PRODUCTIVITY, TECHNICAL CHANGE, AND THE ROLE OF R&D

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PRODUCTIVITY, TECHNICAL CHANGE, AND THE ROLE OF R&D: THE CASE OF PUBLIC SECTOR ENGINEERING AND TEXTILES INDUSTRIES IN EGYPT 1975-1989

by

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ABSTRACT

Egypt suffered from dwindling external sources of finance during the second half of the eighties. There was a strong need for Egypt to rely on its indigenous productive capacity as the driving force for its economic development. Expanding world trade in engineering and textiles industries provided an opportunity for development that was cleverly seized by many developing countries, but not by Egypt.

The main objectives of this research are to identify the specific nature of technical change, measure trends in productivity, test for structural change, and examine the contribution of R&D to production in public sector engineering and textiles industries in Egypt during the period 1975-1989.

Both quantitative and qualitative approaches are used to examine the above issues. Econometric estimation is complemented by descriptive analysis based on field research involving research institutions and many of the companies under study. A good part of the research is based on unpublished materials and data extracted first hand during the course of the work. Of particular importance are interviews held with some of the pioneers of scientific research in Egypt.

The estimation results show that productivity in public sector engineering and textiles firms followed an inverted-U pattern that peaked around 1982-84. While the second half of the seventies witnessed an improvement in performance, in the mid eighties a deterioration started which became particularly evident after 1986. However, R&D played a positive role in the engineering industries in the eighties, suggesting a potential for indigenous R&D.

While these performance trends could be attributed to changes in economic policies, it is suggested that they were primarily affected by 'technological inertia'. Efforts in the sixties to establish a strong technological foundation for industry bore fruit in the seventies. However, limited interest in R&D in the seventies eventually brought about the slack performance of the eighties.

The research findings suggest that Egypt needs a more creative approach to technological management. In particular, technological development is found to be a priority for engineering and textiles industries, which can provide a strong impetus to the country's overall development.

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CHAPTER I

INTRODUCTION

I.1. Statement of Research Question and Objectives

The objective of the research is to study the links between technical change, productivity change, and research and development (R&D) in the public sector engineering and textile industries in Egypt. Specifically, I would like to focus on:

a. identifying the specific nature of technological development in the engineering and textiles industries, and the extent to which productivity change has been affected by public policy in Egypt over the period 1975-1989;

b. estimating the coefficients of productivity change for the industries as a group, and undertaking comparisons among industries;

c. estimating the total and partial factor productivity levels, and explaining the changes in these levels; and

d. estimating the possible role of R&D in production, and linking it to technological and/or productivity change.

I.2. Issues and Problems

Our main concerns in the present context are the interactions between technological development, productivity change, and R&D activities. Within these concerns, a number of supplementary issues arise: the impact of policy changes, local vs. 'imported' R&D efforts and static vs. dynamic comparative advantage (in relation to the policy framework).

The timing of the present study is particularly interesting since the Egyptian government is now taking measures towards privatization of the public sector industries. The current developments in government policy with respect to the public sector thus add a new dimension to the findings of the present study. How did these industries function as part of the public sector, and what was the trend in their development? Will privatization be 'good' or 'bad' for the industry? How will this affect technology, productivity, and R&D activities? All of these questions will be addressed in the context of the present analysis.

I.3. Why Engineering and Textiles Industries

The choice of the textiles and engineering industries as the subject of the present study is based on a number of criteria. Specifically, product orientation and other characteristics of these two industries are different enough so that differences in the role of R&D can be expected. On the one hand, the textiles industry is a traditional consumer good industry based on Egypt's most abundant raw material. It is one of the oldest industries in Egypt, going back to the time of Mohamed Ali in the early 1800's. Activities then included spinning, manufacturing, bleaching, and dyeing cloth, which included cotton, wool, silk, and linen (Mabro and Radwan 1976 p. 13). Actually, Egypt is believed to have been the first nation to develop the hand-loom weaving of cloth, as early as 4000 B.C. (World Bank 1991 p. 46). The textiles industry has deep roots in Egypt's economic system, and today constitutes the major share in manufacturing production and exports, as will be discussed below.

On the other hand, engineering industries are relatively new in Egypt. Companies that currently dominate the industry were established mainly during the mid-fifties, and were later nationalized in the sixties (World Bank 1989b p. 2). They include the production of machinery as well as consumer goods, that are (in most cases) based on imported intermediate goods, and may involve a higher level of knowledge and sophistication than production of textiles.

Because the two industries differ in age, product orientation, and reliance on domestic and foreign intermediate inputs, we expect to find differences in R&D, knowledge and technological sophistication; in efficiency; and in import content and trade performance. These differences are crucial for evaluating the role of public policy in these two sectors.

I.3.1. R&D, Knowledge and Technological Sophistication

We expect the engineering industries to have a higher technological content than textiles. Being an older industry, the latter might include relatively older technologies that rely on Egypt's most abundant resource, its labor force. In order to investigate the hypothesized difference in the level of technological sophistication, it is interesting to examine the extent to which domestic innovation and R&D activities have been undertaken and utilized in the production process in each group of industries.

Our first guess would be that engineering industries may require more sophisticated technologies, which would mean a stronger R&D base and a wider scope for scientific activity than in textiles. On the other hand, an industry such as textiles, which relies on the country's primary agricultural product, could also have a reasonably well established R&D base. This is in contrast to a 'new' line of industries that rely mainly on imported inputs (sometimes being mainly assembly industries, e.g., cars), that sometimes import the technology itself, and that face foreign competition from more technologically advanced countries (e.g. electronics, cars, etc.). This point is one of the main focuses of our research.

I.3.2. Efficiency

In line with the above, we expect the textiles industry to make more efficient use of domestic resources than the engineering industries. The textiles industry relies on Egypt's most abundant raw material, while the engineering industries require more 'high tech' capital and imported intermediate inputs. Egypt is more likely to have a comparative advantage (a Domestic Resource Costs ratio that is less than 1, see Annex I.1) in the former.

Nevertheless, one needs to look at measures of competitiveness over time (dynamic comparative advantage). One should also consider the competitiveness, or lack thereof, of individual industries and lines of manufacturing. In the case of engineering industries, such a close look might find that some activities are actually competitive (see World Bank 1989b pp. 10 & 11).

I.3.3. Trade Performance and Import Content

While both industries can be considered both import-substituting and export-promoting at the same time, the emphasis has been different in each case. On the one hand, engineering industries were mostly established with the purpose of import substitution and the hope of ultimately expanding to export markets. Paradoxically, a good part of the intermediate goods required for the engineering industries were imported (implying a negative effective rate of protection, see Annex I.2). In the textiles industry, on the other hand, emphasis was on export promotion - "to replace gradually exports of a commodity in its raw form by exports of the same commodity processed as finished or semi-finished goods" (Mabro & Radwan 1976 p. 100).

The contrast between the two industry groups is highlighted by the figures for the import content of the Ministry of Industry companies presented in Table I.1 below. Accordingly, textiles have the lowest import content, and engineering has the highest percentage ratio of imported inputs to total inputs purchased, second highest when divided by inputs used, and third highest when imported inputs are divided by exports.

In addition to the above, figures for the trade performance of the two groups of industries place them in a sharp contrast: textiles being the major exporter (highest share in industrial exports) and engineering being the major importer (highest share in industrial imports) in 1987 (see Table I.2 below).

I.3.4. Potential for Egypt's Development

The two industries under study share one major similarity. They represent potential opportunities for Egypt's development. Engineering and textiles were the driving force behind the big leaps taken by the newly industrialized East Asian countries in the past twenty to thirty years. In Hong Kong, for example, industrial growth has been based largely on the expansion of textiles and garments, in addition to watches, electronics and metal engineering (Berger & Hsiao 1988 p. 230). In Taiwan, men's and boys' garments and calculating machines have recorded excellent growth rates in the seventies and eighties. (Berger & Hsiao 1988 p. 194). In South Korea, electronics is considered to have been "the most technologically dynamic sector" in the economy (Patel 1993 p. 182).

In fact, South Korea provides an interesting case for comparison with Egypt, as in the fifties it portrayed characteristics of underdevelopment that were very similar to those of Egypt. Since the fifties, South Korea has achieved remarkable results on the road to development. Between 1960 and 1977, growth of Total Factor Productivity (TFP) was particularly high for textiles and engineering industries, especially transport equipment, machinery and electric machinery (Table I.3). High productivity growth continued in the eighties, with labor productivity in engineering industries increasing by 114% between 1980 and 1985 (Ez El-Din 1991 p. 12).

Engineering and textiles, therefore, could have provided a strong impetus to Egypt's development. In the international arena, world trade in these products expanded after the seventies. With international developments providing the grounds for expansion in these industries, it will be interesting to examine how and why Egypt did or did not benefit from these world trends.

I.4. Methodology

In examining the above questions, I have used both quantitative as well as qualitative approaches. Econometric estimation of productivity change, technological development, specific time period effects, and the role of R&D, are complemented by descriptive analysis based on my field research involving visits to relevant institutions and many of the companies under study.

The limited volume of published material on the subject has made my research topic both ambitious and challenging. A good part of my research is based on unpublished materials and data extracted first hand during the course of my work. In particular, R&D data in engineering firms were put together by the enterprises for the first time. These were provided in response to persistent requests and visits.

Of particular importance are interviews held with some of the pioneers of scientific research and economic development in Egypt[1]. They were able to provide me with the gist of their experience of many years in the field. The value of the information collected from these people is inestimable. I was also able to hold useful meetings with government officials and researchers at the Ministry of Industry (MOI), The Academy of Scientific Research and Technology (ASRT), the National Research Center (NRC), The Institute of National Planning (INP), the Central Agency for Public Mobilization and Statistics (CAPMAS), The Engineering and Textiles Industries Corporations (EIC and TIC), Cairo University and the American University in Cairo (AUC).

I.5. Plan of Work

This dissertation consists of five chapters. In Chapter II, I present a review of the general background against which the industrial sector has operated, providing the sectoral, macroeconomic, and international perspectives as well as a review of the domestic R&D environment. In Chapters III and IV, I provide a detailed analysis of public sector engineering and textiles industries, respectively. I first discuss the structure and performance of the respective industries. I then present my empirical results. In Chapter V, I provide a synthesis of the conclusions, discuss policy implications, and provide suggestions for future research.

Table I.1

Import Content of Ministry of Industry Firms

	Imported Inputs as a Percentage* of: Total Inputs Purchased	Used	Exports
Textiles	17.32 (lowest)	18.39 (lowest)	29.54 (lowest)
Engineering	61.04 (highest)	64.44 (second highest)	555.34 (third highest)
Food	42.11	39.68	1098.80
Chemical	59.09	65.26	798.24
Metal	40.17	48.11	76.59
Mining	28.63	31.88	126.64

* Percentages are based on data in current L.E.
Source: Calculations are based on data from Ministry of Industry 1991, vol. 2 for the year 1989/90.

