological accumulation as an essential element of a successful industrial policy. Therefore, we combine both the PS and NSI approaches in a hybrid framework to reach a conclusion on the actual performance of these TICOs in connecting university and industry. Figure 5 provides a proposed framework analysis. We begin by analyzing the industrial policy and the PS in Egypt to reach a conclusion on the institutional setting in which the Egyptian NSI is situated. We then move to focus on the Egyptian NSI and then to analyze the TICOs performance as one form of UILs.

Figure 5: Hybrid analytical framework



Source: Author

2.2 Literature Review

In this section, we aim to show how prevailing PSs in developing countries impact the state's capacity for TT and fostering UILs. The literature review does not aim at fully covering such broad topics but rather at presenting the relevant elements to the research. The countries were selected based on having relatively similar starting points to Egypt by the end of 1960s, except for Brazil and South Africa, in terms of the industrial sector contribution to the GDP, as shown in table 1. The two exceptional cases, however, show the de-industrialization process that shaped their economic paths before the beginning of the 21st century. It is also noteworthy that other countries may have grown their industrial shares of GDP but not necessarily their exports shares of GDP or the shares of the high-tech products in exports, such as in Colombia and Egypt

The section starts by providing an overview on the state-led industrialization, followed by a section on the PS to better contextualize these policies. We then show the impact of the shift to neoliberal policies in Latin American countries on the industrial sector and we end by a reflection on the NSIs and STI policies in the presented countries, including the UILs.

2.2.1 State-led Industrial Policies

Several countries from East Asia and Latin America, as well as Africa, have experienced strong state-led industrial policies in the past century. Some countries witnessed, as a result, strong growth rates and successful industrialization process while others had their industrial base weakened and technologically downgraded. South Korea provides significant policy lessons to other countries to follow. However, we aim at showing that similar policies are not the only condition for successful industrialization, rather, the political economy matters.

South Korea's industrialization (1960s-80s) relied on the *chaebols*; large family-owned holding companies, that were strongly supported by economic rents from the state taking different forms including subsidies and other protection measures. Meanwhile, performance targets such as export targets were set and enabled the state to distinguish between efficient firms that met the performance goals, and therefore sustained the flow of rents, and inefficient ones that were excluded (Khan and Blankenburg, 2009). Another model is given by Malaysia. The active state policy between the 1970s and 90s was based on attracting FDIs by providing incentives to high-tech MNCs. Such incentives took the form of prioritized infrastructure projects and services and protection from the changing tax schemes due to internal pressures on income redistribution. Instead, domestic firms were subject to these risks but were also rewarded whenever they created linkages with the MNCs (ibid).

Figure 6: Real GDP (2010 USD), scaled to 100 in 1969

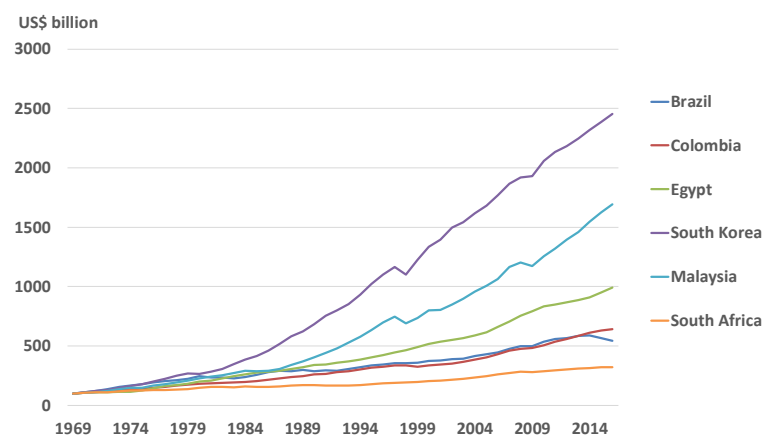
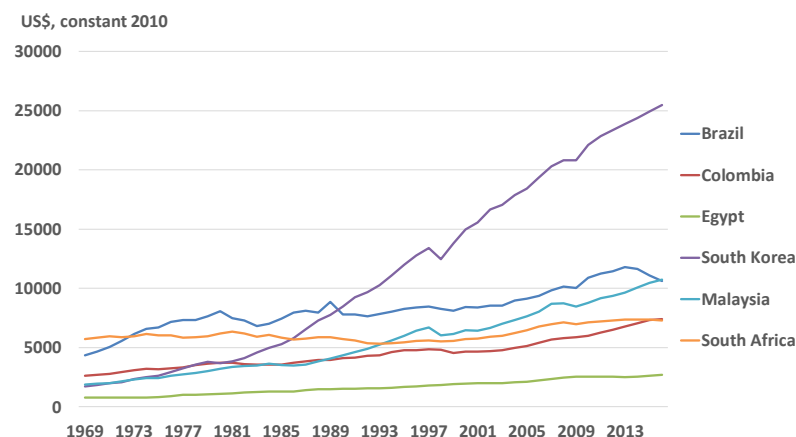


Figure 7: Real GNI per capita (2010 USD)



Source: World Bank Development Indicators Database, 2018

Table 1: Selected Macroeconomic Indicators of Developing/ Late Industrialized Countries

INDICATOR	YEAR	BRAZIL	COLOMBIA	EGYPT	SOUTH KOREA	MALAYSIA	SOUTH AFRICA
INDUSTRY, VALUE ADDED (% OF GDP)	1969	37.4	26.9	27.7	26.6	29.2	38.4
	2016	21.2	32.6	32.9	38.6	38.3	28.9
EXPORTS OF GOODS AND SERVICES (% OF GDP)	1969	6.6	13.2	14.2	10.6	47.4	23.0
	2016	12.5	14.2	10.3	42.2	67.7	30.3
MEDIUM AND HIGH-TECH EXPORTS (% MANUFACTURED EXPORTS)	1990	37.9	24.2	10.6	51.1	53.3	31.0
	2015	41.5	46.0	32.8	76.2	61.8	49.1
FDI, NET INFLOWS (% OF GDP)	1977	1.0	0.3	0.7	0.2	3.1	-0.3
	2016	4.4	4.9	2.4	0.9	4.6	0.8
GNI PER CAPITA (CONSTANT 2010 US\$)	1969	4362	2607	761	1727	1880	5702
	2016	10609	7399	2687	25485	10727	7280
GINI INDEX (WORLD BANK ESTIMATE)	1990	60.5	51.5*	32	NA	47.7*	59.3**
	2015	51.3	50.8***	31.8	31.6****	46.3****	63*****
*1992 **1993 ***2016 ****2009 *****2014							

Source: World Bank Development Indicators Database, 2018

On the other hand, the Latin American countries set off their industrialization phases much earlier than their East Asian peers. Both Brazil and Colombia witnessed strong industrialization starting as early as the 1930s and ending in the 1980s. The process was meant to transfer the economies from agrarian resource-based ones to having a large base of light/heavy manufacturing industries. Strong growth rates were maintained until the end of the 1970s. Brazil shares several aspects of its industrialization policy with South Korea. Both started with import-substitution policies, and supported infant industries by several incentives and protection measures such as preferential access to credit, public investments, import tariffs, etc. However, mobilization of economic resources towards the industrialization process and the outcomes of the policy in terms of the industrialization rates in Brazil were not on par with its peer. On the other hand, the policy directed towards capital-intensive industries in Colombia since the 50s required strong government capacity to monitor the distributed rents, a condition which was not met (ibid).

The case of South Africa is relatively different given the long apartheid history that ended only about 25 years ago. The development of the industrial sector in South Africa was strongly tied to its colonialization and apartheid history. Production was centered around what is known as the Minerals-Energy Complex (MEC), i.e. the mining sector and the sectors that maintained backward and forward linkages to it. During the apartheid era in the 1950s, the state provided support in terms of subsidies and tariff protection, in addition to the establishment of parastatals especially in the energy sector as an essential supportive sector to the MEC. The South African economy boomed but also became increasingly isolated from the rest of the world (Fine, 2008). The MEC notion provides a strong argument as to the de-industrialization of the South African economy over the period of British colonialization and the persistence of the weak industrialization process during post-apartheid times. The weakening of sectors with no direct linkages with MEC and the resulting shift from production of capital goods to primary ones based on the mining industry, as well as the deep financialization of the industrial sector in post-apartheid times, have all contributed to de-industrialization of the South African economy, as shall be illustrated later (Fine and Rustonjee, 1996).

2.2.2 Political Settlements

Khan and Blankenburg (2009) argue that the success of industrialization policies in East Asia, as presented, was due to the historically specific PS prevailing after the end of foreign ruling which enabled the state to implement and monitor its policies. They argue that such settlements are not necessarily found in other developing countries and that per se explains why similar industrial policies might not simply work in their contexts

In many cases, the presence of powerful intermediate groups supporting the state and having links with the industrialist class leads to the continuity of economic rents flows provided by the state to the industrialists whose firms are inefficient and unable to go up the learning curve to become more competitive. In South Korea, the absence of such groups enabled the state of cutting its support to the inefficient chaebols by excluding them from the rent system and directing the rents to other more efficient firms. Meanwhile in Malaysia, the concentration of power in the dominant party enabled the state of preventing the formation of coalitions between the capitalists of MNCs and the government bureaucrats. Had such coalitions been formed, flow of rents would have been sustained allowing the MNCs to solely maintain low-tech manufacturing activities in Malaysia.

Khan and Blankenburg (2009) argue that the poor industrial performance of the Latin American countries cannot be attributed to state intervention as claimed by the orthodox economists since successful industrialization in South East Asian countries had also entailed heavy state intervention. Nor can it be attributed to the absence of favorable international conditions such as foreign aids, an argument used by some heterodox economists. Rather, Khan and Blankenburg (2009) argue that, in countries where policies failed, there had been an incompatible mix of the industrial policies and the state's capacity to enforce these policies given specific patterns in the distribution of power among the country's political and economic groups as shall be discussed in the following paragraphs.

While both Brazil and South Korea had authoritarian regimes, the nature of the clientelist networks in both countries were different. Brazil was characterized by the presence of powerful elites leading fragmented networks of middle and working class non-capitalist groups. Due to the highly fragmented power, the capacity of the state to impose governance mechanisms was weakened. Meanwhile, in South Korea, the private sector was embedded in the supporting factions whereas any political or economic factions causing political instability were politically and economically excluded.

In Colombia, the powerful landed elites competed with industrialists for state rents and therefore weakened the latter's power and its capacity to distribute rents. Alcorta and Peres (1998) also point out to the fragmented structure of industries in Colombia which indicated fragile linkages between industries across the same value chain, weakening the channels through which industries could strengthen their own technological capabilities by adapting to each other's demand for output.

Although there are no explicit studies on the PS in South Africa, we deduct some patterns of power concentration that prevailed during the apartheid and persisted after its end with the adoption of neoliberal policies. The economic power of the mining conglomerates as well as the Afrikaners capitalists (of white Dutch origins) prevented the allocation of capital to non-MEC industries. The

mergers of the Afrikaner capital and the English capital during the British colonialization strengthened the bargaining power of the MEC industrialists to resist and prevent investments in non-MEC industries during the apartheid period (Ashman et al., 2013).

2.2.3 Foreign Investments, Inward Technology Transfer and Neoliberal Policies

By the beginning of the 1980s, Latin American countries shifted towards strong neoliberal policies that were alleged by international finance institutions to successfully contain the late-70s economic crisis as inflation and debt rates were brought down after soaring during the crisis while export rates grew. However, Khan and Blankenburg, (2009) argue that these policies resulted only in a one-off gain to the economy by allowing cheaper capital imports rather than long-term productivity enhancements. Malaver Rodríguez and Vargas Pérez (2005) show how the increase in import penetration in the end of 90s compared to the end of 70s in Colombia rather indicated the loss of international competitiveness.

Similarly, the end of apartheid in the 1990s in South Africa came through while the world was dominated by strong neoliberal policies and which the new post-apartheid government adopted, however with inherited fragile uneducated labour class and basic industries. The strong liberalization policies led to the outflow of capital that was banned from transfer to abroad in the previous era. Instead of attracting FDI, the MEC conglomerates shifted to deeper financialization in the stock markets abroad. The financialization of the economy left the state with even a stronger dependence on MEC for exportation. In the post-apartheid time, the energy sector provides a good example on how the weak political and economic power of the new state in 1994, represented by the dominant party African National Congress (ANC), made the public investments in the sector a difficult task due to the lack of funds and the dominating interests of the international investors (Fine, 2008).

The newly adopted neoliberal policies had significant implications as to the openness for foreign capital and the accompanying structural technological change. Significant de-industrialization resulted from the adoption of the new free market policies, accompanied by international competitiveness pressures from free trade policies, especially in Brazil due to the return to resource-based and low-tech industries, with few exceptions in automobile and aerospace industries. Khan and Blankenburg (2009) emphasize how the cheaper capital imports resulted in technology downgrading. Foreign companies delegated low-tech manufacturing stages to the Latin American countries and did not engage in TT to upgrade the industrial bases of these countries. As the authors propose, the growth in exports that followed the implementation of the neoliberal policies was not the result of a Schumpeterian upgrade to

higher-tech exports. Rather, it was the result of the increased international demand for low-tech and resource-based products in Latin America.

For Colombia, political instability rising due to the exclusion of the middle class led to low attractiveness of the economy to FDIs. Low bargaining power of the state also reflected on the government's inability to impose conditionalities of TT on foreign companies. We see almost the opposite in the case of Malaysia where inward TT policies were quite efficient. Due to political stability and credibility of the state, the state was able to exercise power over MNCs by imposing conditions of TT to domestic firms via creating backward and forward linkages (Khan and Blankenburg, 2009).

2.2.4 On the National Systems of Innovation and University-Industry Linkages

On the Asian side, South Korea is an example of coordinated industrial and technology policies that responded successfully to weaknesses and market failures of the R&D market. Active policies started early after the end of Japanese rule with a focus on labour-intensive sectors where technology was already developed or could be easily imported. Given the prevalence of unskilled labour in the post-Japanese rule, development of a national highly-educated workforce started became a policy objective during the 1950s. Skilled labour represented a cornerstone for developing the higher education system at a later stage (Mazzoleni, 2008). At the same time, the university system in South Korea initially witnessed general weaknesses in terms of low funding and capacity for serving the increasing supply of students. Korea's policy related to production of domestic technology and employment of its scientists and engineers was concentrated in the creation of joint research projects between supported industries and public research institutes. Meanwhile R&D funding was concentrated in public research institutes and corporate R&D rather than in universities (Mazzoleni, 2008).

Late industrializers also show varying sectoral performances as a direct implication of foreign ownership of strategic industries. In Malaysia, while biotechnology firms show higher rates of collaboration to access the newest technologies and innovations in the medical field, the automotive sector shows less collaboration. The latter relies more on standardized processes of assembly. The electronics industry similarly shows less collaborations, however for other strategic reasons. It is dominated by MNCs, with foreign ownership reaching 80.6% in 2007, that tend to have extensive internal R&D activities. In contrast with Malaysia, the electronics industry and telecommunications sector in South Korea benefitted from the development of domestic technology through UIIs (Mazzoleni, 2008).

Import-substitution policies adopted by the end of 1950s in Brazil were criticized as of their ineffectiveness in inducing inward TT through FDIs upon which the state depended for building its

technological capacity. At the same time, the 80s and 90s are considered as the “*two lost decades*” in the modern economic history of Brazil in terms of growth and development. The neoliberal policies adopted led to the withdrawal of the state from its active policy in pushing the innovation rates, leaving the transfer and adoption of new technologies process to market mechanisms. Except for a very limited policy scope in STI that focused on UILs in the 90s, state intervention did not extend to any broader features of the innovation system (Koeller and Gordon, 2013). Similarly in Colombia, the active STI policies in the early 90s aimed at increasing public and private investments in R&D. However, the former declined in the first half of the decade while the latter remained weak (Malaver Rodríguez and Vargas Pérez, 2005).

Development of the South African NSI is considered a recent process given the relatively short post-apartheid period and the national attempts that followed to build the STI sector. However, the apartheid time still resonates in terms of its impact on the South African technological path. The current poverty rates and socio-economic inequality echo the systematic depletion of the black labour capabilities through segregation policies in education and labour that were designed to ensure the continuous supply of cheap labour to the MEC industries. Although the state in the post-apartheid time had several attempts to restructure its STI policy¹, policies were destined not to fully achieve their objectives due to the broader neoliberal policy context in which they were designed. Firms faced fierce international competition while empowerment of black people merely relied on small businesses and educational attainment with the latter bearing fruits only decades later (Baker et al., 2014; Scerri, 2013b). Moreover, UILs in MEC industries remain weak. An empirical case study on the Platinum Group Metals in South Africa revealed that the increased competition post-1994 pushed the firms to seek upgrading their technologies. However, only few firms showed engagement with universities for R&D while such linkages were limited by the firms’ unawareness of the projects run by the state initiatives through the science councils. Additionally, there were no incentives for such linkages while the cost of engagement was deemed high by the firms (Lydall, 2009).

2.3 Research Questions

The thesis aims at understanding how TT from university to industry is shaped by the institutional and political context of Egypt. In particular, we investigate the case of the TICOs and examine their setting within the Egyptian NSI and the broader industrial policy, shaped by the prevailing

¹ See more details on the consecutive Science and Technology policies adopted in the post-apartheid in Scerri, 2013.

political economy. We break down our investigation into four sub-questions/discussions that serve to build up the answer to the question.

1. What are the economic rents and governance mechanisms as dictated by the state's industrial policy?
2. How is the industrial performance shaped by the relationship between the state and the industrialists given the distribution of power among different economic and political factions (i.e. PS) and whether 2011revolution led to any change in the PS?
3. What are the innovation patterns in the Egyptian manufacturing sector before and after 2011 and how are the financial and knowledge flows organized within the NSI?
4. What are the main functions of TICOs in Egypt and what are the main institutional barriers, formal and informal, that weaken their capacity to fully carry out their functions?

The first two questions shall be addressed in the fourth chapter to set a broad political economy context for understanding the developments in the Egyptian NSI while the last two shall be addressed in the fifth chapter.

Chapter 3: Background and Methodology

3.1 Background

The recent economic history of Egypt, beginning from the end of monarchy and the full independence of the British rule in 1952 and until 2011 revolution, can be divided into four distinct periods, interrupted by two major crises: the war with Israel (1967-1973) and the external debt crisis (1985-1990).

The first period starts with the Egyptian president Nasser, who was one of the army “Free Officers” movement that led a military coup and a popular revolution in 1952 against the monarchy rule and British interference. Nasser led a strong state-led import-substitution industrialization (ISI) policy that involved nationalization of foreign and private enterprises and banks and formation of a large public sector. Although the policy resulted in a strong economic growth and a diversified domestic production from low- to high-tech output, the low share of exports and continuous importation of capital goods posed a pressure on the country’s foreign resources. The active ISI policy was effectively halted since the 1967 Six-Day war with Israel, leaving a country with a thin private sector and critical level foreign reserves (Loewe, 2013).

Sadat, the following president and again a military officer, acknowledged the lack of capital and initiated the famous “Open Door” policy to attract foreign capital and import technology from the west. The policy carried incentives and several protection measures to the public and private sectors to invest in specific sectors. However, the policy did not encompass a strict governance mechanism to yield the foreseen objectives. The absence of performance targets to the recipient investors led to the appearance of a class of capitalists that could be described as “parasitic entrepreneurs”. A patron-client relationship between this class and the policy makers allowed the former to gain huge economic rents through preferential treatment. The policy did not yield any structural changes in the manufacturing sector as investments continued to be heavily concentrated in the inefficient public sector, with no technology upgrade to be mentioned, and hence no competitiveness achieved.

The 30-year Mubarak’s era began in the early 80s, directly after the assassination of Sadat by radical Islamists who were former members of the Muslim Brotherhood (MB), a social and religious movement that enjoyed some political and economic freedom during the Sadat’s time (Beinin, 2005). In the first ten years of his period in office, Mubarak followed economic policies similar to that of Sadat, however without allowing the private sector to overtake the public sector’s role in the economy. More importantly, the army emerged as a strong player in the industrial sector through investments in many manufacturing and construction industries, financed by state rental activities such as the sale of public

lands to private investors (Loewe, 2013). The size of the military's budget and contribution to the country's economy grew but remained undisclosed. Facing a global decline in hydrocarbons prices and exports revenues in the late 80s, the economic activity plunged to 1.1% and the debt crisis exacerbated.

Figure 8: Real GDP growth rate

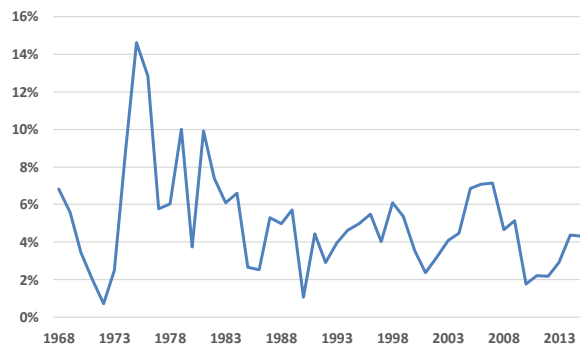


Figure 9: Industry, value added (% of GDP)

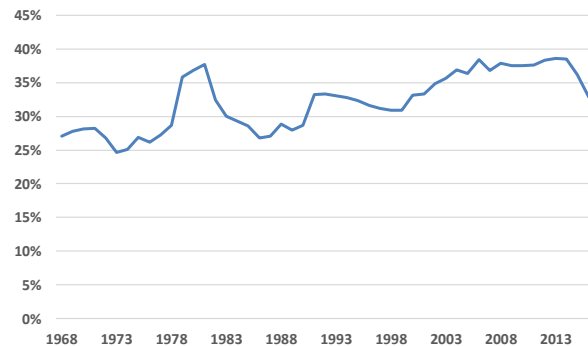
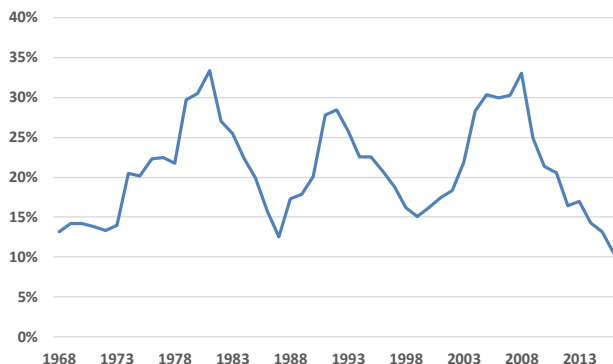


Figure 10: Exports of goods and services (% of GDP)



Source: World Bank Development Indicators, 2018

The third phase started in the early 90s with the Economic Reform and Structural Adjustment Program (ERSAP) dictated by the IMF and debt relief programs from Paris Club countries. Tighter government spending and trade liberalization yielded lower public deficit and debt and accelerated growth in some sectors, while the private sector contribution in the manufacturing sector also grew. However, the privatization efforts promised to the lending institutions were only partially fulfilled. Notably, the growth in the private sector represented an extension of the patron-client networks founded during Sadat's era. Capitalists maintaining relationships with the policy makers had once again access to preferential economic rents (Sfakianakis, 2004). However, over a decade, exports did not diversify or achieve competitiveness and remained dominated by natural resources or low-tech output.

The last phase, to be further discussed in the next chapter, begins with the assignment of a new cabinet in 2004 whose members had technocratic, neoliberal and business-oriented backgrounds

(Loewe, 2013). However, as socio-economic conditions kept deteriorating, 2011 revolution erupted and remarkable changes in the political and economic policies happened since then.

3.2 Methodology

The research mixed methodology depends on literature review of relevant documents and qualitative analysis of semi-structured interviews to answer the four questions. The first question regarding the industrial policy shall be answered using a review of the available literature as well as the relevant laws on investment and ministerial documents in order to determine the distribution of economic rents among different industrial sectors. A review of the academic literature will also provide an answer to the power distribution among different political factions, with a special focus on the relationship between the capitalist class and the ruling coalition. These two questions discussed in chapter four shall be provide a broader political economy context of the Egyptian NSI.

Developments in the NSI are investigated through the available statistics from the national innovation surveys (NIS) conducted in 2010 and 2014. The two surveys give us insights on the variation in innovation rates before and after the revolution as well as across the manufacturing sectors. We, then, move to a narrative description of the NSI by tackling the financial and knowledge flows across the system's actors. We also give an account of the most important institutional changes in the STI policies and governing bodies before and after 2011. Given the complex structure and multiple organizations involved in the NSI, we complement our understanding and presentation of the NSI by an additional interview with an economic researcher from the Science and Technology Development Fund (STDF), the main government R&D funding agency. The last question concerning the UILs, the main contribution of the thesis, seeks to understand and document the institutional weaknesses as encountered by the TICOs in creating and maintaining collaboration between university and industry. Semi-structured interviews were conducted with either the founders or current managers of the TICOs.

Sample Selection: The Academy of Scientific Research and Technology (ASRT), the national authority governing the STI sector, provides a list of 42 out of 43 established TICOs in Egypt². By excluding the TICOs which are in non-manufacturing sector-specific R&D institutions, such as agriculture, natural resources, construction or astronomy, 34 TICOs remain. For the interviews, we selected TICOs belonging to largest recipient institutions of R&D government funding as distributed through the STDF and the ASRT. As shall be illustrated in Chapter 5, government funds received by R&D institutions are highly concentrated in few of them. From the STDF, the National Research Center (NRC) comes first

² Conflicting numbers are found on the official website of the ASRT: see <http://www.asrt.sci.eg/images/tico/1e.pdf> and <http://www.asrt.sci.eg/images/tico/4e.pdf>

receiving 21% of the total funds available between 2008 and 2014. Cairo University (CU) comes second with 14% of the funds, followed by Alexandria University (ALEXU), Ain Shams University, Mansoura University, Assiut University, City of Scientific Research and Technology Applications (SRTA-City) and Suez Canal University. The largest 10 organizations received 78.5% of the total available funding over the same period. On the other hand, over the year 2014/2015, the largest beneficiaries from the ASRT funded projects were: Nile University (NU), American University in Cairo (AUC), Zewail City of Science and Technology, the NRC and the Electronics Research Institute (STI-EGY 2030, 2015).

We attempted to reach the largest five recipients from each of the STDF and ASRT and ended up with a 50% response rate, hence, we conducted five interviews. A list of the interviewees and backgrounds of institutions to which they are affiliated are provided in Annex I while the interviews' schedule is provided in Annex II. Using these interviews, we aim at understanding their functions as mandated by their mother institutions and to reveal the institutional barriers of UILs through these recently established offices. However, it should be clear that we do not intend to generalize our conclusions on UILs in Egypt but rather to tackle the case of TICOs as facilitators of university-industry collaboration.

Given that these TICOs are affiliated with the largest recipients of government R&D funding, we may assume that they face less financial barriers than their peers. However, since TT from R&D institutions to industry is ill-performing – as discussed in chapter 5, we believe that gaining insights from the best funded institutions will better inform the thesis about the institutional and governance hurdles, besides the financial ones.