Table I.2

Import and Export Performance of Textiles and Engineering Industries in 1987*

(Imports and Exports in millions of current US$)

	Textiles	Engineering
Imports	163.1	3036.9
Percentage Share in Industrial Imports	2.5	47.1 (highest among all industries)
Exports	386.6	60.0
Percentage Share in Industrial Exports	52.6 (highest among all industries)	8.2
Percentage Share in World Markets	0.243 (highest among all industries)	0.007 (third lowest among all industries)

* Totals for sub-sectors represent final products.
Source: World Bank 1989a Tables 7, 8 & 9, pp. 17, 18 & 19.

Table I.3

Total Factor Productivity Change
in Egypt, Japan, Korea, & Turkey

Selected Industries, Annual Percentage Change

Egyptian Industries	Egypt 1973-79	Japan 1955-73	South Korea 1960-77	Turkey 1963-76	Non-Egyptian Industries
TEXTILES:					
		1.70	4.51	1.44	Textile Mill Products
		1.94	1.62	2.74	Apparel
Cotton Products	-2.00				
Other Textiles	1.40				
METAL PRODUCTS & ENGINEERING:					
Iron & Steel	0.65	0.96	1.87	0.87	Basic Metals
Transport Equipment	4.52	2.53	5.10	3.33	Transport Equipment
		0.84	6.01	1.51	Fabricated Metals
Fabricated Metals & Machinery	0.46				
		3.14	5.73	1.33	Machinery
Electrical Machinery	3.81	4.42	7.25	1.83	Electrical Machinery
China & Glass	-0.46	1.73	4.53	0.26	Stone, Clay & Glass

Source: World Bank 1983 p. 235 Table 8.4.

Annex I.1: Domestic Resource Cost (DRC) Ratio

The domestic resource cost ratio "measures the amount of 'net' foreign exchange that domestic resources can generate for the firm in question". It is measured as the ratio between the economic value of primary inputs and value-added at international prices.

$$DRC_j = \frac{\sum_{s=1}^{m} f_{sj} P_s}{P_j - \sum_{i=1}^{n} a_{ij} P_i} = \frac{\text{Economic Value of Primary Inputs}}{\text{Value Added at International Prices}}$$

where P_j, P_i and P_s are the shadow prices of the output of industry j, and the material and factor inputs used in the production of j; the a_{ij} are the input-output coefficients for intermediate inputs and the f_{sj} are the input-output coefficients for primary factors of production.

"Minimizing the DRC ratio in tradable goods producing activities is equivalent to maximizing value-added at world prices per unit of domestic resources employed. Thus evaluating firms in terms of their (domestic) resource cost ratio provides a measure of relative economic efficiency. Firms with DRC's less than or equal to one may be classified as efficient in the sense that the domestic resources which they employ produce as much or more value-added at world prices as they would in the activities from which they are drawn. Activities with resource cost ratios greater than unity are termed inefficient in the sense that the resources they use would be more productive in alternative activities."

Finally, the DRC measure is also used to evaluate comparative advantage. Comparative advantage exists if the DRC is less than one. "In addition, the smaller the DRC of an individual activity within an economy, the greater the scope for efficient expansion of exports or import substitutes."
Source: World Bank 1983 pp. 267 & 268.

Annex I.2 Effective Rate of Protection (ERP)

The effective protection rate (ERP) is given by the ratio between value-added in domestic prices and in world prices. It "measures the increase in domestic value added permitted by the structure of trade protection and domestic price controls over the level of value-added in the absence of such restrictions. If all commodities are traded, the effective protective rate is given by:

$$ERP = \frac{P_{jd} - \sum_{i=1}^{m} a_{ij} P_{id}}{P_j - \sum_{i=1}^{m} a_{ij} P_i} = \frac{\text{Value Added at Domestic Prices}}{\text{Value Added at World Prices}}$$

where P_{jd} and P_{id} are the domestic market prices of output and (intermediate) inputs respectively and P_j and Pi are the corresponding world prices." ERP differs from DRC in the numerator, allowing for "the potential for resource costs and transfers arising from the existing structure of protection", as opposed to DRC which takes into account only domestic resource costs actually incurred. The numerator of ERP "shows the scope that domestic prices allow for some combination of domestic resource costs, profits and rents to be incurred in a particular economic activity". The difference between DRC and ERP "depends on the structure of domestic taxes and subsidies and on the supply functions for domestic primary factors". Source: World Bank 1983 p. 269.

Notes

[1] Among these are Dr. Salah Hedayat, the 'Father of Scientific Research in Egypt', Dr. Mohamed Kamel Mahmoud, former Head of the National Research Center, Dr. Sayed Dahmouche, then Head of the Textiles Industries Corporation (TIC), and Dr. Ibrahim Helmy Abdel Rahman, major founder and General Secretary of the Supreme Council of Science (1956-58), Head of Technical Unit of the National Planning Committee in 1957, Head of the Institute of National Planning 1960-63, Head of UNIDO 1967-74, Minister of Planning 1975-76, Advisor to the Prime Minister 1976-85.

CHAPTER II

THE MACRO, SECTORAL AND INTERNATIONAL PERSPECTIVE

II.1. Introduction

In this chapter, we present the domestic and international background against which the industries under study have operated. On the domestic scene, we present the macroeconomic and sectoral context, as well as the policy framework. Within the latter, we focus on employment, trade, pricing, market entry and exit policies. We also present the technological framework and a survey of the R&D environment. On the international scene, we review the major developments pertaining to the industries under study. This chapter provides the basis for the performance evaluation of the industries which follows in chapters III and IV.

II.2 The Domestic Framework

II.2.1. The Macroeconomic Framework

On the morning of the 23rd of July 1952, the Free Officers took over the rule of Egypt, starting a new phase in this country's history. While the Revolution seemed to encourage the predominance of the private sector in the initial years, the second half of the fifties involved a much stronger role for the state as opposed to the private sector.

Government intervention was significant in the sixties. After the 1967 defeat, however, liberalization of the economy was gradually taking shape, and this accelerated after Sadat came to power in 1970. Although a few measures had been taken towards a gradual liberalization of the economy, foreign investors did not respond until after the 1973 war (Mabro and Radwan 1976 p. 69). After the war, Egypt's political and economic stance changed considerably, both internally and internationally. Egypt loosened her ties with the Soviet Union and strengthened relations with the United States. Egypt was entering a whole new era which entailed the formulation of a 'fresh' economic strategy. It is against this background that the October Working Paper of 1974 was formulated, which stipulated a new economic policy symbolized by the equation (Ikram 1980 p. 26):

Arab Capital + Western Technology
+ Abundant Egyptian Resources
= Development and Progress

The October Paper maintained that Egypt was about to enter a "construction battle" where the basic element in the modernization process is an "acceleration of economic growth", which would require changes in the roles performed by the different sectors. Since Egypt would require considerable financial and technological assistance from abroad, an "outward looking" economic policy seemed most appropriate.

And, since public sector experience revealed some shortcomings, e.g. excess bureaucracy, "reorientation" was required to rid the sector of hindrances and make it more efficient. The public sector would concentrate on carrying out the development plan, undertaking basic projects that "would not or could not" be taken up by other sectors, and providing services needed by private and foreign investment. Emphasis was placed on a modernized industry, and "intensive high value agriculture", oil and energy development, and tourism. The paper wished to ensure stability and encourage the private sector to increase production (Ikram 1980 p. 26). This policy was formally adopted in the legislation on Investment of Arab and Foreign Capital and Free Zones (Law 43) of 1974.

After the dramatic shooting of President Sadat in 1981, Mubarak came to power facing the difficult task of leading a country at a critical stage on both the political and economic levels. Although the government has remained committed to a large public sector that required protection and subsidies, the Open Door Policy and its amendments have remained the 'cornerstone' of efforts to attract foreign participation in Egypt's development (American Embassy 1986 p. 8).

Thus, in the 1970s, Egypt was transformed from an economy oriented towards domestic production to one that is dependent on external sources of finance -- oil, the Suez Canal, expatriate worker remittances, and foreign aid. At that time, oil prices were high, the Gulf was booming, and donor agencies were generous and approving. In the eighties, however, and particularly by the second half of the eighties, Egypt faced a different world. Oil prices and Canal revenues declined substantially (a fall of 43% according to Egypt's 1986/7 budget). Remittances dwindled, and foreign aid became harder to obtain, increasing the strain on an already strained economy. With the population increasing incessantly, the ranks of the unemployed swelled, and a huge import bill -- mostly for vital food supplies and capital goods -- had to be met. Egypt faced a $40 billion external debt burden with a debt-service ratio of almost 22% of exports (World Development Report 1989, figures for 1987).

Today, Egypt again faces a changing world. On the international scene, the dawn of the nineties witnessed the end of the cold war and the emergence of the single power of the United States, culminating in the Gulf War of 1991. Egypt's role in this war gained the approval of the West, resulting in the relief of a significant portion of Egypt's debt burden, a move which partially made up for the sharp cut in the remittances caused by the War. Domestically, Egypt is seeking the approval of donor agencies by following the World Bank 'prescription' of privatization, removing the impediments to imports, freeing the exchange rate, and phasing out subsidies.

II.2.2. The Policy Framework

Policies related to the industrial sector during the period under study were a reflection of the general political systems prevailing at different times. The decade following the Revolution witnessed the emergence of a mixed system where the private sector coexisted with an ever-expanding public sector with the government continually extending its intervention in and control of the economy (Mabro and Radwan 1976 p. 39). In particular, 'the great change to socialism' started in 1957 (Ministry of Industry and Mineral Wealth 1964 p. 16). Public sector expansion in industry continued throughout the sixties until 1973 when liberalization of the economy started and the 'Open Door Policy' was adopted in 1974. Encouragement of the private sector involvement in industry has been a government policy ever since.

This general scenario of tension between public and private sector involvement has been accompanied by a set of employment, pricing, trade and foreign exchange policies which at times supported, and at others hampered the public sector. This chapter presents an overview of these policies. It will be interesting to draw inferences on the extent to which such policies have acted to encourage or hamper the development of the industries under study during the seventies and eighties. Such conclusions will follow from the analysis of the two industries to follow in later chapters.

II.2.2.1.Historical Summary

Immediately after the 1952 Revolution, there was a continuation of the industrial development which had started since 1930 with limited tariff protection that increased in 1949-51. Industry used Western technology with foreign sources of funding, especially in spinning and weaving. Egyptian industry was internationally integrated. Industrial exports were encouraged (Abdel Rahman, interview).

The new government set out to achieve industrial development as one of its major goals. In late 1952, the Permanent Council for the Development of National Production (PCDNP) was handed the task of studying development projects in the different sectors, and, particularly, of recommending policies with the purpose of developing manufacturing into "the main sector of the economy" (Mabro & Radwan 1976 p. 65). To this end, the primary aim of the government was to create "an atmosphere of confidence" for both foreign and domestic investors (Abdalla 1978 p. 97). The National Planning Council (NPC) issued legislation organizing the investment of foreign capital in development projects and limiting investment in building operations so that investments could be diverted to industrial development. Moreover, the Industrial Bank was established to promote industry. Further legislation attempted to consolidate and facilitate its task by granting loans or becoming itself a shareholder in some industrial projects (Ministry of Industry and Mineral Wealth 1964 p. 174). Finally, private investment in industry was encouraged in a variety of forms (Mabro & Radwan 1976 p. 66).