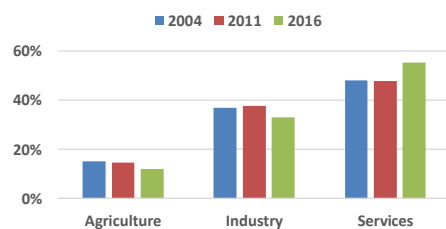
Chapter 4: Industrial Policy and Political Settlements in Egypt

In this chapter, we tackle the interaction between the PS and the industrial policy in Egypt hinting to relevant changes in each after 2011 revolution. We first provide a quick overview on the manufacturing industries in Egypt and then move to tackle in detail the economic rents and governance mechanisms as per Khan's framework. Lastly, we show how the rising power of the politically excluded MB contributed to the 2011 revolution and whether it resulted in a permanent change in the PS, if any.

4.1 Manufacturing Industries and the Industrial Policy in Egypt

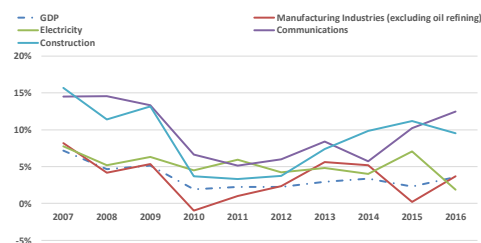
Egypt's economy is diversified among agriculture, mining, manufacturing and services sectors. Mining and related manufacturing sectors (oil refinement) constituted about 13.5% of GDP in Fiscal Year (FY) 2016/2017. On the other hand, all other manufacturing industries amounted to only 12.8%³. Figure 14 shows that most of the manufacturing activities are concentrated either in resource-based (59%) or low-tech industries such as food & beverage (17%). Literature stresses that even in industries with advanced technologies, such as the automotive industry, production is limited to low-tech components. Hence, the increasing share of medium- to high-tech exports has been associated with a decline in the prices of hydrocarbons after 2007 global financial crisis (figure 10) while competitiveness of Egyptian exports in lower-tech industries relies more on energy and water subsidies which significantly decreases the cost of production, rather than quality or high-tech components in high value-added goods (Loewe, 2013, p. 52).

Figure 11: Value added by sector (% of GDP)



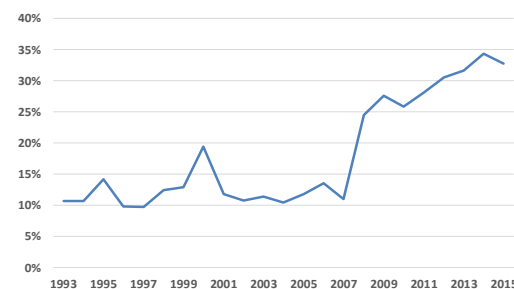
Source: World Bank DataBase, 2018

Figure 12: Fastest growing sectors in real GDP



Source: Central Bank of Egypt, 2018

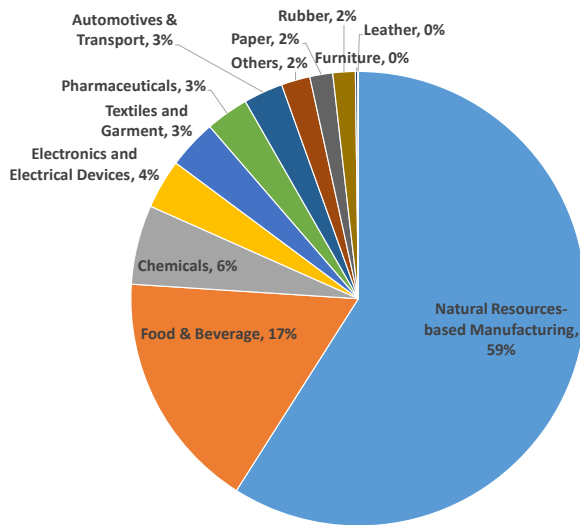
Figure 13: Medium and high-tech exports (% manufactured exports)



Source: World Bank DataBase, 2018

³[http://www.cbe.org.eg/_layouts/xlviewer.aspx?id=/Time%20Series%20Documents/GDP/GDP%20at%20factor%20cost%20\(current\)/GDP_factor%20cost_Current%20prices_Annual.xlsx&DefaultItemOpen=1](http://www.cbe.org.eg/_layouts/xlviewer.aspx?id=/Time%20Series%20Documents/GDP/GDP%20at%20factor%20cost%20(current)/GDP_factor%20cost_Current%20prices_Annual.xlsx&DefaultItemOpen=1)

Figure 14: Contribution of industries to manufacturing FY 2015/2016



Source: World Bank Development Indicators, 2018

4.2 Economic Rents and Governance Mechanisms

The new Egyptian cabinet formed in 2004 adopted neo-liberal financial and trade policies until 2011 and continued the privatization process of the public sector. Industrial policies were executed by three main institutions: The Ministry of Trade and Industry (MTI), Ministry of Investment (MOI) and the Social Fund for Development with the latter dedicated to financing small and medium enterprises (SMEs).

The MTI in 2006 set up a development strategy for the manufacturing industries targeting several institutional frameworks including facilitating access to finance and land and enhancing TT and innovation capacity of firms. The MTI strategy was put by a group of individuals with close relationship to the ruling coalition and were composed of top bureaucrats, academics and businessmen, all lying in supporting factions. In addition, the competition law was issued in 2005 but law enforcement was exclusively in the hands of the Prime Minister.

The MTI established twelve TT centers, mostly sector-specific, whose main mandate was to connect firms based on their technological needs with R&D institutions. The Industrial Modernization Center (IMC) was also established and had the most active role in enhancing large firms' capacities for R&D and innovation, in addition to providing technological support to local suppliers for exporting value chains. The IMC received heavy funding from the European Union (EU) (59% of its budget) over the five years before the revolution while the automotive sector benefitted extensively (Loewe, 2013).

On the other hand, the main mandate of the MOI, established with the new cabinet, was to attract FDI and manage free economic zones where firms enjoyed preferential rates of customs and taxes. The MOI worked on establishing transparency and accountability and reducing the extent of the institutional bureaucracy for foreign investors through clearer registration procedures and less red tape. Consequently, foreign capital inflow increased and customs tariffs were decreased. Protection against foreign investment in specific sectors such as production of steel, aluminum and fertilizers (energy-intensive industries) and engineering services, all falling within the construction sector industries.

Relevant to Khan's framework of PS, a review of the relevant laws on incentives to investors revealed that rents provided through incentives were highly fragmented among different industries (table 2), and mostly where foreign investors were involved. In the aftermath of 2011, foreign capital flew out of the country and foreign reserves dropped to critical levels pushing the economy to the verge of a currency crisis. Hence, the government's engagement with the IMF and foreign donor loans has maintained the former's orientation towards attracting FDI and pushing for enhancements in the investment climate for foreign investors which facilitated rent extraction by MNCs. Meanwhile, raising competitiveness of domestic industry through formal institutions continued to depend on fragmented strategies where each ministry established its own capacity and technology building agencies, rather than a unified and clear strategy for increasing the industry's value added. Consequently, rents came in general forms and were not tailored for industry-specific needs. Even industrial sectors that were given preferential treatment, such as the automotive, textiles and leather products, were not selected based on their potential of technological upgrade and hence acquiring a competitive advantage.

On the other hand, we also note that informal institutions existing within patron-client networks of ruling coalition and investors has shaped the performance of different industries. Earlier during the 90s, the rapid increase in population and the decline in rents created from hydrocarbons exports and slowly growing Suez Canal revenues and remittances made it difficult to sustain subsidies and employment levels in the oversized public sector. The privatization process allowed the coming back of business entrepreneurs. However, the strongest capitalists arose from the bureaucratic class who was offered rents through asymmetric access to information and bargain purchases of public sector through privatization process. More businessmen joined the National Democratic Party, the ruling party, after 2004 and the party became strongly supported by a growing base of capitalists. The newly appointed cabinet in 2004 was dominated by pro-liberalization technocratic individuals, including Ahmed Nazif, a businessman and a telecommunication engineer who supported the sector heavily pushing it to become the fastest growing sector in the economy (Loewe, 2013).

In a study by Abdel-Latif and Schmitz, (2010), three of the fastest growing/largest industries, food, Information and Computer Technology (ICT) and iron and cement (construction materials), enjoyed economic benefits from the government and maintained close relationships with the policy makers. The food industry is composed of a small number of investors with high entrepreneurial capabilities, including foreign investors, who maintain their power effectively by being fully represented in the chamber of food industry. Meanwhile, investors in the ICT sector were “*handpicked*” by the minister of communication through informal networks and provided necessary protection; (being excluded from the law of competition (Loewe, 2013). Indeed, the sector has been enjoying a strong growth since the last decade. The construction sector inputs, including iron and cement (being energy-intensive industries), have enjoyed heavily subsidized energy prices. Investors in the sector were among the strongest supporting factions of the ruling coalition during Mubarak’s presidency. Meanwhile, we find, for example, that the furniture industry was poorly represented by the chamber of furniture industry which involved only 10% of the producers who were closely related to the government officials and received exclusive economic benefits.

On the other hand and as mentioned earlier, the military rule has dominated politics in Egypt ever since 1952 and the army has been economically active through its businesses, mostly in production of consumer goods for domestic consumption. The army’s budget and the size of its economic production are not publicly disclosed, however some studies estimate the book value at around 200 billion USD between the 80s and 90s (Loewe, 2013, p. 24). Military economic production enjoys huge rents including exemption from taxes and access to cheap labour (soldiers in duty) (Hanieh, 2011).

Table 2: Examples of economic rents as allocated by the industrial policy

Economic Rent	Provided by	Provided to
- Quota-free access to US market	MOI/Qualifying Industrial Zones	Mostly textiles (clothes)/ mostly foreign investors
- Cheaper lands	MOI/Free Zones	50% exported production in all industries except energy-intensive projects
- Exemption from taxes and customs and import/export regulations		
- Capital import subsidies	IMC/MTI	Several industries dominated by automotive industry.
- Technical and financial assistance to increase productivity and technology component		
- 15% subsidy of exported value	MTI	Engineering, textiles, chemicals, and food,
- Reduced bureaucracy	MOI	FDI

Source: compiled by the author from laws and government strategies

The industrial policy in Egypt significantly lacks a governance mechanism through which performance-based allocation of rents is imposed. Implementing agencies are self-monitoring and report their activities to ministries under which they operate. For example, the IMC monitored the engaged firms based on investments, sales, exports and employment indicators. However, the IMC itself reported its activity to the MTI. Similarly, the MOI's monitored its main agency for attracting FDI (GAFI) by the number of attracted firms, exports of free zones and employment, while its monitoring Board of Directors is dominated by businessmen⁴. Hence, we deduct that the “**reciprocity principle**” is absent. The “**Reciprocal Control Mechanisms**” (RCMs), as Amsden (2003) puts it, are mechanisms by which the government monitors the performance of the firms through specific standards in return for the government's support. In the case of Egypt, rents in the form of allocated lands, for example, are not provided or evaluated based on firm's performance or efficiency while export subsidies are only provided ex-post and not to induce specific firms for raising their export capacity (Loewe, 2013).

4.3 Political Settlements Before and After 2011

In this section, we do not seek to give a full account of the events that took place before and after 2011 nor the causes behind them. Rather, we seek to shed some light on the changes in power distribution (i.e. PS) that accompanied these events, whether inducing or resulting from them.

Numerous factors have contributed to the spark of 2011 revolution. Clearly, socio-economic conditions have been deteriorating for a long time as poverty and inequality were on the rise. Whether there had been external actors involved in the course of events or not, we obviously note the rising political power of the MB⁵ before 2011 and their strong involvement in the revolution. Parliamentary elections in 2010 resulted in a clear exclusion of the MB that did not match their popularity, acquiring only a very low percentage of number of seats won, in contrast with the pro-regime alliances and individuals, represented by the NDP, who gained about 95% of the total number of seats in the parliament (Shehata, 2011). Political tension accumulated until just before the anticipated presidential elections, which were interrupted by 2011 revolution. The MB's explicit participation in the revolution came at a later stage, as the uprising proved strong, coherent, and persistent. In any case, the MB assumed leadership later as it was the most organized opposition group with a popular base. Following the fall of Mubarak's regime in February 2011, the MB's members organized themselves in a newly

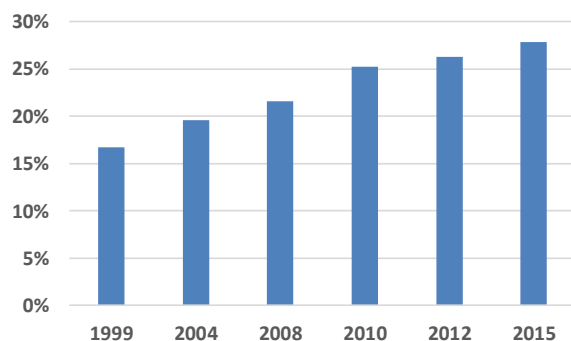
⁴ <http://www.gafi.gov.eg/English/AboutUs/Pages/default.aspx>

⁵ MB was established in 1928 by a young Egyptian man (Hassan El Banna), as a religious and social organization with the aim of reaching higher social and political justice as its central call. Although the MB was initiated as a social group, it evolved over time to be politically active, both formally through acknowledged political participation and informally through violent actions, in addition to owning a large economic capital and involvement in the business sector. For a more detailed historical account on the MB, see (Beinin, 2005).

formed political party (Freedom and Justice Party), by which they participated in the parliamentary and presidential elections, the latter taking place in 2012 and resulting in the MB's candidate (Mohamed Morsi) becoming the first Islamist President of Egypt. The MB started losing their popularity amid the government's controversial political and social decisions as well as unclear economic policies. One year later after the MB being in office, another uprising took place in 2013, resulting in the overthrow of the Islamist president while the MB's expulsion from power was followed by probably the heaviest security crackdown against its members, costing the group a huge loss in their financial and human resources (Létourneau, 2016). In 2014, El-Sisi, Minister of Defence and Military Production during Morsi's presidential period, was elected as President.

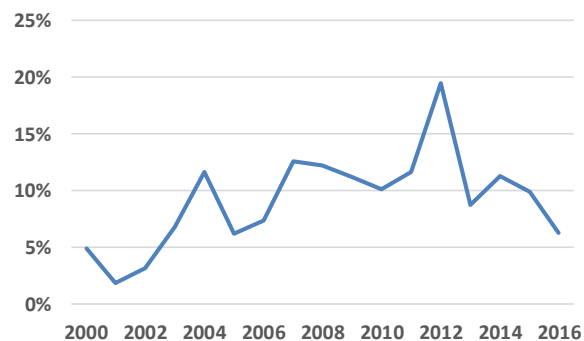
Following the economic slowdown and a period of chaotic politics, El-Sisi promised and managed to restore political order and economic growth over his four years in office. The new regime eradicated the MB's opposition and further constrained political liberties as several presidential candidates were eliminated from running the latest presidential elections in 2018. At the moment, opposition is clearly excluded and does not represent a real threat to regime. However, the rising cost of living due to the contractionary fiscal policies and continuous liberalization of prices may lead to some pressure or be threatening to the regime in the longer-term, (Ignatiev, 2017).

Figure 15: Poverty HC at National Poverty Line (% of population)



Source: World Bank DataBank, 2018

Figure 16: Inflation, GDP deflator (annual %)



Conclusion

The variation in the sectoral performance of the manufacturing industries in Egypt are better understood within the view of patron-client relationships between the capitalists and the ruling coalition. While some industries maintained strong growth before and after 2011, including construction materials, food and ICT (service) sectors, others exhibited slower growth patterns. We find that industries with stronger growth paths encompassed strong and mutual benefit relationships of political and economic support with the ruling coalition. Investors received economic rents in return of political

support for the regime, whether before 2011 revolution or after the end of the MB rule in 2013. Clearly, the PS remained unchanged after 2011 given the relatively quick elimination of the opposition groups, most notably the MB. On the other hand, growth did not necessarily reflect competitiveness or technological upgrade. According to Khan, as the supporting factions (investors of specific industries in this case) acquire enough power, they tend to weaken the state's capacity of enforcing governance mechanisms such that economic rents are maintained without meeting any required standards.

Figure 17: Political settlements and patron-client networks in Egypt according to Khan's framework

		HORIZONTAL DISTRIBUTION OF POWER: EXCLUDED FACTIONS	
		Weak	Strong
VERTICAL DISTRIBUTION OF POWER: LOWER LEVEL FACTIONS	Weak	Potential Developmental Coalition	Vulnerable Authoritarian Coalition (2011)
	Strong	Weak Dominant Party (Before and After 2011)	Competitive Clientelism

		TECHNOLOGICAL-ENTREPRENEURIAL CAPABILITIES	
		High	Low
HOLDING POWER OF PRODUCTIVE INVESTORS	High	High Capability and Powerfully Networked ICT, Food, Construction Materials, FDIs	Moderate to Low Capability and Powerfully Networked Energy, Automotive
	Low	High Capability but Politically Weak Furniture, Textiles	Moderate to Low Capability and Politically Weak SMEs in wide range of industries

Source: Author

Chapter 5: National System of Innovation and University-Industry Linkages in Egypt

The chapter is divided into two main sections: the first draws on the general characteristics of the Egyptian NSI while the second looks more closely on the UILs by presenting five cases of the TICOs which were recently established to induce domestic TT. We end with a brief conclusion then move to conclude on the thesis in chapter six.

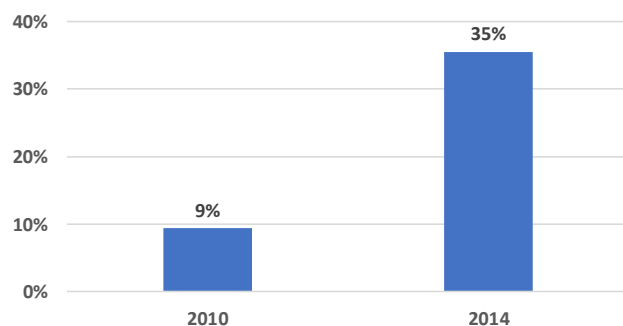
5. Characteristics of the Egyptian NSI

We begin our analysis of the Egyptian NSI with an overview on the innovation rates in the manufacturing sector based on the NISs conducted in 2010 and 2014. The 2010 NIS covers the period from 2008 until 2010, while the 2015 NIS covers the period (2012-2014). We then move to discuss two types of flows among the system's main actors: financial and knowledge flows.

5.1.1 Innovation Performance

The NISs reveal a leap in the innovation rates after 2011 revolution. Although the official figures are doubted by literature (Hanafi and Arvanitis, 2015) as well as one of the TICO interviewees, the latter revealed that the entrepreneurial activity witnessed a surge after 2011 due to the numerous supporting programs initiated by the government. A careful look at the most innovative sectors, we find that, aside from beverage industry, traditional and basic industries showed the least rates of innovation, while industries encompassing higher R&D activities were among the most innovative.

Figure 18: Percentage of innovative firms in the manufacturing sector



Source: UNESCO Institute Statistics (UIS), 2018

Figure 19: Percentage of innovative firms in each size class, 2014

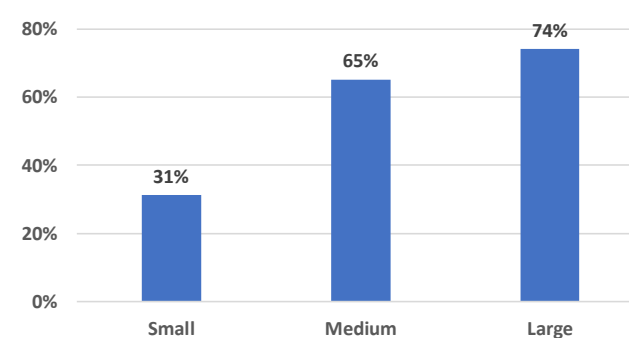
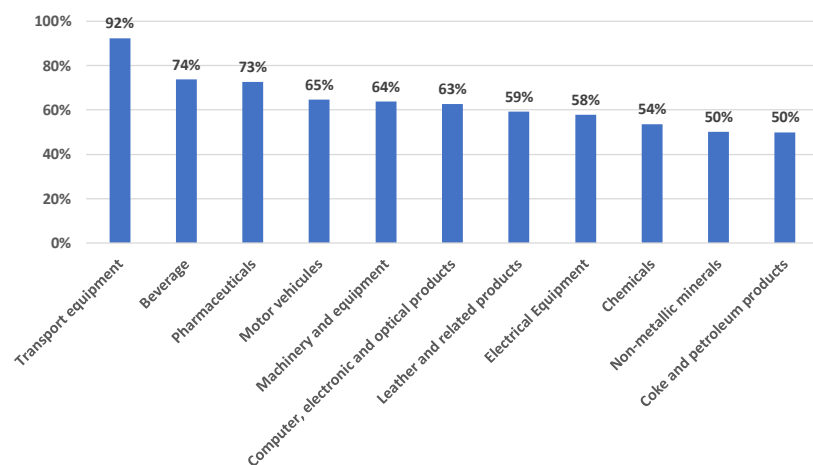
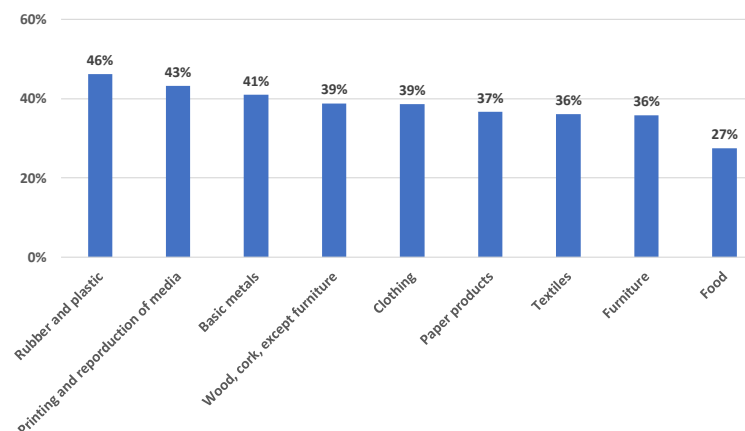


Figure 20: Most innovative sectors, 2014 - % of innovative firms



Source: UIS, 2018

Figure 21: Least innovative sectors, 2014 - % of innovative firms

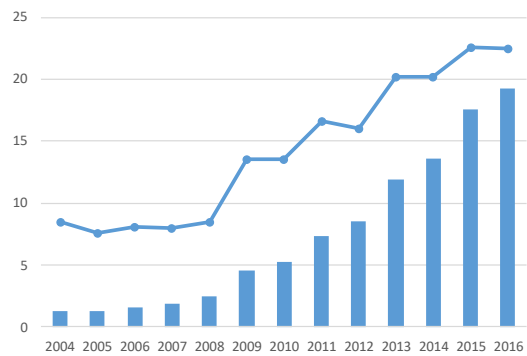


5.1.2 Financial and Knowledge flows

a. Financial Flows

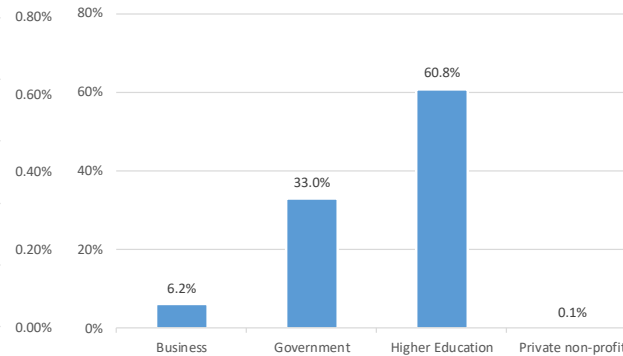
Gross expenditure on R&D (GERD) has been growing over the past decade rapidly since 2009. As the figures below show, the bulk of R&D expenditure comes from the government, with negligible amounts from business, higher education, non-profit organizations and abroad. However, we note that gathering and releasing macro statistics on R&D is quite a recent process. One of the interviewees mentioned that the leap detected in 2009 in GERD is due to the inclusion of Business Expenditure on R&D (BERD) which was not captured before. A specialized body, the Egyptian Science, Technology and Innovation Observatory (ESTIO), was only established by the government in 2014 to gather and publish data on STI in Egypt including the innovation surveys. Hence, we take into account that the government's agency capabilities to gather comprehensive and consistent data are still weak and therefore macro statistics on STI in Egypt do not fully reflect the sector's reality.

Figure 22: GERD (in billion EGP) and GERD to GDP



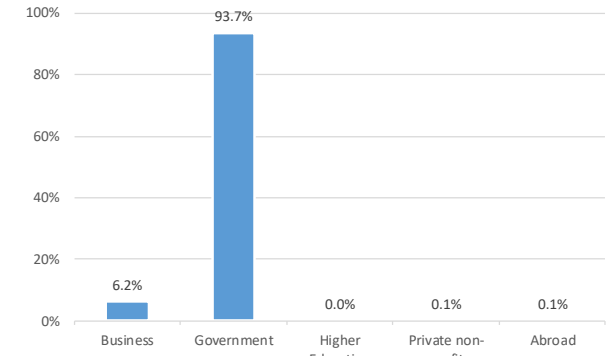
Source: UIS, 2018 and ESTIO, 2017

Figure 23: GERD by performance, 2015



Source: UIS, 2018

Figure 24: GERD by source of fund, 2015



Source: UIS, 2018

In order to interpret these statistics correctly, it is important to understand the R&D structure in Egypt. While the higher education system is dominated by public universities (in terms of number of researchers) whose budgets come from the government, we can understand why their contribution to R&D as a source of fund is negligible although they contribute 60.8% in terms of performance. On the other hand, public R&D institutes (which fall into the government category rather than higher education) perform about 33% of R&D.

The small figure of BERD might be due to difficulties in its measurement or the overall weakness in private R&D. One source of BERD is venture capital, which has no clear map in the literature. There are, though, some initiatives by the government that are implemented through the MOI to connect entrepreneurs with venture capital funds. These are usually dedicated to SMEs and mostly concentrated in the ICT sector. Venture capital funds however, do not engage in high-risk projects at early stages (Alaa El-Din et al., 2012). Bond et al. (2012) discuss the weak presence of venture capital in Egypt compared to some neighboring countries such as Lebanon and Tunisia. According to their study, researchers feel safer sticking to their low-pay government jobs than seeking risky investments from the private sector. They conclude, however, that the entrepreneurial and innovation activities have been on the rise after the revolution, in line with our interviewees. The same BERD figure found in both performance and as a source of fund indicates that financial and knowledge flows from the government to the private sector are particularly weak. Lastly, we doubt the very small figure in “abroad” category, given the strong presence of foreign funding and the role it played in inducing institutional changes (section 5.1.2) as per the literature and interviews.

b. Knowledge Flows

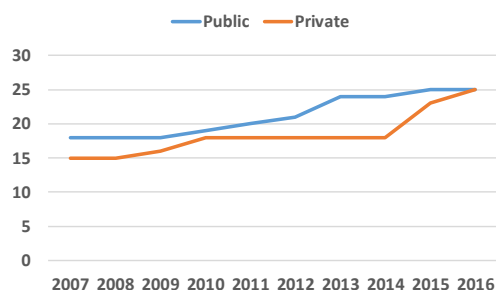
The higher education system in Egypt, the largest R&D performer, is comprised of 50 universities, equally distributed between public and private universities, in addition to a large number of technical institutes. The public universities are characterized by being large and old. The oldest is Al-Azhar University which dates back to 988 A.D. The national CU and the foreign AUC were established in the early 1900s. During the socialist regime of Nasser, several universities were established across the country due to the growth in enrollment rates and incoming foreign students from the region and Africa. In the 1990s, a new law was issued to allow the establishment of private universities to meet the increasing demand for higher education and the limited capacity of the public universities (Samy and ElShayeb, 2017). However, the private universities are much less oriented towards R&D and more towards education (STI-EGY 2030, 2015, p. 27), in addition to being selective of students from higher social and income groups and contributing to social segregation (Hanafi and Arvanitis, 2015).