Yet despite efforts at encouraging private domestic and foreign investment immediately after the Revolution, the lack of a substantial flow of foreign investment proved to be frustrating to development efforts, particularly industrialization. The government's attitude thus changed during the mid-fifties, and it gradually increased its intervention in industrial activities (Abdalla 1978 pp. 98-9). The Ministry of Industry was established in July 1956 in order to draw up, and supervise the execution of, a new plan for industrialization (Ministry of Industry and Mineral Wealth 1964 p. 174).

By 1957 the concept of central planning had become totally accepted by the government as a means of achieving economic development (Abdalla 1978 p. 98). With industrialization being a main pillar of such development, the 'socialist line' was at the base of the industrial movement. The state supported major projects which did not yield quick returns on the investment, e.g., iron & steel. The government contributions to the capital of new industrial projects were made through the Industrial Bank and the deposits of savings banks, pensions, insurance, and other administrations in charge of savings (Ministry of Industry and Mineral Wealth 1964 p. 289).

In January of 1957, the PCDNP was officially 'dissolved'. Its functions were taken over by two institutions: the National Planning Committee and the Economic Organism. The ministries of Industry and Agriculture drafted two five-year plans for the respective sectors. The First Industrial Plan of 1957 (formally terminated on June 30, 1960) included the uncompleted parts of projects that had begun with government participation since 1953, joint projects that were already approved and scheduled for 1957 or later, new joint projects evaluated and approved by the PCNDP or the Ministry of Industry, and all the 'important' industrial projects contemplated at that time by the private sector (Mabro & Radwan 1976 pp. 66-7).

According to the Ministry of Industry Report, the First Industrial Program "had the chief characteristic of realizing a balance between the development of basic industries and the development of consumer goods industries."

The program had three goals (Ministry of Industry and Mineral Wealth 1964 pp. 178-9):

> 1. to realize self sufficiency in all goods which could be produced locally and which were imported for local consumption,
>
> 2. the expansion of industries which could find favorable export markets as long as the elements necessary for success of these industries exist in the country. In this way such industries may be a source of foreign currency, and
>
> 3. establishment of basic industries which are the foundation of industrial progress with particular attention to those basic industries which were not covered by development during the past years.

With 47% of the total needs of the First Industrial Program being in foreign currency, the Program was financed by loans from the Soviet Union, Federal Republic of Germany, Japan, and the German Democratic Republic (Ministry of Industry and Mineral Wealth 1964 pp. 180-181). The share of government participation in the planned investment in industry within the Program was 21% (in Mabro and Radwan 1976 p. 67). Mabro and Radwan, however, argue that the actual extent of government participation may have reached 30-40% or more (Mabro and Radwan 1976 p. 68).

The industrialization program was totally tied to the Soviet Union system of management and information. This period was the time of cooperation with the Soviets. The source of technology imports was changed to the Eastern Block

- namely the Soviet Union, Czechoslovakia and Hungary. The centralization of management and planning meant in turn the centralization of management and planning for innovation and development. (Abdel Rahman, interview)

As exports to the West became less, there was no foreign currency to finance the importation of spare parts for old equipment relying on Western technology. The resulting operation below full capacity due to lack of maintenance were partially responsible for production of lower quality products (Abdel Rahman, interview).

Later on, the sixties witnessed a significant change in the economic system in Egypt. Massive waves of nationalization and sequestration took place. Central planning prevailed and the First Five-Year Plan for Economic and Social Development was adopted in July 1960. The features and policies of this economic system have to a large extent influenced the industrialization pattern and efficiency levels of Egyptian industry. Although many of these policies were initiated in the fifties, they acquired considerable significance in the sixties "when the state assumed almost complete control of modern sectors of the economy" (Mabro & Radwan 1976 p. 64).

In drawing up the Five-Year Plan, the government sought diversification as an attempt to rid Egypt of her almost total dependence on the trade of her one export crop -

namely cotton. Such trade was believed to have affected Egypt's economic stability by subjecting it to fluctuations of the world market. The emphasis on developing the industrial sector was the manifestation of this diversification intention, and hence the top priority of the Plan (Abdalla 1978 p. 108).

Investments allocated to industry alone totalled L.E. 434 million out of L.E. 1697 million of total investment planned over the five years (Ministry of Industry and Mineral Wealth 1964 p. 185). This included the residual projects of the First Industrial Program as part of the Second Industrial Program, which covered the industrial sector as part of the Overall Economic and Social Development Plan (Ministry of Industry and Mineral Wealth 1964 p. 182). By then, industrial expansion has become "almost exclusively" a government activity carried out by the public sector (Mabro & Radwan 1976 p. 68). In fact, private sector shares in industrial investment were less than 10% throughout the sixties (Mabro & Radwan 1976 Table 4.5 p. 69).

The importance of the private sector thus was diminished. The public sector developed with minimum competition prevailing. However, this period also witnessed a generally low level of activity in the economy due to the Yemen war, the breaking of Union with Syria, and the cut of American wheat aid due to disputes centered on Egypt's building of the High Dam (Abdel Rahman, interview). The shortage of foreign exchange in the sixties (partly due to the decline in exports to the West) culminated in a financial crisis that carried through to the 1967 war. There were no external sources for financing industrial development. Innovation was very limited. Infrastructure (power, telephones) became dysfunctional (Abdel Rahman, interview).

Overall, industrial policies remained unchanged throughout the sixties. Investment continued to be made primarily by the public sector. Projects were initiated either by the ministries or relevant organizations and included as part of annual programs. Implementation of projects depended on the availability of foreign exchange, especially offers of project aid from the Eastern Block (Mabro & Radwan 1976 p. 68).

The start of the seventies, however, witnessed some modernization and renovation of industry - with a Russian base, yet based on stronger relations with the West. In 1971/2, Russian experts were expelled, and relations with the Soviet Union were limited (Abdel Rahman, interview).

In 1973, industrial investment and policy started taking on a different shape, paving the road for the 'Open Door Policy' adopted by Sadat in 1974. As a part of this policy, the monopoly of the government on trade and finance was discontinued, the exchange regime was to a large extent liberalized, and Law 43 was enacted to encourage private domestic and foreign capital investment (Handoussa 1988a p. 36). Egypt's economic policies thus took on a totally different stance from the preceding decade.

Public sector industrial enterprises maintained the formal status of joint stock companies; however, in most cases the state was the exclusive shareholder. This system thus incorporated the firms within the government apparatus (Mabro & Radwan 1976 p. 74). This might have, to some extent, limited the firms' autonomy and flexibility in encouraging technical innovation and allocating potential investments to research and development.

The 'oil period' (1973-78) also witnessed the phenomenon of migration, inflation, and the signing of the Camp David Agreement. During this period, there were more resources for industry, mostly supplied from Western sources. Rehabilitation of industries which had deteriorated, and expansion of private sector, small and medium size industries, all took place during this period (Abdel Rahman, interview). Nevertheless, the quality of industrial production deteriorated. There was less discipline and rigor in production especially when compared to the quality attainable in the mid fifties, e.g., in textiles. There was also looseness in management, and a lower level of supervision. Most external sources of finance were Arab sources, with no technology, but a strong emphasis on infrastructure (Abdel Rahman, interview). Despite the above, local research capabilities improved. Designing, supervision, testing, consultancy, as well as basic research in national research institutions, all increased. Still, technology was essentially foreign, namely Western (Abdel Rahman, interview).

At the beginning of the eighties, Arab aid was cut; and American, Japanese, Italian, French, and German aid expanded. This period witnessed the start of expanded external sources of financing for the Egyptian economy: oil and Suez Canal revenues, remittances, and borrowing (Abdel Rahman, interview). By 1984, the abundance of external resources allowed investment in industry on a large scale. However, in 1984-85 the price of oil went down, and the quality of overall production generally fell. There were hardly any exports, hence no stimulation from outside or inside (Abdel Rahman, interview). The mid-eighties also marked the start of the adoption of the World Bank policy prescription: privatization, phasing out subsidies, and relaxing the impediments to imports.

However, under the pressure of the financial crisis in the second half of the eighties, there have been more industrialized exports. With the drive for exports came improvement in quality, in order to compete better in external markets. The private sector has improved the quality of consumer goods, and some were exported to Arab and even Western countries. Compared to the public sector where the level of technology was not very high, the private sector had more flexibility and better access to foreign exchange and was thus more capable of importing technology. Although there was greater innovation at different levels, current levels of efficiency and productivity still left much to be desired (Abdel Rahman, interview).

To sum up, the Revolution of 1952 started out by encouraging the private sector. This trend did not last very long; the start of the sixties witnessed massive nationalization waves, a tremendous expansion of role of the state, and government involvement in almost all aspects of the economy. With the advent of the seventies, gradual liberalization eventually culminated in the Open Door Policy in 1974, with the nation swinging heavily towards the West, and welcoming an expanding private sector. This trend continued throughout the seventies and eighties. The eighties were also marked by heavy reliance on external sources of finance, whose availability gradually declined, especially by the second half of the decade.

The respective expansion of, and interaction between, the private and public sectors were significantly affected by the ideological changes of the government. Although reasonably strong foundations were laid for the public sector in the sixties, the seventies witnessed an expansion of the private sector. This expansion is sometimes claimed to have occurred at the expense of the public sector, a trend which continued throughout the eighties. Such claim, and others, can be judged in light of more details on specific policies adopted during the time period under study. These policies will be the subject of the following sections.

II.2.2.2. Employment Policies

Employment policies governing the industrial sector today are deeply rooted in the socialist laws of the sixties. The strong support provided by the state for workers guaranteed certain rights for laborers. Among these laws was one fixing workers' hours at seven hours daily. Government documents hail the law as having resulted in providing employment for almost 36,000 additional workers whose wages amounted to L.E. 5.6 million (about 1.7 million $US at today's exchange rate). Other laws included raising the minimum daily wage of the workers to p.t. 25 (about 7.6 cents at today's exchange rate), giving the worker a share of the organization's profits, and allowing workers and employees to be represented on the boards of directors of their companies (Ministry of Industry and Mineral Wealth 1964 p. 27). Centers for vocational training were also established in order to raise the productive efficiency of workers and to train unskilled workers and supply new ones to existing plants

(Ministry of Industry and Mineral Wealth 1964 pp.27-8).

Employment policies have remained practically unchanged since that time, as they touch a sensitive political chord. Even today, as the public sector is being reduced, the government is always assuring the workers that their rights will remain unchanged.

II.2.2.3. Market Constraints: Entry and Exit Policies

Related to the government's keenness on preserving employment there has been a resistance to plant closures. These have represented exit barriers that are also deeply rooted in the policies of the sixties. Exit barriers include 'direct budgetary support to ailing industries, continuous extension of credit (both from banks and from other enterprises), and even direct bans on the closure of loss-making enterprises' (World Bank 1989b p. vii). In fact, plant closures or any reduction in the scale of operations are prohibited by law (Labor Laws 48 and 137 of the public and private sector), unless approved by a committee chaired by the Prime Minister. In practice, no industrial public enterprise has been closed down. It is somewhat easier for private sector firms to go bankrupt, although this still has its problems with the banks (World Bank 1989b p. 28).

In addition to these exit barriers, there have been barriers to market entry. Since the seventies, joint venture investment projects under law 43 (and previously law 230) have required the approval of the Investment Authority. Similarly, the approval of the General Organization for Industrialization (GOFI) is required for local private investments under the Company Law 159 (and the Private Company Law 21). These agencies are presided over by a committee chaired by the Prime Minister and representing the different ministries. The Prime Minister thus "has legal authority to accept or reject investment proposals" (World Bank 1989b p. 27). The fact that entry into, and exit from, the market are, in the end dependent on an approval from the Prime Minister is a major hindrance to these changes.

In practice, potential investors also require the approval of the particular ministry concerned with their investment. Approvals are usually granted to industrial projects except in one case: when there is a surplus in the production of the product in the domestic market (World Bank 1989b p. 27). The Government, therefore, may reject potentially efficient operations at the expense of implicitly subsidizing existing ventures, regardless of the level of efficiency of their operation.

Although in the eighties Egypt reduced barriers to market entry, the government still seemed reluctant to allow the establishment of new industrial plants because of the expected competition with the public sector. The result was a constraint on competition and a limitation on the range of goods available in the domestic market (World Bank 1989b p. vii). In addition, such barriers represented a constraint on the introduction of new technology, the impact being strongest among those potentially innovative entrepreneurs who dared to seek such business where government activity had already been established (World Bank 1989b p. vii).

In August 1989, the Government passed a new Investment Law (No. 203) designed to coordinate the provision of investment incentives under the New Communities Investment Law and Law 43. The purpose of this law is "to eliminate possible duplication of incentives" (World Bank 1989b p. 27). The impact of this law is yet to be evaluated based on investments in the 1990s.

II.2.2.4. Trade Policies

The history of trade policies reflects the desire of the government to protect infant industry in the fifties and sixties, and the subsequent attempt to 'free the market' after 1974. The period immediately following the Revolution (1952-1956) was characterized by increasing protection on cotton yarn and low/medium grade fabrics, consumer goods, and tariff exemptions on raw materials and capital goods, specifically machinery and equipment required for industry. Import licensing was re-introduced in 1952, and tariff protection was increased several times throughout the fifties[1] (Mabro and Radwan 1976 p. 62).

Government documents hail the intention to expand exports in the sixties. According to Ministry of Industry documents (Ministry of Industry and Mineral Wealth 1964 p. 321), a quality check was a prerequisite to export, and exporters were refunded all custom duties, excise duties or other duties paid on imported raw materials used under a 'draw back' system. Also, exporters could be provisionally exempted from import duties if imported goods were to be re-exported after being processed in Egypt. Moreover, a share of the loss suffered by an exporting factory was to be paid if it was proved impossible for the factory to cover the loss.

Despite the above, operations of the public sector firms and the few private export firms that survived the 1961 nationalizations were hindered by administrative controls. In fact the Public Organization for Foreign Trade seems to have been ineffective in providing the necessary flexibility, incentives, and skills needed to promote exports. It seems that the institutions of the system might have been partly to blame for the poor performance of exports during that decade (Mabro and Radwan 1976 pp. 72-3).

On the import side, import licensing, which was introduced to control imports in the fifties, continued until 1964. The system was then replaced by direct system of import allocation. Lengthy bureaucratic requirements and red tape delayed applications for licenses and import orders. This in turn led to bottle-necks in production, the underutilization of capital, and the stockpiling of imported intermediate inputs and raw material stocks to hedge against delays. It also resulted in failure to exploit low price opportunities when they came up on world markets and to optimize the timing of importing raw materials characterized by seasonal price patterns (Mabro & Radwan 1976 p. 73). Finally, priority for sources of raw material imports was accorded to recipient countries of Egypt's exports. Barter deals were not uncommon. (Ministry of Industry and Mineral Wealth 1964 p. 321)

Except for a few timid liberalization steps in the late sixties and early seventies, the system did not fundamentally change until the 'Open Door Policy' was adopted in 1974. At that time, the government started to liberalize trade and exchange regimes. Measures such as relaxation of exchange controls, termination of bilateral trade agreements, and periodic review of official exchange rates were taken. Private trading companies were permitted to operate. (Handoussa 1988a p. 37). Moreover, the private sector was encouraged to export, and allowed to import through utilizing the facilities of the parallel foreign exchange market. Import licenses were granted more liberally than in the sixties; yet they were still required (Mabro and Radwan 1976 p. 74).

Despite the above, the growth of manufactured exports was hampered by improper domestic policies (Handoussa 1988a p. 37). First, the excessively high rates of effective protection offered by the structure of nominal tariffs to producers selling in domestic markets provided a strong anti-export bias. Second, a "chronically overvalued" exchange rate contributed to inhibiting exports (Handoussa 1988a p. 27). Finally, slow administrative procedures and unattractive incentive packages provided for exporters also inhibited exports. This inadequate access to foreign markets entailed a loss, as the export potential was not fully exploited and delays led to the accumulation of inventories and the emergence of idle capacity (Mabro & Radwan 1976 p. 74).

Since 1979, there have been major changes in the exchange rate regime. Before 1979, the range between the Central Bank and Commercial Bank rates on the one hand, and the free market rate (used to finance own exchange imports) on the other was rather narrow: $1 = 0.7 and 0.78 L.E. respectively. By 1981, this range widened significantly: 0.7 at the Central Bank, 0.84 at the Commercial Bank, and 1 at the free market. The multiple exchange rate system was thus formally in action. In addition, the "weighted average nominal exchange rate (had) increased to about 0.80" representing "a nominal depreciation of the Egyptian pound" (World Bank 1983 p. 87). Egypt finally freed the exchange rate at the end of 1985, which in turn led to a devaluation of the pound. Nevertheless, the cumbersome measures and bureaucratic delays for exporters (particularly the export tax rebate system) have continued into the eighties. By 1988, and as part of adopting the World Bank prescription, the government attempted to reduce bureaucratic export procedures (Handoussa 1988a p. 38).

Today, there is much talk about liberalizing trade. Bans on imports are being removed. At the time of writing this report, the price of cotton was finally being liberalized. The Egyptian stock exchange is beginning to function. There is talk of adjusting import tariffs to accommodate the needs of local producers, i.e. lowering the tariffs on imported inputs and raw materials as opposed to final products (especially those coming from the Far East).

II.2.2.5. Pricing Policies

In line with the above, pricing policies have changed, reflecting the general spirit of the political system. Throughout the sixties, administered prices were the norm for most manufactured goods. This was a consequence of public ownership extending over modern industry (Mabro & Radwan 1976 p. 71). Prices were fixed for both popular goods and luxuries, and for the same good even if it was produced in different plants. The unified price was based on cost plus a "fair" margin which would provide a "reasonable" profit to the producer. Government documents praise this system as it is said to provide an additional profit margin gained by factories that achieve cost cuts, and, conversely, an incentive to eliminate waste for high cost firms (Ministry of Industry and Mineral Wealth 1964 p. 317). Moreover, a subsidy was granted to factories that wished to export their products after comparing the cost price of the locally produced commodities and the market price of foreign counterparts. Exports were allowed only when the export price was confirmed to cover the cost of imported raw materials and a surplus to meet the remaining element of cost (Ministry of Industry and Mineral Wealth 1964 pp. 317-8).

In contrast to what seemed to prevail in the sixties, essential commodities and luxuries did not receive the same subsidy treatment in the seventies. Retail selling prices were regulated by the government in such a way that essential commodities were subsidized (usually at the expense of the enterprise) while luxury consumer goods were heavily taxed, even within the same industry. In the case of textiles, for example, rationed cloth and popular fabrics that catered to high income consumers were priced "above competitive international equivalents" (Handoussa 1978 p. 505).

According to Handoussa, price distortions could be attributed to three sets of conflicting forces. First, high effective protection for some intermediate good industries has increased the production costs for enterprises using these as intermediate inputs. On the other hand, a number of traded and non-traded inputs (e.g. petroleum fuels, cotton fiber, and transport services) were priced below their opportunity cost. Finally, retail prices have implied either a tax (consumer durables) or a subsidy (food products) (Handoussa 1978 p. 505).

The real price situation is described by Mabro and Radwan as "chaotic". Although price revisions were frequent, they often took place after sizeable lags in response to shortages or gluts "which they fail to cure". The price mechanism is described as being vague, and it is difficult to guess prices that clear the market. Rather than being set out to achieve specific objectives, price revisions take place for a variety of causes: foreign exchange constraints, rising costs in one firm, requirements for additional fiscal revenues, etc. The authors express their doubts that the Price Planning Agency created in the seventies has brought about any lessening of the chaos (Mabro & Radwan 1976 p. 71).

In addition to the above, there was price discrimination by type of product and also by type of ownership. The typical public sector firm faced regulated prices on its output, together with substantial subsidies on its commodity inputs. The extent of effective protection is determined by the extent to which these two sets of implicit subsidies and taxes offset each other. Most public enterprises in sectors that are competitive would probably prefer a system where they would be charged the tariff inclusive input price, but would be allowed to sell their output at the international price. For private sector firms, in contrast, the bulk of effective protection is delivered by the tariff structure. The role played by price controls and input subsidies is not as important as it is for the public sector. For the latter, "incentives are cumulative in the sense that implicit subsidies on inputs, where applicable, raise effective protection above the levels which would prevail in their absence" (World Bank 1983 p. xvi).

Handoussa agrees that Egypt's system of centralized price controls has tended to discriminate between the public and private sector, particularly discriminating against Law 43 firms. On the output side, private sector firms manufacture very few of the products that are subject to price controls (e.g. cement, soft drinks and selected food products). On the input side, Law 43 companies alone have been charged for use of energy and aluminium prices that are closer to international prices as compared to the highly subsidized prices charged to public and other private companies.

Domestic inputs used by public sector firms to produce basic consumer goods are underpriced, a policy which closely corresponds to subsidizing output selling prices (e.g. cotton seed used for vegetable oil industry, electricity and natural gas for the fertilizer industry) (Handoussa 1988a p. 39).

Handoussa explains that public sector companies sell their output under three price systems. First, a centrally-fixed pricing system applies to a limited number of basic commodities (19 products). These include cotton yarn, woollen yarn, refrigerators, washing machines, and passenger cars. Although many of these are subsidized through budget subsidies to the producer these are largely inadequate. The producer is still implicitly taxed since he sells at a price that does not recover full cost even after the receipt of the subsidy. Ex-factory prices[2] for these products remained the same for the period 1970-1985. Changes in these prices require approval by an interministerial committee chaired by the Prime Minister. These product groups account for more than 30% of the total value of output produced by companies affiliated with the Ministry of Industry. Under-pricing of these products imposes losses on public sector firms, which in turn, implies economic inefficiencies (Handoussa 1988a pp. 40-1).