The public R&D centers are the second largest R&D performer in the economy. Egypt has a large number of public R&D centers in different scientific disciplines. About 13 of them are affiliated to the Ministry of Higher Education and Scientific Research (MOHESR) while there are more than 200 centers affiliated to other ministries and more than 100 falling under the universities (Hanafi and Arvanitis, 2015, p. 48). The absent coordination among the public R&D centers that fall under the MOHESR and those that fall under other ministries is currently debated among the policy makers (Bahgat, 2016, p. 90). According to the STDF interviewee, the MOHESR is supervising the R&D carried out at their affiliated centers and takes the responsibility of aligning their R&D activities with the identified national priority sectors. However, the MOHESR argues that, in case of R&D centers affiliated to other ministries, their activities should be coordinated and aligned with the national strategy, which is not the case at the moment.

A similar distribution of funds can be observed in the large number of researchers who are heavily concentrated in the public universities and R&D centers. Full-time Equivalent (FTE) of researchers in the public R&D centers is almost fully dedicated to R&D activities (98.24% of Head Count (HC)), while researchers in the higher education sector contribute by only 36.7% of their time to R&D (ESTIO, 2017). One study points to the potential exaggeration in the last figure, given that the actual time dedicated to R&D in the universities does not exceed 10% of the total time for academic jobs (Hanafi and Arvanitis, 2015, p. 143). Researchers' duties, including university staff, are either teaching or R&D activities. Around 40% only of all researchers are dedicated to R&D while the rest carry out

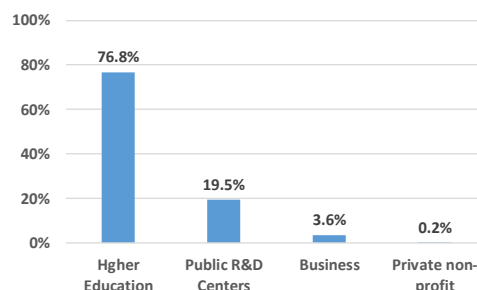
teaching activities (STI-EGY 2030, 2015, p. 27). The largest two R&D centers, the NRC and the Agriculture Research Center (ARC), jointly hired about 63.8% of the total number of researchers (HC) in 2016.

Figure 25: Number of public and private universities



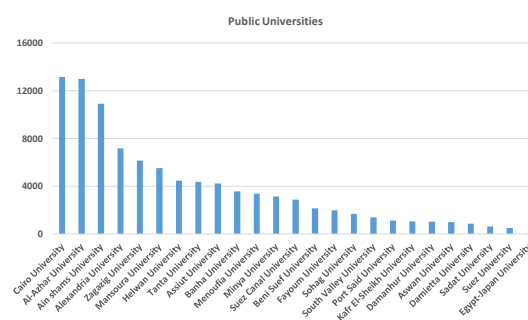
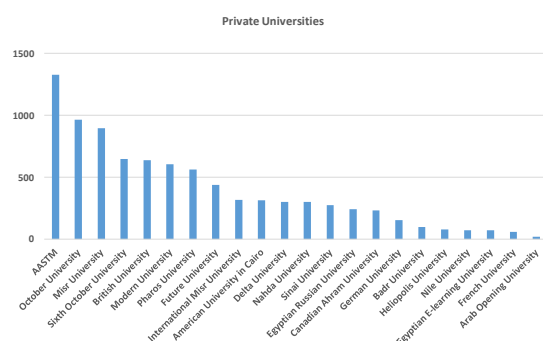
Source: ESTIO, 2014 and ESTIO, 2017

Figure 26: Researchers (HC) by sector, 2016



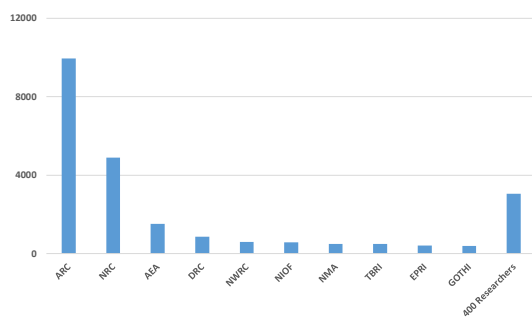
Source: ESTIO, 2017

Figure 27: Distribution of Researchers in Public and Private Universities, 2016



Source: ESTIO, 2017

Figure 28: Distribution of researchers in public R&D centers (HC), 2016



Source: ESTIO, 2017

Input and output of the NSI do not necessarily match when it comes to the valorization of knowledge and R&D activities. For example, universities and public R&D centers are low-performers in terms of the numbers of granted patents. On the contrary, business sector is much more active in patent filing and has the largest share (81%) of the granted patents at the Egyptian Patent Office (EPO). In the

next section, we show how the IPR policy and practices weaken the university's registration of patents based on insights drawn from the interviewees.

Figure 29: Granted Patents, EPO, 2016

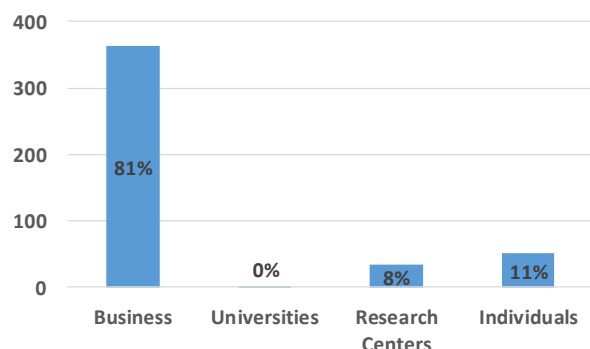
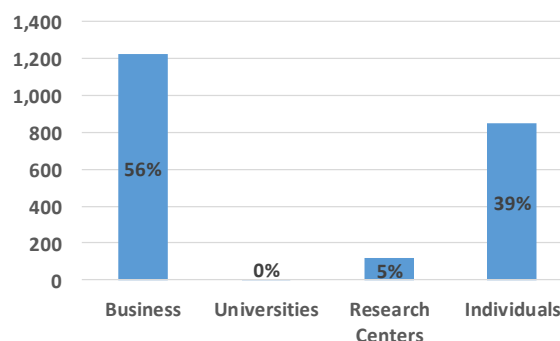
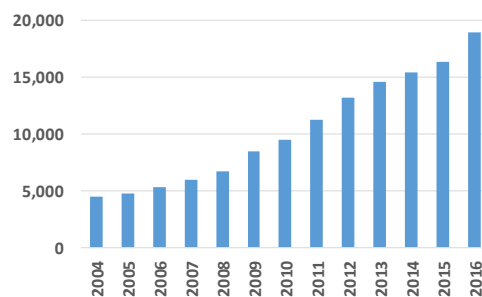


Figure 30: Patent applications, EPO, 2016

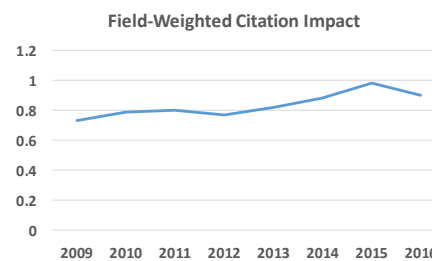


Source: ESTIO, 2017

The strong growth in the number of international publications occurred after 2007 structural change in the governance system (Hanafi and Arvanitis, 2015, p. 111), as shall be illustrated later. Impact measured through citations remains low, but field weighted citation impact, which compares the output (publication) citation to the global average, is on the rise, approaching 1 (equals to expected global average) (ESTIO, 2017). We also find that productivity, as measured by publication per researcher, varies among the universities and does not correspond to the university size in terms of number of researchers or received funds. In a study done by Hanafi and Arvanitis (2015) to analyze the variation in a large set of STI indicators across the Arab countries, the authors conclude that the involvement of universities in R&D does not depend on their sizes, but rather on their internal policies. We find this conclusion corresponding to the fact that the largest universities in terms of number of researchers and received funding are not necessarily the most productive (table 3). For example, the largest two universities in Egypt, CU and Al-Azhar university, have much less publications per researcher compared to other smaller universities. They are mostly focused on teaching and have little research activity that is concentrated in very specific departments while the promotion system does not incentivize research activities.

Figure 31: Publications in international periodicals

Source: ESTIO, 2014 and 2017

Figure 32: Field-Weighted Citation Impact

Source: ESTIO, 2017

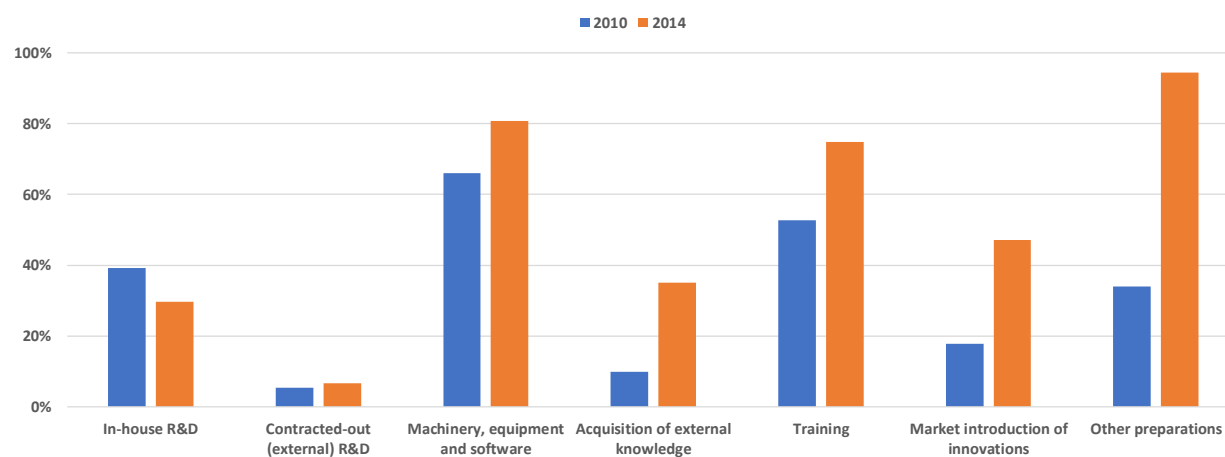
Table 3: Publication per researcher in government universities with the largest number of publications

UNIVERSITY	NUMBER OF INTERNATIONAL PUBLICATIONS	% OF TOTAL NUMBER OF INTERNATIONAL PUBLICATIONS IN ALL UNIVERSITIES	PUBLICATION PER RESEARCHER
HELWAN UNIVERSITY	612	3.2%	0.57
MANSOURA UNIVERSITY	1529	8.1%	0.45
CAIRO UNIVERSITY	3580	19.0%	0.27
ASSIUT UNIVERSITY	977	5.2%	0.23
AIN SHAMS UNIVERSITY	2082	11.0%	0.19
TANTA UNIVERSITY	806	4.3%	0.18
ZAGAZIG UNIVERSITY	1082	5.7%	0.17
ALEXANDRIA UNIVERSITY	1594	8.4%	0.12
AL-AZHAR UNIVERSITY	863	4.6%	0.12

Source: ESTIO, 2017

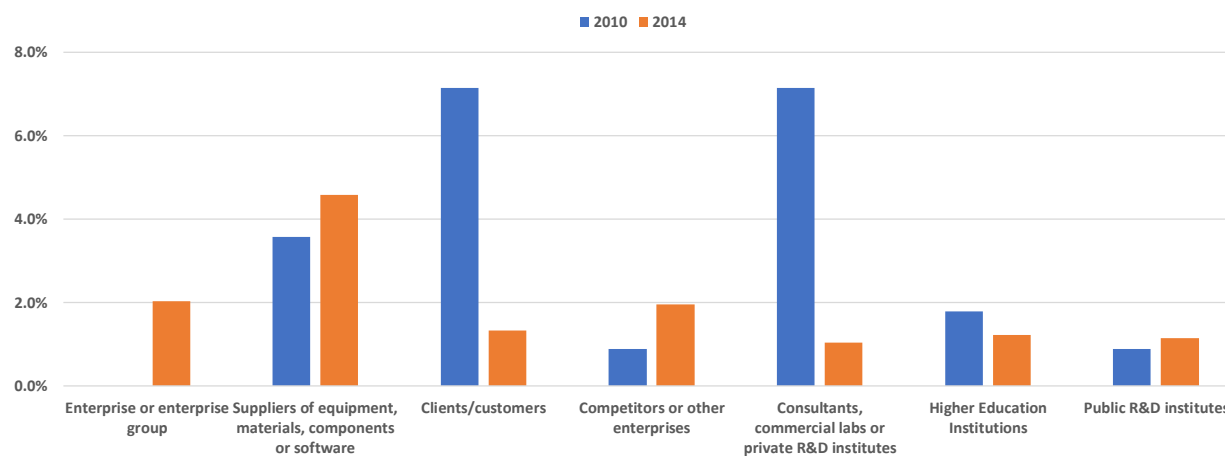
Lastly, innovation statistics demonstrate the weak linkages and knowledge flows between academia and industry, represented by low rates of external R&D compared to in-house R&D, in addition to the very low rates of cooperation with higher education and public research institutions. Lack of supporting innovation schemes to the firms or their unawareness of the existing ones are decisive factors in UILs. On the other hand, private firms lack interest in getting involved with the state's organizations, (i.e. public universities or R&D centers). Even more, there is a low level of confidence in the government's supporting schemes (Hanafi and Arvanitis, 2015, p. 160), a conclusion that was reiterated by the interviewees. We dedicate section 5.2 to the UILs and the impact on knowledge valorization and TT.