The second pricing system for public sector companies is one which involves price negotiations between the firm and the supervising ministry, any other relevant ministry and sometimes the major customer. Prices are determined on a cost plus basis with a mark-up varying between 5% and 10% (about 900 products). This prevents any price increase except after long delays. The objective of this system was to hold down inflation. Handoussa argues, however, that "given the absence of fiscal and monetary restraint by the government", it has brought about exactly the opposite effect (Handoussa 1988a p. 42).

The third price system was introduced in 1984/5, as part of a gradual but significant process of price reform. It first applied to fuel, textile and garments sector (except for cotton yarn), but then gradually covered other groups of products, including engineering. Within this system of price liberalization, "enterprises are free to set their selling prices according to market forces" (Handoussa 1988a p. 43).

Price reforms included price revisions by the Ministry of Industry for a large number of products. Another reform started in 1985/6 involving the gradual elimination of explicit production subsidies through negotiations between the Ministry of Industry and the relevant purchasing ministries (supply, housing, economy, agriculture). The first set of commodities included within this system were popular cloth and cooking coal (1985/6) and fertilizers (1986/7). By 1986/7, products that were still receiving production subsidies were vegetable oil, and soap, milk, tinned food, tanned leather, and coke (Handoussa 1988a p. 44). With the remaining explicit subsidies being removed, Handoussa recommends that the next step "in the reform agenda" be "the elimination of implicit subsidies on inputs purchased" by public sector firms "and the gradual decontrol of selling prices" (Handoussa 1988a p. 45). Today, there is talk of freeing the price of cotton, in particular.

II.2.3. <u>The Sectoral Context</u>

Against this background, the share of industry (manufacturing plus mining) in GDP rose from 1960 until 1979 and then gradually returned to 1960 levels in 1987 and 1988 (see Table II.1). Declining oil revenues after 1984 may account for a part of the decline. The share of the manufacturing sector alone in GDP was 20% in 1960, reached a high of 28% in 1979, then declined to a disappointing 14% of GDP in 1987 and 1988 (see Table II.1). The share of agriculture in GDP decreased throughout the 1960-1988 period, and the share of services increased in the eighties, particularly in 1987 and 1988. Between 1960-1970 sectoral industrial GDP grew at an average annual rate of 5.4%. Between 1970-79, the rate became 6.8%, declining to 5.1% between 1980 and 1988 (see Table II.2). Manufacturing alone grew at an average annual rate of 4.7% between 1960-1970, 8% between 1970-1979, and 5.6% between 1980-1988 (see Table II.2).

In general, GDP growth rates were highest in the seventies. While services provided the major share (Table II.1), and exhibited the highest growth rate (Table II.2), manufacturing grew at a relatively high rate, especially when compared with agriculture (Table II.2). Growth rates for GDP as well as for all sectors were lower in the eighties than in the earlier decade (Table II.2).

Within the manufacturing sector, textiles (and clothing) firms have provided the major share of manufacturing value-added, with this share falling from 35% in 1970 to 27% in 1986 (see Table II.3). In contrast, machinery and transport equipment had the lowest share in 1970 (5%), but this share rose to 11% in 1975, and remained at or above this level up to 1986 (Table II.3).

Public and private companies monitored by the Ministry of Industry provided 80% of industrial output, at least in the eighties. From this category, textiles industries represented 24.3% of industrial output in 1982/3 and 21.9% in 1986/7, while the share of engineering and metal industries was 23.2% in 1982/3 and 19.7% in 1986/7 (Table II.4).

Within Ministry of Industry public firms, textiles constituted 25% of output and employed about 42% of the work force in 1989. Engineering constituted 11.4% of the output and employed 11.7% of the work force (see Tables II.5 and II.6).

II.2.4. Technological Framework and the R&D Environment:

In this section, we describe the development of the technological orientation of industry and survey the R&D environment in Egypt. Our analysis pertains to industry in general, with emphasis on engineering and textiles whenever possible.

II.2.4.1. Historical Background

Before 1952 (1920-1952), technological achievements were mostly related to the agricultural sector (Institute of National Planning 1985 p. 162). The relatively wide sphere of technological development in industry before 1952 was limited by foreign control of capital, occupation, and custom laws favoring foreign goods (Institute of National Planning 1985 p. 169). There was, however, a Department of Technical Research and Development in the army. This was established in 1947-48 for undertaking applied research for armaments and was funded by the army. According to Salah Hedayat, referred to by many as "the Father of Scientific Research in Egypt", the establishment of this unit marked the beginning of scientific research in Egypt (Hedayat, interview).

In 1952, the government initiated a project for developing the Wadi Al Natroun valley. Originally intended to insure the survival of the area, the project included pioneering research and development work that lasted for seven years. Research covered a number of areas: agriculture, food preservation, mineral water, glass, and soap. Mr. Hedayat is proud to have led this project. He considers it an important step for R&D in Egypt.

At that time, industry was using Western technology with foreign sources of funding, especially in spinning and weaving. Local technology was poor. Equipment, patents, and experts were imported (Abdel Rahman, interview). This trend continued for the first half of the fifties.

In 1956, two major developments occurred. First, the Foad I National Council for Research (established in 1939 and involved in funding some R&D programs in universities and different government departments and institutions in the late forties) was transformed into a national institute for research called the National Research Center (NRC) (Mahmoud 1986 p. 10). Moreover, the Supreme Council for Scientific Research[3] was established "as a central scientific body" to coordinate and set a scientific plan for directing scientific research in Egypt in the different fields of agriculture, industry, health, and production. The First Five Year Research Plan was drawn up to be implemented by existing agencies and bodies including universities, ministries and scientific research agents (Hedayat, interview).

During that time, particularly between 1957 and 1964, industry was following an ambitious program of industrialization, involving the centralization of management and of planning for innovation and development. More importantly, this program was totally tied to the Soviet Union's management and information systems. This period was the time of cooperation with the Soviets. The source of technology imports was changed to the Eastern Block, namely, the Soviet Union, Czechoslovakia, and Hungary (Abdel Rahman, interview).

While technology imported from the Eastern Block involved training workshops, Western machinery donors tended to keep the rights to provide maintenance, repair, and spare parts. As exports to the West fell, there was no foreign currency available for importing spare parts for old equipment based on Western technology. As a result, industry operated below full capacity. Under-utilization and lack of maintenance were partially responsible for lower quality production (Abdel Rahman, interview).

Paradoxically, since the development and maintenance of old factories (relying on Western technology) could not be undertaken by the Soviets, this situation led to some efforts at strengthening local technological capacity, and hence the development of indigenous research activities. The pharmaceutical industries, for example, were initially packing industries for raw material from the West (Switzerland, England, and others). In 1957, pharmaceutical factories were established to produce basic chemicals - a big step with reliance on indigenous capacities rather than either the West or the East. Iron and Steel industries were established originally by the Germans, then expanded by the Russians (Abdel Rahman, interview). In addition, this period witnessed the introduction of new technologies in petrochemicals, mining, food industries, chemicals, engineering and metal projects (Institute of National Planning 1985 pp. 192-3).

In fact, Egyptian industry underwent a "big technological leap" starting in 1957 (Institute of National Planning (INP) 1985 p. 175). This trend towards modern technology was affected by a number of factors. Among these was the general atmosphere of "almost total Egyptianization" of sources of power (search, generation, and distribution) (INP 1985 p. 184). Without a single turn-key project, investments were being directed more towards intermediate industries as opposed to the consumer industries as in the forties. These involved a larger scientific component (INP 1985 p. 185) and led to the development of local design capabilities[4] (INP 1985 p. 188). The State also encouraged the cooperation of universities with industry; the General Industrialization Organization established a division for industrial design (INP p. 190). Both the 1957 and the 1961 development plans involved the establishment of centers for vocational training (INP 1985 pp. 199 & 200). The latter entailed the expansion of university and technical education and graduate research work (INP 1985 p. 200)).

In particular, the period 1960-1964 witnessed a boom in scientific research in Egypt (Hedayat, interview). The Ministry of Scientific Research and Technology was established in 1960 in order to be responsible for the planning, implementation and follow up of the research plan.

Hedayat explains:

> Prior to the establishment of the Ministry, the First Five Year Research Plan was supposed to be implemented by existing agencies and bodies including universities, ministries and scientific research agencies. Although the universities bought buildings and offices, there was no implementation. The Supreme Council for Scientific Research was only a consultant/advisory body and did not have executive powers. Follow up was virtually nonexistent. Links were weak; they were left to the researchers' conscience. The researchers themselves were protective of their positions. That is why the Ministry was established in 1960 in order to be responsible for planning, implementation and follow up. In establishing the Ministry, we studied scientific research systems existing abroad. The presence of the Minister in the Cabinet makes him get a feel of the difficulties of every Minister. (Hedayat, interview)

In general, the sixties was the period for the creation and flourishing of scientific research in Egypt. In fact considerable gains were achieved in industry in the sixties because of the knowledge of a "competent group of managers and engineers that, relative to Egypt's stage of development, makes the country quite unique" (Handoussa, interview). These were "sophisticated recipients who borrow a technology with a full understanding of 'what is going on', and an ability to operate, manage, and even improve on the technology borrowed". In the pharmaceutical industries, for example, there were imports from different sources managed by competent people who knew how to manage the production process. In the heavy chemicals industry, the Talkha fertilizer plant was designed by Egyptians, and the extent to which the machinery was adapted to different conditions was quite remarkable. Other notable examples were textiles and petrochemicals (Handoussa, interview).

Yet as the sixties went on, the financial crisis became more and more pronounced, especially after the 1967 war. There were no external sources for financing industrial development. As a result, innovation was limited. Infrastructure (power, telephones) deteriorated (Abdel Rahman, interview). Nevertheless, the end of the sixties witnessed some modernization and renovation of industry - with a Russian base, yet based on stronger relations with the West. In 1971/2, Russian experts were expelled, and relations with the Soviet Union were curtailed.

On the whole, the experience of the sixties was short lived. Although some industrial bodies succeeded in breaking down some technological packages, such indigenous research efforts did not reach the degree of controlling the technology (El Issawi, interview). On the one hand, there was no consideration of some aspects of technology (transfer, absorption, local capabilities, adaptation, innovation) as part of the basis of choosing and approving investment projects (Institute of National Planning 1985 p. 200). On the other hand, it was not understood that research labs should be established prior to the plant in order to play a specific role in choosing appropriate technology, the adaptation of equipment to local conditions, treatment of raw materials to suit incoming technology, modification or addition to the latter (INP 1985 p. 200). Performance was measured solely from the financial accounting perspective, with no objectives set from the technological point of view (INP 1985 p. 200).

For this and other reasons, organic and legal links between research centers and production centers remained extremely weak. The former became academic institutions with publication being a prerequisite for promotion, and the latter became concerned with the quantity of production rather than its nature, quality, cost and development, and merely interested in budget figures (INP 1985 p. 201). In 1979, out of 15,000 PhD's in Egypt, only 42 were in industry, while 185 were in power and electricity, and 501 in agriculture.