Figure 33: Sources of Information - % of manufacturing firms



Source: UIS, 2018

Figure 34: Partners of innovation activities - % of manufacturing firms



Source: UIS, 2018

5.1.2 R&D Governance Structure and Technology Transfer

The governance system of the Egyptian NSI is old and is complicated to depict due to the large number of institutions involved, their unclear governance relationships and the frequently changing structure. We already hinted to the broader institutional framework of innovation in the last chapter as we discussed the industrial policy in Egypt. Hence, in this section, we focus on the formal R&D institutions falling under the MOHESR. An interview with an economic researcher at the STDF, the main government funding body, was conducted to enhance and verify our understanding of the system's governance structure.

To begin with, the Higher Council for Science and Technology (HCST), established in 2006 under the direct supervision of the Prime Minister, was mandated to develop a national strategy for the STI in Egypt and provide guidance to the MOHESR with regard to R&D. The council was constituted of the most prominent Egyptian science figures in addition to representatives of the powerful political and economic entities in Egypt. However, our interviewee revealed that the HCST was only convened about twice before 2011 and became non-functioning after.

Meanwhile, the EU provided an initial grant in two phases to the ministry through the Research Development and Innovation (RDI) programme. The first phase took place before the revolution with a total amount of 11 million EUR, while the second phase came in 2011 and represented a continuation to the first phase based on the latter's results with a funding of about 20 million EUR, out of which 12 million EUR are dedicated to an innovation fund focusing on national and European priority sectors⁶.

The RDI program had a significant impact on the governance structure of the R&D in Egypt. According to Hanafi and Arvanitis, (2015, p. 79), the program *"appeared as a larger framework in which national research could be both embedded and obtain additional funding"*. In the same year, a new governance structure emerged, and one vital institution, the ASRT, was restructured to alleviate the pressure of the huge non-performing R&D administrative body, while the STDF was established to be the independent official R&D funding agency of the government, according to the STDF interviewee. Before creating the STDF, the ASRT carried out the funding process of the R&D projects and assumed the role of a technical thinktank for different scientific and research fields. The STDF strategy was mandated by the HCST, although it currently follows the MOHESR.

The relationship between the ASRT and the STDF, as told by our interviewee, is an interesting case and reflects the persistent power balances between the old (ASRT) and the new (STDF) institutions. Although the R&D funding function was fully assumed by the STDF, the ASRT maintained its political

⁶ <http://www.rdi.eg.net/AboutRDI/Background/Pages/default.aspx>

power by funding R&D projects, marketed by the latter as “national campaigns” for strategic needs, such as food security or treatment of local epidemics, rather than R&D projects. The interviewee stressed that the restructuring process in 2007 did not involve any changes in the formal mandates of the presidential decree by which the ASRT was established. Such a decree gives the ASRT the authority of funding R&D projects. However, the establishment of the STDF was supposed to be reflected on the ASRT role as an advisory and coordinating body. *“The political power maintained by the ASRT management by participating in such campaigns may not have otherwise accrued from funding R&D projects that are not necessarily acknowledged in the political sphere, though they might be of high scientific value-added”*, the interviewee said. Hence, whenever the ASRT seeks coordination with the STDF for the funded projects, the former usually informs the latter by sending them “a list of funded campaigns”.

On the other hand, the STDF receives its budget for R&D projects from the MOHESR. It provides funding to all R&D activities in Egypt, after studying the requested funds by the researcher or the institution. The projects can be performed by any R&D actor, whether public or private, and not necessarily the ones affiliated to the MOHESR. Usually, the R&D performers have access to funds from other ministries as well. Since the new structure was set in 2007, there has been a shift towards a more competitive distribution of funds to the research projects, whether national ones or in collaboration with abroad. The new governance mechanism, influenced by the bilateral agreements with the EU as mentioned earlier, attracted the researchers due to the clearer tender and funding procedures (Hanafi and Arvanitis, 2015, p. 146). However, coordination of R&D funding remains an issue.

The 2014 constitutional amendment and the 2015 National Strategy for STI

In a constitutional amendment in 2014, the government set a new target mandate for the Gross Expenditure on R&D (GERD) at 1% of GDP to be reached by FY 2016/2017, which has been already missed, and to increase the allocated rate gradually to meet international rates⁷ (ESTIO, 2016). The new budget of FY 2018/2019 was being planned at the parliament, at the time of the dissertations’ writing. According to the STDF researcher, the Ministry of Finance (MOF) faces a strong pressure from the MOHESR and the other technical ministries for increased R&D allowances. While the MOF should meet the constitutional requirement of achieving GERD of 1% of GDP or even a close percentage to be approved by the Members of Parliament, the budgets are constantly losing their values due to the strong devaluation of the Egyptian Pound (EGP), which lost about 60% of its value since 2015 (Central

⁷ OECD countries had a GERD to GDP ratio of 2.4% in 2015 (OECD Database, 2017).

Bank of Egypt Statistics, 2018⁸). The MOF is committed to bringing down the fiscal deficit, which soared to 13.3% of GDP in Fiscal Year 2012/2013 (10.9% of GDP in FY 2016), and the gross government debt which reached 96.9% of GDP in FY 2015/2016 (IMF, 2018). Hence, the MOF may not provide the STDF its requested budget since R&D expenditure (included in the 1% of GDP constitutional mandate) might be allocated to non-MOHESR R&D actors. Moreover, the allocated budgets do not necessarily reflect performance-based governance.

Although the need for a national strategy for STI with defined priorities, projects and plans was pronounced by the government since 2006, the strategy was only issued about a decade later in 2015. The strategy acknowledged several weaknesses in the STI sector, among which are the weak R&D output such as the number of patents, the absence of a monitoring and evaluation system for researchers and R&D institutions as well as the presence of policy and institutional obstacles, weak collaboration with abroad, unclear R&D priority areas, uncoordinated funding among different financing institutions, and finally the threat of increased competitiveness from abroad due to the trade liberalization policies (STI-EGY 2030, 2015, pp. 27–30). Hence, the national strategy focused on two dimensions: (a) creation of a pro-innovation environment, by addressing STI policies, investment and international collaboration among other elements and (b) supporting knowledge production and transfer in all sectors. The MOHESR, in coordination with the other concerned ministries, is currently working on refining the national strategy to identify the actual priorities. The MOHESR is contacting the other ministries to update and match the previously-identified sectors, projects, and priorities in the strategy to match the current priorities of each ministry, which better aligns the strategy with the national priorities in the industry and other sectors (STDF interview).

Technology Transfer and University-Industry Linkages

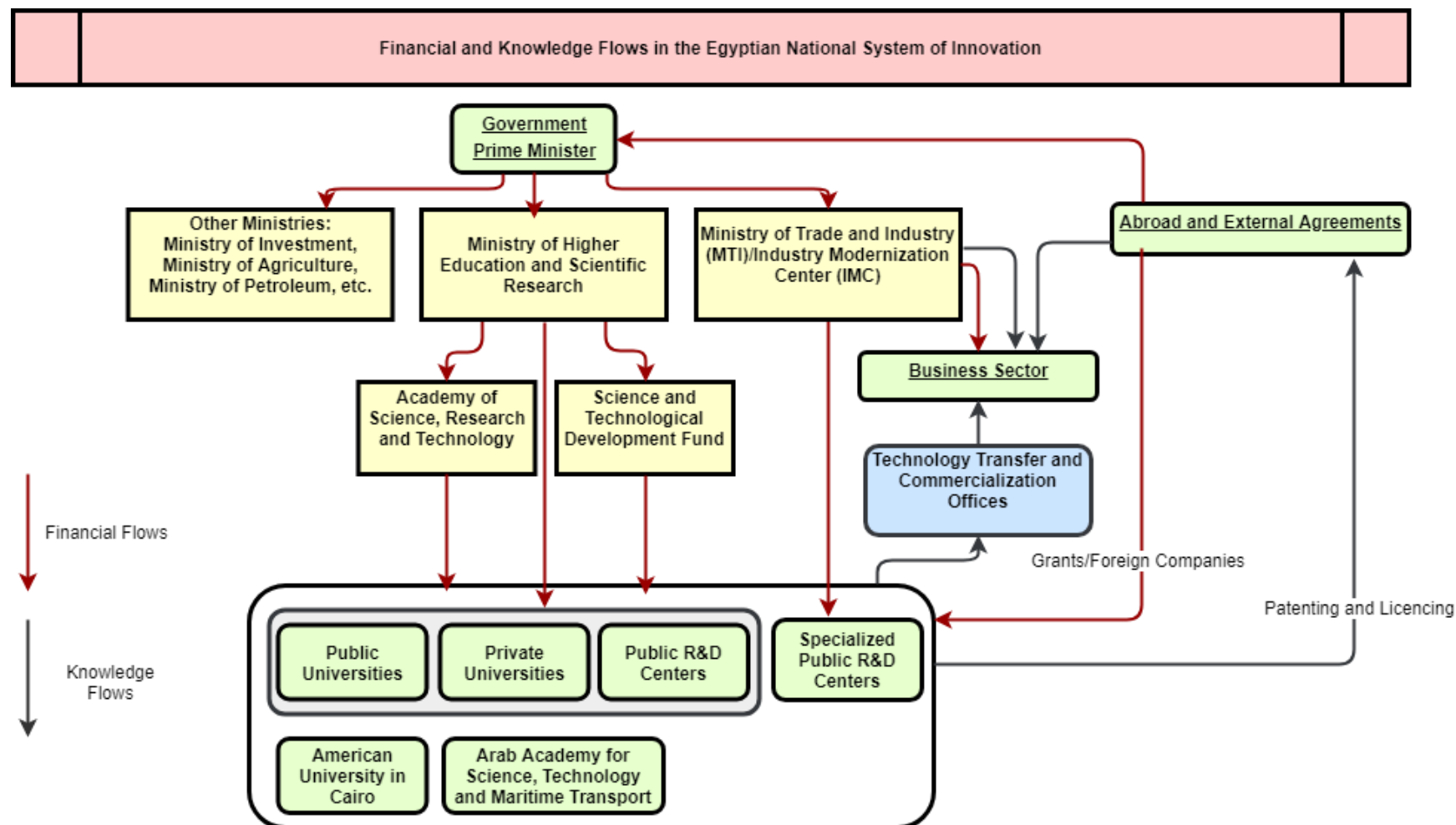
The SRTA-City, formerly known as Mubarak City of Science and Technology (MUSCAT), was established in 1991 as a science park, with the aim of serving the R&D requirements of the industrial region where it is situated. The region encompasses about 40% of the Egyptian industrial activities (Abdel-Fattah et al., 2013). According to Chalony and Moisseron (2010), it received strong financial and capital support (including advanced equipment and machinery) from the government in addition to being provided with well-trained researchers. Although it proved high productivity in terms of international scientific publications, it did not manage to create linkages with the industry. It was concluded by Hanafi and Arvanitis (2015, p. 48) that it has been acting as an academic R&D center, not

⁸ <http://www.cbe.org.eg/en/EconomicResearch/Statistics/Pages/ExchangeRateshistorical.aspx>

as a center dedicated to research in relation with industry, even though the main domains of research (mainly biotechnology and computer science) could have been of interest to the industry.

Meanwhile, establishment of the TICOs at the universities and research centers was a new initiative by the EU before 2011 and started with only offices in four universities. Although we shall dedicate the next section to understanding the newly evolving UILs and in particular through the TICOs, it is important to mention here that the EU initiative was expanded by the government after 2011 to establish 35 TICOs all over the country as a result of a perceived success of the EU project, according to one interview.

Figure 35: Financial and knowledge flows in the Egyptian National System of Innovation



Source: Author

5.2 University-Industry Linkages

In this section, we discuss TT from university to industry and the patterns of such collaboration. More specifically, we conducted semi-structured interviews with officials from five TICOs whose main function is linking their institutions R&D output with the industries. The offices differed in their names according to their functions. However, for easiness of discussion, we stick to the (TICO) acronym and refer to different functions within the text as needed.

5.2.1 Establishment of TICOs

Available institutional reports and interviews differ as to the exact beginning of TICOs in terms of number of offices and their funding. However, we may conclude that about four TICOs were established between 2008 and 2010, including the ones in the CU, the AUC and ALEXU, with an initial funding from the EU project “TEMPUS – Enterprise-University Partnership” (United Nations Economic and Social Commission for Western Asia (ESCWA), 2017, p. 25). The ALEXU respondent claims that their first office, named Grants, Innovation & Technology Transfer Center (GITEC), was selected by the ASRT as the best TICO in Egypt in 2013 and constituted the model for establishing the other 35 offices, funded by the ASRT. An approximate budget of 700,000 EGP was provided for each office over the period of two years (2014-2016) to establish TICOs in universities and R&D centers in the first phase. The second phase (2016-2018) encompassed funding extension for 20 offices with a total grant of 500,000 EGP for each⁹.

Among the first established offices we contacted were the ones in CU, ALEXU, AUC, while among the late comers we contacted were the NU and the NRC, the second largest public R&D center in terms of the number of researchers and the largest recipient of government funding (STI-EGY 2030, 2015, p. 24).

5.2.2 Model of Operations and Mandated Functions

The interviews revealed that the operational models differ among TICOs established before 2011 with foreign funding and those established after 2011 by the ASRT. In this section, we refer to the majority of TICOs which were established after 2011. In the consequent sub-sections, we discuss differences among TICOs according to their funding, IPR activity and approach to industry.

In each TICO, there are three separate offices (with a maximum of 2 employees), each with a different function: (a) TTO has the main function of establishing linkages between academia and business, (b) Technology Innovation Support Center (TISC) involved in registration of IPRs and (c) Grant

⁹ <http://www.asrt.sci.eg/images/tico/1e.pdf>

and International Cooperation Office (GICO), responsible for helping researchers find and acquire grants for their research projects.

The NRC respondent revealed that the first phase of establishing TICOs was intended for constructing a database of all R&D projects which were carried out at the NRC back then and which covered 150 different R&D specialized areas, corresponding to the same number of R&D departments at the NRC. The database was then filtered to focus on applied R&D that could be matched with the industrial needs. The database was also useful in spotting research projects that had IP potential and consequently were registered. The NRC depends on holding permanent and temporary exhibitions of prototypes and patents produced by the researchers at the NRC and in other geographical areas to attract the private sector. Similarly, TT activities at the NU started by a scouting activity to understand the researchers' capabilities, their sources of funding and their current industrial interests as well as the R&D status quo at the university. Consequently, the office contacted the business sector, seeking collaboration opportunities based on the survey findings.

5.2.3 Sources of Funding

Sufficient and sustainable funding is a persistent issue for TT. On one side, TICOs are not assigned a separate budget from their mother institutions (universities or R&D centers). According to CU respondent, the main funding comes from the ASRT and is deemed insufficient for supporting its activities. This acts as a disincentive when it comes to IPR as shall be discussed in the coming sub-section. The NRC respondent confirmed that after two years of the ASRT funding, the TICO did not achieve sustainable revenue from its activities. On the other hand, the TICO does not have its own financial autonomy as TICO's funding is disbursed by the NRC financial department which leads to an additional bureaucratic step. This was also confirmed by ALEXU respondent who mentioned that autonomy of the university and TICOs is very low and that any required disbursement of funds by the office from the university must also be approved by the MOF. Even more, the respondent mentioned that he, as the manager, avoids the government funding due to the enormous bureaucratic issues involved in such funding while there is no time commitment from the government side for a clear and consistent payment schedule which rather complicates the R&D project and its feasibility. Interestingly, bureaucracy among government agencies was among the barriers that STDF interviewee mentioned as the latter lacked full autonomy in disbursing its own funds from the MOF.

The NRC respondent estimated that R&D projects aimed at inducing collaboration with industry and financed through TICO receive very low funding, costing between 30-40k EGP per each project; approximately 1500 Euro. The ALEXU respondent reiterated that the initial funding received from

the ASRT was a one-off budget and might not be sustainable at later stages. The ALEXU TICO, which was established by an external grant, continues to highly depend on foreign grants and funding for inducing collaboration with industry, *“given the negligible funding from the government”* (ALEXU interview). According to the respondent, the TICO is expected to become self-sustaining or receive funding from its university. However, by the time of interview, the respondent estimated that 80% of the TICO’s funding comes from foreign sources whether the private sector or grant agencies. Foreign funding has been also essential for the same TICO in raising the capacity of its personnel in the fields of IPR and TT with the help of a USAID grant. The respondent explained that this has been a crucial phase, *“perhaps more important than the institutional establishment of the TICOs”*, given the absence of the IPR culture and the weak technical capabilities for evaluation of new technologies by TICO’s personnel. Interviews with the newer TICOs showed that they were less active in attracting foreign grants for financing R&D projects. For example, the NU office was involved in an EU-funded project for entrepreneurship. However, it was more related to capacity building prior to the initiation of the TICO activities. The NU is a young university (established about 10 years ago) with very focused educational and research activities in engineering and business. By the time we conducted our interview, the TICO activities were suspended until the renewal of the ASRT grant. The NU encompasses disciplines in technology management and business administration, and therefore it contributed in the establishment of the other TICOs by providing training to the TICOs personnel, including professors, in technology management. The university has been supporting previous nation-wide entrepreneurship initiatives in other universities.

Other sources of domestic funding are available but are not statistically clear. As we have seen in the previous section, contribution of private non-profit sector to GERD is very small (0.1%). CU interviewee mentioned that their TICO was the only one that managed to attract external funding from the NGO “Banque Misr Foundation”, an independent NGO founded in 2007 and receives a share of the annual profits of the Egyptian public-sector bank “Banque Misr”, for providing financial support to scientific research and universities, among other community development activities¹⁰. Although we did not verify such a piece of information from other TICOs, but no NGOs were mentioned in the other interviews as a significant financial partner. The interviewee proposed that the absent role of the banking system in financing R&D is due to the long-time horizon of R&D funding and the weaknesses in relevant legislations, such as the IPR policies, which also keeps the private R&D low.

5.2.4 Intellectual Property Rights

¹⁰ <http://www.banquemisr.com/en/banque-misr-foundation>

Encouraging the registration of IPRs is one of the main mandates of TICOs in Egypt. ALEXU TICO has helped researchers with the registration of their IPRs. An initial survey done by the office revealed the very low number of patents registered by the name of ALEXU, while most researchers tend to register individually. Such a tendency was mainly due to the absence of the IP culture among the researchers (ALEXU interview), but more importantly the absence of a clear IPR policy at the universities until 2011. Despite the issuance of the Law on Protection of Intellectual Property Rights since 2002, there are only eight universities listed on the database of IPR policies of universities and research institutions page on the World Intellectual Property Organization (WIPO) website¹¹ Out of these eight universities, only the AUC had a clear policy with listed cash royalties accruing to the inventors, ranging from 70% to 33% of the net revenues based on different income segments¹². However, the AUC is an exceptional case as a foreign university that is not governed by the law organizing domestic universities in Egypt. The AUC interviewee revealed that it is very rare to register the university's IPR at the EPO. Aside from facing bureaucracy, the current IPR law gives the right of any financial proceedings from the IPR to the financing agency. Hence, the ASRT, for example, keeps 85-98% of the income accruing from IPRs of R&D projects financed by the academy, which represents a huge disincentive to the researcher. In this case, it is common that researchers register the IPR as individuals given the weak accountability system at the university. This, in turn represents another disincentive to the industry in collaborating with researchers whose IPRs are prone to potential legal conflicts with the university in the future. The ALEXU interviewee suggests that such an IPR policy might be due to the perception of the government that such funding comes from public money that belongs to the taxpayers and therefore ownership of the resulting revenues should remain in the hands of the government.

Currently, researchers from the ALEXU or outside, and within its geographical area, approach the office with their results while the office plays a crucial role in the registration process, which sometimes results in a successful IPR registration or may end by no-registration in case of the pre-existence of similar results/inventions. Other interviewees believe that TICOs' role in driving IPRs is still in an early phase of disseminating the IPR culture among the researchers and getting them trained on the steps required for IPR registration (NRC interview).

5.2.5 Collaboration with Industry

During the interviews, respondents revealed that valorization of academic knowledge (extracting its economic value) through the TICOs take place through either one of two ways: (a)

¹¹ http://www.wipo.int/about-ip/en/universities_research/ip_policies/search.jsp?territory_code=EG

¹² <http://schools.aucegypt.edu/about/Policies/Documents/IntellectualPropertyPolicy2014.pdf>

marketing the R&D output of a research project to the private sector, or (b) assisting the researchers in establishing their own start-up based on their output. No respondents mentioned any case where collaborations were initiated by the industry to meet their R&D needs.

Compiling a database of the current and previous R&D projects at the R&D institutions in the first phase of TICO's establishment was deemed by all respondents as an essential step toward approaching different industries according to their needs and potentials for new technologies or technology upgrade. However, in three out of the five cases, the respondents confirmed that it is very likely for the domestic industries to reject collaboration with R&D institutions. Two main reasons for this rejection were mentioned. First, domestic investor was considered as risk-averse compared to their foreign peers (ALEXU and AUC interviews). Costly R&D is deemed unessential by the domestic industry in the absence of competition among producers. With unsaturated domestic market, products with low quality still get sold at the market at profitable prices without incentivizing producers to spend on enhancing quality (NRC interview). Second, mistrust of private sector in R&D institutions and government agencies in general was reiterated in three interviews. Whether the private sector is sought after by the TICO's to finance R&D with potential economic value for the firms or for selling researchers' innovations, ambiguity of IPR policies and weak rule of law were among the most repeated causes of mistrust. Consequently, TICO's may resort to foreign firms abroad or those with domestic affiliations. In CU, AUC and ALEXU, TICO's successfully market innovations to foreign firms abroad and in the NU, the TICO initiated collaboration with at least three joint ventures in Egypt. Although we do not have exact figures on the share of foreign collaborations where TICO's were involved, respondents referred to their significant contribution to the total activity of the TICO's. The ALEXU respondent acknowledged that mistrust is understandable, and their TICO was working on building this trust over time. For this purpose, the TICO approaches the industry by offering training or consultancies without fees and through funding from European or American grant agencies. Such an approach was perceived by the respondent to effectively increase trust at the industry's side over time as the industrial partners gradually realize the value-added that academia can bring to firms by building up their technical capabilities.

In case of creating start-ups, the small TICO at CU initiated the "Cairo University Technology Transfer Competition" with the aim of inducing TT by assisting researchers with innovative ideas in establishing their own start-ups. The TICO provided the required training for all invited candidates (competitors) to develop their own ideas into a project and assisted in proposal writing while having preliminary agreements with foreign firms abroad as potential buyers of the innovations. Creation of

university spin-offs or separate start-ups face institutional obstacles. The CU interviewee referred to a significant institutional hurdle when it comes to the creation of spin-offs due to the article number 104 “Law no. 49 for 1972 – Regulation of Universities”. This article prohibits a university professor from working or participating in industrial or services sectors; *“perceived as lowering the esteem associated with professorship”*, according to the respondent who believed that such *“an article stems back from an older law where working in trade is acknowledged to be associated with a lower social status”*. The same law allows researchers, only on exceptional basis subject to the approval of the faculty’s council and university’s president, to temporarily work in industry, provide technical consultations, or perform TT (article no. 88, Law no. 49 for 1972). This is a clear example showing how formal and informal institutions intertwine together to limit the power of the university system as the governing law prohibits the university from investing in commercial or industrial activities (CU interview). While this law persisted for more than forty years, a new law (Law no. 23 for 2018 – Incentives to Science, Technology and Innovation) has been issued in March 2018 which allows the R&D institutions and researchers to establish spin-offs or technological incubators with the aim of valorizing all forms of R&D output. The interviewees expressed both hopes and doubts about the law. The NRC interviewee explained that the law shall be useful in cases where private sector has not welcomed the adoption of new technologies or innovations presented by the R&D institution. Meanwhile, the AUC interviewee (whose university does not necessarily benefit from the law, being a foreign university and has already been active in establishing start-ups) expressed doubts regarding the monitoring of firm capital by public R&D institutions.

When asked about the national strategy and whether it reflected on TICOs’ activities by being assigned priority sectors, all respondents replied negatively and some of them even expressed their pessimism and doubts about the strategy’s practicality, given the absence of R&D culture and the persistent bureaucracy. ALEXU respondent acknowledged that the strategy has not been effective since the action plan does not enable the actors to perform their functions autonomously due to the previously-mentioned institutional hurdles. Aside from the strategy, he confirmed that the government’s initiatives for technology production and transfer initiatives, which fall under different ministries, vary in their performance and importance. Some of them have been successful but remain limited in their scale.

Although the national strategy does not dictate the priority sectors, researchers at R&D centers are being directed towards more applied research that is relevant to the industrial sector. In that scope, the ASRT projects are becoming more focused on developing domestic technology and enhancing TT, in

addition to building up the researchers' skills in estimating the costs of production by industry in order to validate the economic feasibility of their research products (NRC interview). Respondents revealed that medical and pharmaceutical sectors dominate the public R&D. However, one interviewee emphasized that legislations are especially burdening in these two sectors since the required experimental and commercial permits take too long and face heavy bureaucracy to be issued (CU interview). Engineering comes second with a focus on ICT and renewable energy sectors. The former receives a strong support from the government and has been in a boom since 2007 while the latter has become a priority after the energy crisis that occurred in the aftermath of 2011 revolution (ALEXU interview), as elaborated in chapter 4. Most of the NU R&D activities fall within the engineering disciplines, given the nature of the university as mentioned before. Successful collaborations are not numerous but included the automotive sector where a team of researchers became accommodated within the production line of the company to solve technical problems facing the production line as well as a project for technological deepening of domestically manufactured home appliances. For lower-tech industries, food and textiles were among the most dynamic and R&D promising (NRC, ALEXU), in line with their relative shares in the manufacturing sector (chapter 4). The NRC respondent, as a TICO personnel and a researcher in the textiles sector, was commissioned for conducting a project by the ASRT to introduce R&D culture at the domestic textiles factories. The respondent referred to the critical need for the NRC to establish firms which would enable the center to fill in the gaps in the value chain of some industries where private sector is not willing to do. An example of a chemical product that came out as an R&D output but was not successfully marketed to the industry. However, the industry expressed willingness to use it as an input. In this case, the NRC may establish its own factory firm for producing the chemical.

Conclusion

In this section, we discussed the role of TICOs as empirically deduced from the interviews we conducted. TICOs are still in an early phase of development. Their funding from the government remains insufficient for fully carrying out their mandates. In addition, the institutional framework in which they operate remains incomplete and their collaboration with the industry tends to reflect the industrial and policy fragmentation. Legislations are frequently changing and the R&D culture, along with an awareness of the IPRs, is still very incipient and takes time to be disseminated among different actors.