No matter how the experience of the sixties is judged, the advent of the seventies witnessed a shrinking of technological awareness and national scientific advance. According to Hedayat, "Sadat did not visit one scientific institution in his life" (Hedayat, interview). Particularly after 1974, there was no technological development except in new industrial projects established by private capital - Egyptian, Arab, or foreign - with the approval of and, supposedly, under the supervision of the Investment Organization (INP 1985 p. 210). Such efforts, of course, were concentrated in the private sector.

The most important characteristic of technology acquisition in the seventies was reliance on Western sources. This meant concentrating on technology transfer and not building the indigenous base for technological development. Empirically, this trend was reflected in the transfer of technology product rather than technology itself, as there was no local achievement of industrial knowledge and skills which would allow gradual replacement of foreign experts and equipment (INP 1985 p. 212).

A study of a sample of projects contracted during this period showed 64% to include technical assistance of the technology transfer type, 46% of the projects incorporating a training element (INP 1985 p. 231). One third of the projects were among the highly scientific group (43 in food industries and 41 in spinning and weaving) . Engineering projects were only 11% of the total (INP 1985 p. 240). The authors of the Institute of National Planning report write:

> A close look into the nature of projects points to the low scientific level of the new industries compared to those undertaken during the period of planned development. In addition, the projects did not include any R&D labs, despite the funds received from foreign sources. Scientific and technical effort offered by foreign sources was confined to training of workers to use equipment, and in a few cases, working a quality control lab. Some of (these) projects actually represent an impediment to available, or even potential, local capabilities, as the import of primary or intermediate goods is set as a condition. In most, if not all, cases (except special goods such as soft drinks), local research capabilities could have developed the Egyptian product at least to the level of the foreign counterpart if funds equal to one year's dues to the foreign counterpart had been allocated to local research and development. Several of these projects involved the use of equipment embodying already-developed technology rather than the development of new technology (INP 1985 pp. 241, 243, 244 & 246).

Although the 'oil period' (1973-78) witnessed the flow of more funds for industry, the quality of industrial production deteriorated, especially when compared to the quality attained in the mid-fifties (e.g. textiles). There was less discipline and rigor in production. There was also looseness in management and a lower level of supervision. Most external funds came from Arab sources, and placed a strong emphasis on infrastructure rather than technology (Abdel Rahman, interview). Despite the above, local research improved. This included designing, supervision, testing, consultancies, as well as basic research in national research institutions. Still, technology was essentially foreign - namely Western (Abdel Rahman, interview) and work was mostly beneficial to the private sector.

Handoussa agrees that there may have been a trend towards turn-key projects in the seventies as one group of entrepreneurs did not have enough experience dealing with projects. These were the new rich who had only capital, but no experience, and hence were more inclined to develop turn-key projects. Yet, argues Handoussa, there was another group of old timers, who brought in the experience of the sixties to private sector projects in the seventies. These were former public sector employees who joined the private sector in the seventies. Handoussa agrees that most of the skills, training, and know how was acquired by the public sector in the sixties; the pool of knowledge was in the hands of pubic sector engineers. These moved into the private sector in the seventies. "There was a continuity not a break. What is different is the focus of the projects: much less emphasis on heavy industry" (Handoussa, interview).

With the start of the eighties, the abundance of external resources led to investment in industry on a very large scale. However,in 1984-85 the price of oil went down, and the quality of production generally fell. There were hardly any exports, hence no stimulation from outside or inside (Abdel Rahman, interview). In the second half of the eighties, however, the export drive brought about an improvement in quality, which was mostly achieved in the private sector. Compared to the public sector where the level of technology was not very high, the private sector was capable of importing technology. There was greater innovation at different levels, yet efficiency and productivity left much to be desired (Abdel Rahman, interview).

By 1990, the public sector firms trailed behind the expanding private sector. They suffered from the legacy of the policies of previous decades. The technological boom of the sixties was a distant past; whether there has been any significant technological development since then is questionable[5].

II.2.4.2. <u>Research and Development Environment</u>

In this section we present a survey of the R&D environment in Egypt, with emphasis on industry, particularly engineering and textiles. We review R&D expenditures, personnel, and infrastructure.

II.2.4.2.1. R&D Expenditures

> Tell me how much a nation spends on scientific research, and I will tell you what kind of nation it is, and what kind of people and what kind of international position this nation occupies. (Mansour, 1991b)

Egypt spends 1.2% of its GNP for research and development. Although the same as India (Al Akhbar 1992b), this level is low compared to developed countries and even to some developing countries (see Table II.7). In 1989, Japan[6] spent 85 billion dollars (3% of national income) on scientific research and development. This represented double what the country spent 10 years before (Mansour 1991b). In South Korea, R&D expenditure as percentage of GNP increased from 0.39% in 1970 to 1.28% in 1984 (Patel 1993 Table 4.4 p. 174). Egypt's ratio was 0.5% in 1969, 0.8% in 1979, and 1.2% in 1982 (Mahmoud 1986 p. 3).

The major source for the financing of R&D activities is the state budget. Other financial sources for R&D institutions include the production and service sectors (through sponsoring research contracts) as well as foreign and international R&D funding agencies (Mahmoud 1986 p. 3). Obtaining funds from the latter source "depends usually upon the personal efforts of the heads of institutions, and in rare cases on some priorities of national programs" (Mahmoud 1986 p. 3). In general, R&D activities are financed by a method of "global financing". This entails allocating a lump sum of money in the yearly budget of the concerned R&D institution. This allocation is usually made in local currency (Mahmoud 1986 p. 3).

II.2.4.2.2. R&D Personnel

In 1986, there were 52,180 scientists and engineers working in R&D institutions (part time and full time) (Mahmoud 1986 p. 2). These represented 452 per million of the population. This is a modest figure compared to an impressive 3720 for the Soviet Union, 2680 for the United States, and 2970 for the Federal Republic of Germany, and 4950 for Poland (see Table II.8). Of these scientists and engineers, only 16% were working in productive sectors, while 73.5% were in higher education 10.5% in general services). Of the 16% working in productive sectors, 35.8% were working in industry. The rest were in agriculture (57.8%), water works (3.8%), construction (2%), and transport and communication (0.6%) (see Table II.8). Accordingly, only 5.73% of scientists and engineers in Egypt are working in industry. This compares to about 70% for the United States (Mahmoud 1986 p. 5).

II.2.4.2.3. R&D Infrastructure

In 1986, there were 297 institutions performing science and technology (S&T) activities in Egypt. More than 90% of these are involved in R&D activities (275 institutions). Of these, 60 institutions are involved in R&D activities related to the productive sector while the rest are in higher education (184), and in general services (31) (Mahmoud 1987 p.4). Classified by field of research, more than 40% of institutions are involved in social sciences (44.1%). Medical sciences follow with 17%, then engineering and technology with 14.4% and natural sciences with 7%. The remaining 0.5% are multi-disciplinary (Mahmoud 1986 p. 3.).

Major R&D institutions within the government structure are grouped into 3 main categories: the Ministry of Higher Education (11 universities[7] plus Al Azhar which is affiliated with the Ministry of Awkaf), the Ministry of Scientific Research, and other Ministries including the Ministry of Industry (Mahmoud 1986, p. 6). (Details are presented in Annex II.1.) A major component of the Ministry of Scientific Research is the Academy of Scientific Research and Technology (ASRT), which has the National Research Center (NRC) as an affiliate.

Originally established in 1956 as "The Supreme Council of Science", (Mahmoud 1986 p. 10), and carrying several titles in the sixties, the ASRT was finally established in 1971 by a presidential decree (Mahmoud 1986 p. 11). The ASRT was assigned the responsibility for national science and technology policies since its original establishment in 1956. It is the national body which supports research and technology application. It is responsible for research planning, coordination, funding, and follow-up, as well as setting policies for linking research to application (Hebeish, interview).

The Academy is composed of thirteen specialized councils (magalis naw'eya) which "represent the research community" (Hebeish, interview). The councils "carry out ASRT functions (in planning and coordinating of scientific research at the national level), and mobilize science and technology manpower, independent of their sectoral belonging, to serve in national development priorities" (Mahmoud 1986 p. 12).

Among these councils is the Council for Industry Research. The Council is composed of individual members as well as representatives from universities and research centers. The main function of the Council is to formulate a research plan that supports and goes along with the priorities of the national development plan for the industrial sector (Hebeish, interview). Drawing up such a plan is a process that involves several steps. The Council starts by consulting institutions which include the Chamber of Industry, the National Specialized Councils, the Parliament (Maglis Al Shaab), and the Senate (Maglis al Shura) on the development priorities for industry. The Council then agrees on a number of research topics and suggested projects that coincide with the priorities of the industrial development plan and that provide the scientific and technical element to solve industry problems. Members of the Council then carefully review, screen, sort out, and short list these projects. They study the requirements, duration, and estimates of the required funding for each project. A conference is then held at the Ministry of Industry where this work is presented to the industry, including both the responsible Minister and company representatives. After several consultations and deliberations between the Council and the Minister of Industry, research projects are finally agreed upon. They are then advertized in the newspapers[8]. Applications are received by evaluation committees formed by the Council (of Industry in this case). All, or part of, the research funding is provided by the institution or company to benefit from the research (Hebeish, interview).

The First Five Year Plan 1982-87 was set following the above procedure, allocating 32,915,476 L.E. to research. Out of this allocation, the ASRT Specialized Council on Industry received 1.5 million L.E., representing 4.63% of budget allocation (see Table II.9) (ASRT 1990a p. 50). Of the thirty one industrial projects of the ASRT First Five Year Plan for 1982/3-1986/7, 26% were implemented in R&D institutions of ministries, as opposed to 29% in universities and 45% in R&D institutions of the ASRT (Mahmoud 1986 p. 37). Out of the total research budget of the Plan, 34.62% was allocated to universities, 38.59% to ministries, and 25.88% to research centers and institutions affiliated with the ASRT president (see Table II.10). Of the 12.8 million L.E. allocated to research with ministries, production ministries got 78.62%. The Ministry of Industry received a modest 2.55% of the total 12.8 million (an amount of 323,360 L.E. representing 3.24% of the subtotal accorded to production ministries) (see Table II.11). Of the 8.5 million allocated to research centers and institutions affiliated with the ASRT president, NRC received 43.05% or 3.7 million L.E. (ASRT 1990a p. 55).

The Second Five Year S&T Plan: 1987-1992 extended to other areas not covered by the councils (ASRT 1990a p. 85). Research projects in the plan covered by the Specialized Council on Industry numbered 64: 3 phase II, 11 ongoing, and 51 new projects (ASRT Table 8 p. 88). This is almost double the number of projects in the previous plan (33 projects).

In addition to its major responsibility of planning the science and technology policy for Egypt, the Academy is also responsible for the overall management of eight research institutions, the largest and most important of which is the National Research Center (NRC). NRC possesses almost 70% of human and material resources of all ASRT institutes (Mahmoud 1986 p. 15). The Center received 43.05% of the research funds accorded to all the research institutions affiliated with the Academy under the Five Year Research Plan 1982-1987 (3.7 million L.E. out of 8.5 million L.E., and 40 out of 81 research projects) (Academy of Scientific Research 1990a p.

55). In fact NRC is the largest R&D institution in Egypt (El Refaie, interview). It employs more than 3000 scientists (Masters and PhD holders) (Al Akhbar 1992b).

NRC was established in 1939 as a prototype named Foad I National Council for Research (Mahmoud 1986 p. 10). It reflected an awareness of the need for establishing specialized R&D institutions "to cater for the development of different Egyptian industries". This awareness was coupled with a realization of the financial and technical infeasibility of establishing such institutions inside the industrial enterprises themselves (Mahmoud 1986 p. 24). Accordingly, The Council was established, and by the late forties, its activities involved financing some R&D programs in universities and several government departments and institutions. In 1956, the Council became a national research institution and was called the National Research Center (NRC) (Mahmoud 1986 p. 10). NRC was intended to undertake R&D activities "contributing to national welfare" (Mahmoud 1986 p. 15). Specifically, the NRC founding charter describes its objectives as "the promotion of scientific research, both basic and applied, specially in the fields of industry, agriculture, medicine, and all matters related to the National Economy" (Mahmoud 1986 p. 25).

The Center underwent three stages of development. In the first ten years, the Center policy concentrated on the development of research staff in all branches that serve the national economy (El Refaie, interview). Efforts towards this end included granting scholarships, encouraging young university faculty staff to join the NRC , sending them abroad to specialize in applied research, and inviting foreign professors to supervise applied research carried out at NRC. These practices resulted in an expansion in the human resource base of NRC. Between 1956-1961, many new units for industrial R&D were opened. Among these were units for metallurgy, textile dyeing and finishing, textile spinning and weaving, electronics, and mechanical engineering (Mahmoud 1986 p. 25). Although research efforts during that time were described as "self oriented" with secondary relevance to national development (Mahmoud 1986 p. 17), some few researchers maintained personal contacts with their respective industries and solved some of their problems (Mahmoud 1986 p. 27). In fact, this was the time when the foundations were laid for a strongly industry-based research institution.

Starting gradually in the sixties, and for the next ten years, there were more applied research activities. Center management started contacting companies and production sites (El Refaie, interview) within a general policy of a "gradual and systematic interaction" with the production sectors (Mahmoud 1986 p. 27). Among the steps taken in this regard was the "twinning" of the NRC departments (particularly those that were industrially oriented) "with the respective production firms through formation of a joint committee in the industrial firm itself formed from the personnel responsible for production and R and D personnel from the Center". In addition, training courses, seminars, and conferences were organized for the production personnel "to upgrade their knowledge and keep them up to date with the latest technological advances in their respective fields". According to NRC ex-head Dr. Mahmoud, about 60% of the contract research sponsored during this period was directed to the local production sectors (Mahmoud 1986 p. 29).

In the mid seventies, activities of the NRC were limited to five major areas: food and agriculture, industrial research, energy, health and environment, and natural resources. A new R&D management system was introduced in which researchers were allowed to use funds from the NRC budget only if they chose research problems that addressed national priorities in the five major areas (Mahmoud 1986 p.28). Center activities became oriented to solving specific economic or national problems within the framework of national development priorities (El Refaie, interview).

In line with its special areas of research, the Center comprises 13 divisions which in turn are subdivided into specialized laboratories or departments. A total of 56 laboratories and two institutes make up the functioning R&D body of the NRC (Mahmoud 1986 p. 15). In the engineering field, the Engineering Research Division includes 94 researchers, and 70 assistants, who are divided into three departments (El Refaie, interview). The Textile Research Division included a total of 39 researchers and research assistants in 1987 (Mahmoud 1987 p. 56).

NRC receives its funding from three sources. The bulk of the funding is provided by the government as a yearly budget allocation. This allocation covers salaries of R&D personnel, operating and capital expenses (Mahmoud 1986 pp. 16). In addition, NRC receives research grants from the Academy and other external funding sources (domestic and foreign). Finally, contract research is a major source of NRC funds (Mahmoud 1986 p. 17).

The system of contract research was gradually introduced by NRC in the seventies so that production sectors could "bring their problems related to raw materials, processing, productivity and quality control, etc to NRC" (Mahmoud 1986 p. 27). Contracts are of three types: internal, local, and foreign. Internal contracts are signed by the head of NRC and the researcher to undertake a certain project (NRC funding). Local contracts are funded from companies, institutions, and ministries from their budget, and are aimed at solving problems, developing industries, or otherwise serving these different sectors. The contract is therefore between the company and the head of NRC. Finally, contracts between NRC and foreign agencies pertain to research undertaken by the former and funded by the latter (El Refaie, interview).

Between 1975-80, about 152 contracts were signed between the NRC and three categories of sponsors: production sector companies (mainly industrial firms from both the public and private sectors), the ASRT (which gave research grants to the NRC for certain national priority problems), and international and foreign funding agencies (Mahmoud 1986 p. 29).

Also affiliated with the Academy is the Technical and Technological Consulting, Studies and Research Fund, which was established by presidential decree 67 in 1988. The Fund was established "to make use of national applied research centers and Egyptian universities as national expertise 'houses' (beyout khebra)". In fact, the objective of the Fund is to change the slogan of scientific research centers and universities into national beyout khebra (Al Ahram 1992a). Its Board includes all Heads of the Ministry of Scientific Research and its institutions, as well as representatives of universities, the Ministry of Industry, and other renowned personnel (Ministry of Scientific Research 1990). Since its establishment in 1988, the fund has been involved in more than 65 projects for different agencies (Al Ahram 1992a).

In addition to the above, Madinet Mubarak (Mubarak City) was being established at the time of writing this report. According to Adel Ezz, then Minister of Scientific Research; "We do not need more than 5% foreign expertise, provided these foreign experts work among the Egyptian work teams, so that we can rely on ourselves in the rare fields, and this is the philosophy on which Madinet Mubarak for Scientific Research is based." (Al Ahram 1992a)

II.2.4.2.4.Conclusion

On the whole, one has to give credit to the government's efforts in the sixties aimed at establishing the foundations of a strong scientific base and encouraging indigenous R&D activities (investment in R&D infrastructure and personnel). Unfortunately, research is a long-term investment. The efforts of the sixties were interrupted, or at least distracted, by the technological orientation of the seventies, leaning more towards imported technologies rather than indigenous efforts. The trend towards 'turn-key' projects was a case in point. This occurred mostly in the private sector. Since then, technological developments in the public sector have been limited.

The experience of the sixties, at least as far as R&D is concerned, was certainly short-lived. The links between the R&D bodies and users, particularly the public sector, were not given enough time to develop. Despite sporadic individual stories of success, a coherent R&D plan, from the initial stage of priority setting until application and follow up, was missing. The mere investment in research, therefore, was not sufficient to ensure technological development. El Haggar writes:

> Scientific research in Egypt has failed to cope with the requirements for technological development. Egypt is still suffering from the lack of a comprehensive well studied research plan, the lack of coordination between the different research agencies, and the reliance of these centers on the annual funding from the state, without follow up for the quantity and quality of work. (El Haggar, 1991a)

II.3. The International Context

In this section, we move from the domestic to the international scene. We look at major international developments pertaining to engineering and textile industries since the sixties. Such developments involved changes on both the supply and demand side, shifts in international comparative advantage, expansion in world trade, and the emergence of the 'Newly Industrialized Countries' of Asia.

In the engineering industries, the introduction and development of the microchip technology in the seventies was a turning point in engineering, particularly electronics, technology. The introduction of personal computers for the first time by IBM at the start of the eighties was followed by the development of computer software and expansion in computer memory. Since then, the vast expansion and rapid advance of computer technology has been unprecedented. Rising wage levels and increasing capital intensity have been characteristic of electronics production. The increased use of automation in the production of other engineering goods was part of the rapid advance of Western technology. This technology was adopted and developed by the Japanese later in the eighties, and later by the Newly Industrialized Countries (NIC's) of the Far East. This was accompanied by a generally changing demand in favor of Japanese (and later NIC) engineering products; particularly cars, electronics, and electrical products.

World trade in engineering products expanded considerably, particularly in the seventies. While growth rates for engineering exports varied between 16.5% and 25% for developed countries in the seventies (see Table II.12), figures ranged between 38-50% for some developing countries (Brazil, Singapore, South Korea, Turkey and Hong Kong) but was only 26% for India. While growth rates for both groups were generally lower in the eighties, growth rates for some developing countries still exceeded those of the developed countries.

Throughout the eighties, international trade in engineering goods grew at around 7% annually (in real terms). Many developing countries have been part of this growth. Exports of engineering goods increased from almost nothing in 1965 to more than US$ 18 billion in 1987 for the thirty five "lower middle income" countries (GNP ranging between US$ 500 and US$ 2000 in 1987). In fact Jordan and Tunisia, whose economies are much smaller than Egypt, export more than US$ 100 million annually, which is three to four times more than Egypt (see Table II.13 and World Bank 1989b p. 3).

In the textiles industry, major developments since the 1960's included rapid technological advance, increasing wage levels, changes in consumer tastes, and the increased use of synthetic fibers and their blends (De Vries and Brakel 1983 p. 7). The latter development, together with the fast growth of the knitting industry, geared production towards yarn and away from woven fabrics. Accordingly, the competitive position of large integrated textile mills deteriorated compared to that of man-made fibers and yarn producers (De Vries and Brakel 1983 p. ii).

As technology advanced at a rapid rate, some branches of the industry were able to adjust to the high costs of labor. Increased investment in new, faster and more automated equipment, and the increasing use of modern production techniques, have resulted in higher efficiency and a rapid increase in the capital intensity of the process of spinning and weaving (De Vries and Brakel 1983 p. 7). This development marked an important shift in international comparative advantage in textiles from low-wage to industrial countries. LDC's remained competitive only with respect to downstream low wage and low value-added activities (De Vries and Brakel 1983 pp. 24-5).

Some of these countries, however, have adapted to the new world scene. They did not totally lose their competitive edge in spinning and weaving. Countries like South Korea, Hong Kong, and Taiwan "have quickly learned how to master and adopt new technology in standard textiles" (De Vries and Brakel 1983 p. 25). Morocco and Turkey (see Table II.14) "followed more or less the Asian pattern of shifting export emphasis away from lower value-added products to higher value added products" in the 1980's (World Bank 1991 p. 55). These countries have succeeded in capturing a larger share of the world textile market. By the middle of the eighties, the share of developing countries in world textile exports was 32%, compared to only 15% in the middle of the fifties (World Bank 1991 p. 52).

In addition, developing countries have gained (and/or maintained) comparative advantage in apparel manufacturing since technological innovation in the developed world was not as marked in this area[9]. Accordingly, several manufacturers in the industrialized countries closed down a large part of their textile industries. In order to survive, the remaining manufacturers had to relocate at least the apparel part of their production to lower wage countries. By the mid eighties, the share of the developing countries in world garment exports was 53%, compared to only 15% in the mid fifties (World Bank 1991 p. 52).