Chapter 6: Conclusion

In this short chapter, we summarize and conclude the findings of the thesis. The question we sought to answer throughout the thesis is how the TICOs, as TT institutions, are set to function within the Egyptian NSI and the broader political economy of industrial policies. We followed a series of analyses starting by the industrial policy and its contextualization within the prevailing distribution of political and economic power to better understand the STI policy formulation and the incentives for public-private collaborations. The thesis main contribution lies in understanding the UILs from a new perspective; that is the political economy of industrial policies.

The case of Egypt reflects several elements from the experience of other countries as discussed in the literature review. We find that Egypt resembles the case of Brazil where FDI has previously been concentrated in low value-added production phases with no induced inward TT. It is also contrary to the case of Malaysia whose FDI attraction targeted the increase of the technological component in the domestic industry. Rather, FDI, along with foreign debt, is sought after by the Egyptian government to fill in the gap of foreign currency, which has been especially worsening since 2011 political turmoil. Such an extended period of political instability has left the state with a low bargaining power in the face of the incoming FDI as was the case in Colombia. On the other hand, domestic capitalists (mostly in low-tech industries), with relatively concentrated political power, effectively exchange support to the ruling coalition with economic rents, however without any mechanisms for ensuring technological or value-chain upgrade.

While reforming the STI institutions is taking place slowly, we deduct that the PS that has persisted for such a long time, without real changes after 2011, does not indicate any changes in the power distribution and hence, in the incentives and governance mechanisms toward a successful industrial policy as described by Khan. The neoliberal economic environment in which the STI policies are being shaped in Egypt does not allow for an effective TT through the free-market mechanisms, as was in Brazil.

The thesis carries several research areas forward. For example, it does not tackle the factors which keeps the military on top of the political and economic scene for such a long period. The historical advancement of politics in the Middle East region has a huge bearing on its political and economic paths and further studies need to take into account the broader regional context and its impact on the NSI and TT. The military business, enjoying huge economic rents, is a phenomenon per se that should be studied, given the neoliberal economics that is shaping the government's economic policy (and ideology). There is a pressing need for accommodating the NSI analysis, which implies the historical specificity of each

system, to different analytical perspectives in the developing countries. We chose the PS approach to tackle the NSI from the industrial policy perspective. However, further research may seek to analyze other economic and social aspects, such as gender inequality or social enterprises, in the developing countries where informal institutions prevail.

Annex I: List of Interviewees and the Affiliated Organizations

INSTITUTION	INTERVIEWEE	BACKGROUND OF THE INSTITUTION
CAIRO UNIVERSITY	Manager of TICO	First established university in the modern history of Egypt. It is the largest university in Cairo, after the Islamic Al-Azhar university, in terms of the number of students and researchers and the largest ever in terms of scientific publications.
AMERICAN UNIVERSITY IN CAIRO	Founder and current manager of TICO	One of only two foreign universities operating in Egypt with strong entrepreneurial facilities and capabilities.
ALEXANDRIA UNIVERSITY	Founder of TICO	Formally established in 1952, it is the third largest public university in Egypt after Cairo and Ain Shams universities and the largest in the delta region.
NILE UNIVERSITY	Manager of TICO	A young and small university with a focus on creating top-level R&D in engineering and business administration disciplines.
NATIONAL RESEARCH CENTER	Co-founder and manager of TICO	The largest multidisciplinary basic and applied research center in Egypt that was established during Nasser era inspired by the former Soviet Union R&D model.
SCIENCE AND TECHNOLOGY DEVELOPMENT FUND	Economic Researcher	Founded in 2007 in the process of STI institutional restructuring, it was mandated to be the official government institution of R&D funding.

Annex II: Semi-Structured Interview Schedule with TICOs

First: General Questions

- What is the main role of the institution?
- Who initiates the collaboration with business? You, Government, Business?
- If government initiates collaboration with industry, at which phase do you contribute?
- What type of research do you carry out? (Basic, Applied, Commercialization)
- Who sets your mandates? Yourself, Government? What is the institution's degree of autonomy?
- What are the sources of funding? Did it increase/decrease after 2011? By how much?
- What do you know about the recently issued NSSTI? Did it affect your workflow? If yes, how?
- What is the rate of collaboration (how many projects per year?) Do you have a target rate?

Second: Relationship with Government

- What is the relationship?
- How are the agreements of collaboration initiated? What are the stages of the process? (financing, implementation, evaluation, ...etc.)
- Is there a monitoring system for your collaboration? If yes, how does it work?

Third: Relationship with Industry

- How do you get informed about the needs of business?
- How does the process of collaboration go? (agreements, financing, etc.)
- What are the criteria for selection? How do you assess the capabilities of project implementation by the businesses involved?
- Do you get feedback on collaboration from the business after the end of the project?
- Does collaboration continue after the project ends?
- What are the barriers and facilitators/incentives of collaboration? Is there a difference between pre- and post- 2011? More/less barriers/incentives?

References

1. Abdel-Fattah, Y.R., Kashyout, A.-H.B. and Sheta, W.M. (2013), "Egypt's Science and Technology Parks Outlook: A Focus on SRTACity (City for Scientific Research and Technology Applications)", *World Technopolis Review*, Vol. 2 No. 2, pp. 96–108.
2. Abdel-Latif, A. and Schmitz, H. (2010), "Growth Alliances: Insights from Egypt", *Business & Politics*, Vol. 12 No. 4, pp. 1–27.
3. Alaa El-Din, M., Kash, M.N. and Fahmy, S. (2012), *Egypt's Innovation Ecosystem*, Science and Technology Development Fund (STDF), Cairo, Egypt.
4. Alcorta, L. and Peres, W. (1998), "Innovation systems and technological specialization in Latin America and the Caribbean", *Research Policy*, Vol. 26 No. 7, pp. 857–881.
5. Ashman, S., Fine, B. and Newman, S. (2013), "Systems of Accumulation and the Evolving MEC", in Fine, B., Saraswati, J. and Tavasci, D. (Eds.), *Beyond the Developmental State: Industrial Policy into the Twenty-First Century*, Pluto Press.
6. Bahgat, A. (2016), *Les Agences de Financement de La Recherche Comme Outil Central Des Politiques Publiques de Sciences et Technologies*, Sciences-Po-Grenoble.
7. Baker, L., Newell, P. and Phillips, J. (2014), "The Political Economy of Energy Transitions: The Case of South Africa", *New Political Economy*, Vol. 19 No. 6, pp. 791–818.
8. Beinín, J. (2005), "Political Islam and the new global economy: The political economy of an Egyptian social movement", *CR: The New Centennial Review*, Vol. 5 No. 1, pp. 111–139.
9. Bond, M., Maram, H., Soliman, A. and Khatatab, R. (2012), *Science and Innovation in Egypt*, Atlas of Islamic World Science and Innovation.
10. Chalony, C.L. and Moisseron, J.-Y. (2010), "Research Governance in Egypt: Biotechnology as a Case Study", *Science, Technology and Society*, Vol. 15 No. 2, pp. 371–397.
11. ESTIO. (2014), "Science and Technology Indicators", Egyptian Science, Technology and Innovation Observatory.
12. ESTIO. (2017), "Science and Technology Indicators", Egyptian Science, Technology and Innovation Observatory.
13. Etzkowitz, H. and Leydesdorff, L. (2000), "The dynamics of innovation: from National Systems and 'Mode 2' to a Triple Helix of university–industry–government relations", *Research Policy*, Vol. 29 No. 2, pp. 109–123.
14. Fagerberg, J. (2004), "Innovation: a guide to the literature", Georgia Institute of Technology.

15. Fagerberg, J. and Sapprasert, K. (2011), "National innovation systems: the emergence of a new approach", *Science and Public Policy*, Vol. 38 No. 9, pp. 669–679.
16. Fine, B. (2008), "The Minerals-Energy Complex is dead: long live the MEC?", presented at the Amandla Colloquium, 'Continuity and discontinuity of capitalism in post-apartheid South Africa', Cape Town.
17. Fine, B. and Rustomjee, Z. (1996), *The Political Economy of South Africa: From Minerals Energy Complex to Industrialization*.
18. Hanafi, S. and Arvanitis, R. (2015), *Knowledge Production in the Arab World: The Impossible Promise*, Routledge.
19. Hanieh, A. (2011), "Beyond Mubarak: Reframing The 'Politics' and 'Economics' of Egypt's Uprising", *Studies in Political Economy*, Vol. 87 No. 1, pp. 7–27.
20. Ignatiev, P. (2017), "Egypt under the rule of Abdel Fattah El-Sisi: Internal Challenges", *Actual Problems of International Relations*, No. 132, pp. 4–17.
21. Khan, M. (2010), "Political settlements and the governance of growth-enhancing institutions".
22. Khan, M.H. (2013), "Political settlements and the design of technology policy", *The Industrial Policy Revolution II*, Springer, pp. 243–280.
23. Khan, M.H. and Blankenburg, S. (2009), "The Political Economy of Industrial Policy in Asia and Latin America", in Cimoli, M., Dosi, G. and Stiglitz, J.E. (Eds.), *Industrial Policy and Development*, Oxford University Press, pp. 336–377.
24. Koeller, P. and Gordon, J.L. (2013), "Brazil", in Scerri, M. and Lastres, H.M. (Eds.), *BRICS National Systems of Innovation: The Role of the State*, Routledge, pp. 23–75.
25. Krueger, A.O. (1974), "The Political Economy of the Rent-Seeking Society", *The American Economic Review*, Vol. 64 No. 3, pp. 291–303.
26. Létourneau, J.-F. (2016), "Explaining the Muslim Brotherhood's Rise and Fall in Egypt", *Mediterranean Politics*, Vol. 21 No. 2, pp. 300–307.
27. Leydesdorff, L. (2012), "The triple helix, quadruple helix,..., and an N-tuple of helices: explanatory models for analyzing the knowledge-based economy?", *Journal of the Knowledge Economy*, Vol. 3 No. 1, pp. 25–35.
28. Loewe, M. (2013), "Industrial policy in Egypt 2004-2011".
29. Lundvall, B. (2005), "National Innovation Systems—Analytical Concept and Development Tool", *Dynamics of Industry and Innovation: Organizations, Networks and Systems*, presented at the

DRUID Tenth Anniversary Summer Conference, Copenhagen, Denmark, available at:<https://doi.org/10.1080/13662710601130863>.

30. Lydall, M. (2009), "Backward linkage development in the South African PGM industry: A case study", *Resources Policy*, Vol. 34 No. 3, pp. 112–120.
31. Malaver Rodríguez, F. and Vargas Pérez, M. (2005), "The relationship between policy, and advances in science, technology and innovation in Colombia: 1990-2005", *Cuadernos de Administración*, Vol. 18 No. 30, pp. 39–78.
32. Mazzoleni, R. (2008), "Catching up and academic institutions: A comparative study of past national experiences", *The Journal of Development Studies*, Vol. 44 No. 5, pp. 678–700.
33. Mazzoleni, R. and Nelson, R.R. (2009), "The roles of research at universities and public labs in economic catch-up", in Cimoli, M., Dosi, G. and Stiglitz, J. (Eds.), *Industrial Policy and Development: The Political Economy of Capabilities Accumulation*, Oxford University Press, Oxford.
34. Niosi, J., viotti, P.S., Bellon, B. and Crow, M. (1993), "National Systems of Innovation: In Search of a Workable Concept", *Technology in Society*, Vol. 15, pp. 207–227.
35. OECD. (1997), *National Innovation Systems*, available at: <https://www.oecd.org/science/inno/2101733.pdf> (accessed 16 May 2018).
36. Samy, D. and ElShayeb, Y. (2017), *Overview of the Higher Education System - Egypt*, Education, Audiovisual and Culture Executive Agency (EACEA), European Union, available at: https://eacea.ec.europa.eu/sites/eacea-site/files/countryfiches_egypt_2017.pdf (accessed 27 March 2018).
37. Scerri, M. (2013a), "Modes of innovation and the prospects for economic integration in Africa", *Africa Insight*, Vol. 43 No. 3, pp. 80–99.
38. Scerri, M. (2013b), "South Africa", in Scerri, M. and Lastres, H.M. (Eds.), *BRICS National Systems of Innovation: The Role of the State*, Routledge, pp. 248–314.
39. Schumpeter, J.A. and Opie, R. (1934), *The Theory of Economic Development: An Inquiry into Profits, Capital, Credit, Interest, and the Business Cycle.*, Harvard University Press, Cambridge, Mass.
40. Sfakianakis, J. (2004), "The Whales of the Nile: Networks, Businessmen, and Bureaucrats During the Era of Privatization in Egypt", in Heydemann, S. (Ed.), *Networks of Privilege in the Middle East: The Politics of Economic Reform Revisited*, Palgrave Macmillan US, New York, pp. 77–100.

41. Shehata, D. (2011), "The fall of the Pharaoh: how Hosni Mubarak's reign came to an end", *Foreign Affairs*, pp. 26–32.
42. STI-EGY 2030. (2015), "National Strategy Science, Technology and Innovation 2015 - 2030", Ministry of Higher Education and Scientific Research (MOHESR).
43. United Nations Economic and Social Commission for Western Asia (ESCWA). (2017), *National Technology Development and Transfer System in Egypt*, available at: https://www.unescwa.org/sites/www.unescwa.org/files/page_attachments/egypt_ntto_book.pdf (accessed 29 May 2018).
44. Watkins, A., Papaioannou, T., Kale, D. and Mugwagwa, J. (2014), "National innovation systems, developing countries, and the role of intermediaries: a critical review of the literature".