For newly industrialized countries, both engineering and textiles have been the driving force behind their rapid development. In Hong Kong, for example, industrial growth has been based largely on the expansion of textiles and garments. Since the late 1950s, watches, electronics, and metal engineering, together with textiles and garments have been the most important industries, accounting for two fifths of its exports (Berger & Hsiao 1988 p. 230). In Taiwan, mens' and boys' garments and calculating machines recorded excellent growth rates between 1972-84. In particular, exports of calculators and accounting machines jumped from 0.7 million pieces in 1982 to 1,838 million pieces in 1983, and grew further to 5,444 million pieces in 1984 (Berger & Hsiao 1988 p. 194). In South Korea, electronics is considered to have been the most technologically dynamic sector in the economy (Patel 1993 p. 182).

South Korea provides a particularly interesting case for comparison as in the fifties it portrayed characteristics of underdevelopment that were very similar to those of Egypt. Handoussa writes:

> (South Korea) is said to have shared with Egypt all of the burdens of poverty and underdevelopment combined: a heritage of colonisation which retarded education and diversification of the economy, dependence on one cash crop (Korea's rice corresponding to Egypt's cotton), an inherent resource imbalance with very limited agricultural land coupled with overpopulation, and a subsistence level of income for the majority of the population. In addition, Korea has early suffered from its partition in 1945 followed by the devastating war between North and South in 1950- 53... Today (1986), South Korea has surmounted the most difficult stage of its development process .... It has brought population growth to manageable levels and has retained a remarkably equitable distribution of income for its 40 million citizens, while raising the average per capita income to $2000 (as estimated for 1984) up from $87 in 1962. This compares with Egypt's per capita income of $750 in 1983, up from $150 in 1960. (Handoussa 1986 pp. 5,6)

In South Korea, total factor productivity (TFP) changes in textiles and engineering industries stand in sharp contrast to Egypt. While the annual percentage change of TFP in cotton textiles in Egypt between 1973 and 1979 was negative (-2.0%), the figure for Korea (between 1960-1977) was 1.62% and 4.51% for textiles as a whole (World Bank 1983, p. 235).

In the fabricated metals and machinery industries, average annual TFP change in Egypt was 0.46%, while in Korea it was 5.73%. The average annual TFP change for electric machinery was 3.81% for Egypt, while in Korea it was 7.25% (see Table I.12 in Chapter I). Corresponding figures for Japan also stand in sharp contrast to those for Egypt.

To sum up, developments on the world scene since the seventies have provided an opportunity for developing countries to expand their production and trade in engineering and textiles industries. The Newly Industrialized Countries of Asia (NIC's), and countries like Turkey and Morocco, have succeeded in exploiting this opportunity. Egypt's performance will be the subject of the coming chapters.

II.4. Conclusion

In this chapter, we presented the domestic and international framework within which engineering and textiles industries have operated in the period under research. To summarize, the changes in the political system after the 1952 revolution, particularly those occurring in the early sixties, have continued to influence the economic system, at least until the time of writing this report. Although the 'Open Door Policy' brought about several developments towards a market economy, these took place mostly in the private sector. The public sector was always constrained by policy restrictions that were deeply rooted in the socialist drive of the sixties. In fact the Open Door Policy only managed to create a sharp dualism between the private and public sectors in the economy. Such dualism was not in favor of the public sector. For one thing, the private sector was in a position to offer high wages to its employees, which meant attracting higher caliber labor. In addition, private enterprises had the resources to procure modern technology, even if it was 'turn-key'.

The above-mentioned developments were reflected in the technological orientation of the industries: the sixties witnessed a scientific boom, a trend towards utilizing indigenous technological capacity, perhaps with an Eastern Block influence involving a large training component. With the advent of the Open Door Policy, there was an expansion in the adoption of Western technology (without much training), and at a larger scale in the private sector. This expansion meant the reliance on imported rather than local R&D output (no training and no maintenance).

Finally, on the international scene, the stage was set for countries like Egypt to join the expansion in production and trade in these industries. The NIC's have certainly seized this opportunity. How Egyptian engineering and textiles industries have operated in this context will be examined in the next two chapters.

Table II.1

Percentage Share of Industry and Manufacturing in Egypt's GDP

(data on GDP in millions of current US $)

Year	Industry (%)	Manufacturing (%)	Agriculture (%)	Services (%)
1960	24	20	30	46
1965	27	n.a.	29	45
1978	30	25	29	41
1979	35	28	23	42
1983	33	n.a.	20	47
1984	33	n.a.	20	48
1985	31	n.a.	20	49
1987	25	14	21	54
1988	25	14	21	54

Source: World Bank, World Development Report, various issues.
Notes: (from World Development Report 1990 pp. 246-7)

1. GDP measures the total output of goods and services for final use produced by residents and non-residents, regardless of the allocation to domestic and foreign claims. It is calculated without making deductions for depreciation of "man made assets or depletion and degradation of natural resources".
2. Figures for GDP are dollar values converted from domestic currencies using official exchange rates. For a few countries where the official exchange rate does not reflect the rate effectively applied to actual foreign exchange transactions, an alternative conversion factor is used.

Table II.2

Average Annual Growth Rates of GDP, National and by Sectors, 1960-1988*

Years	GDP	Industry	Manufacturing	Agriculture	Services
1960-70	4.5	5.4	4.7	2.9	5.1
1970-79	7.4	6.8	8.0	2.7	11.0
1980-88	5.7	5.1	5.6	2.6	7.3

Source: World Bank, World Development Report, various issues.

*Partially rebased 1980 constant price series in domestic currencies are used to compute the growth rates in Table II.2. (World Development Report 1990 pp. 246-7)

Table II.3.

Percentage Distribution of Manufacturing Value-Added

Year	Food & Agriculture	Textiles & Clothing	Machinery & Transport Equipment	Chemicals	Other Manufacturing
1970	22	35	5	7	32
1975	17	34	11	13	25
1978	21	28	12	8	31
1982	20	26	13	9	32
1984	24	29	13	8	26
1986	20	27	13	10	31

Source: World Bank, World Development Report, various issues.
Notes: (from World Development Report 1990 p. 248)

1. Data for distribution of manufacturing value-added among industries are provided by the UNIDO, and distribution calculations are from national currencies in constant prices.
2. Data for 1984 and 1986 are in constant 1980 prices. Data for 1978 are in constant 1975 prices. Data for 1970 and 1975 are in constant 1970 prices.
3. The category 'other manufacturing' includes a number of industries including: wood and related products, paper and related products, petroleum and related products, basic metals and mineral products, fabricated metal products and professional goods, and other industries.

Table II.4

Percentage Share of Industrial Output and Average Growth Rate for Textiles and Engineering Industries

	% share of industrial output		Average Growth Rate
	1982/3	1986/7	82/3-86/7
Textiles	24.3	21.9	0.4
Engineering (& metal industries)	23.2	19.7	-1.2

Source: World Bank 1989a, vol 1, p. 11.
Note: Table covers public and private companies monitored by Ministry of Industry, which produce 80% of industrial output.

Table II.5

Distribution of Output of the Ministry of Industry By Subgroup of Industries (1989/90)

Industry	Output (1000 current L.E.)	Share (%)
Textiles	3,995,826	25.04
Food	5,463,704	34.25
Chemical	2,226,802	13.96
Engineering	1,810,765	11.35
Metal	2,166,334	13.58
Mining	289,908	1.82
Total	15,953,339	100.00

Source: Based on Ministry of Industry Performance Evaluation Reports, various issues.

Table II.6

Distribution of Work Force of the Ministry of Industry
By Subgroup of Industries (1989/90):

	Thousands of persons	Share (%)
Textiles	235	41.74
Food	104	18.47
Chemical	69	12.26
Engineering	66	11.72
Metal	62	11.01
Mining	27	4.80
Total	563	100.00

Source: Based on Ministry of Industry Performance Evaluation Reports, various issues.

Table II.7

R&D funding and Personnel in Selected Countries
(Various Years)

	R&D funding (% of GNP)	Scientists & Engineers per million population
USA	2.6	2,680
UK	2.5	n.a.
FRG	2.5	2,970
Soviet Union	2.1	3,720
Japan	2.5	n.a.
Egypt	1.2 (estimated)	452
Poland	n.a.	4,980

Source: Compiled from different tables in Mahmoud 1986 p. 4.

Table II.8

The Distribution of Egypt's Scientists and Engineers Among Higher Education, Productive, and General Services Sectors

Sector	Number	% of Total	% of Productive
Higher Education	38,341	73.5	
Productive	8,373	16.0	100.0
Agriculture			57.8
Industry			35.8
Water Works			3.8
Construction			2.0
Transport & Communication			0.6
General Services	5,466	10.5	
Total	52,180	100.0	

Source: Compiled based on Mahmoud 1986, p. 2.

Table II.9

Distribution of Research Projects in the Five Year Plan, 1982/3-1986/7, According to Research Fields

Field	Projects Number	Projects Funding (L.E.)	Share(%) of Number	Share(%) of Funding
Resources & Production	146	23,427,887	45.63	71.19
of which Industry	33	1,522,614	10.31	4.63
Services	68	4,290,643	21.25	13.03
Infrastructure	38	3,116,453	11.87	9.46
Socio-economic Developments	39	892,144	12.19	2.71
Basic Services	29	1,188,349	9.07	3.61
Total	320	32,915,476	100.00	100.00

Source: ASRT 1990a, p. 51.

Table II.10

Participation and Funds Allocated to Various Agencies in the Five Year Plan, 1982/3-1986/7

Agency	Participation		Funding	
	Number of Projects	Share(%)	Current L.E.	Share(%)
Universities	125	39.06	11,395,670	34.62
Ministries	102	31.88	12,703,306	38.59
Research Centers & Institutions affiliated to ASRT President	81	25.31	8,519,725	25.88
Other	12	3.75	296,775	0.91
Total	320	100.00	32,915,476	100.00

Source: ASRT 1990a, p. 52.

Table II.11

Distribution and Funding of all Projects
in the Five Year Plan 1982/3-1986/7 by Ministry

Ministry	Projects Number	Projects Funding (L.E.)	Share (%) Number	Share (%) Funding
Production Ministries	54	9,987,602	52.94	78.62
of which Industry*	7	323,360	6.86	2.55
Services Ministries	31	993,179	30.39	7.82
Infrastructure Ministries	17	1,422,525	16.67	13.56
Total	102	12,703,306	100.00	100.00

*This represents 2.55% of the total funding.

Note: Although production ministries received 78.62% of the total funding accorded to all ministries, industry got only 2.55% of the total or 3.24% of the funding accorded to production ministries).

Source: ASRT 1990a, p. 54 Table 5.

Table II.12

International Comparisons of Growth Rates of Engineering Exports, 1970-80 and 1981-87

	Annual Growth Rates (%) 1970-80	1981-87
Developed Countries:		
France	20.0	5.1
Germany	18.3	8.5
Japan	25.0	11.1
United Kingdom	17.5	3.5
United States	16.6	3.9
Developing Countries:		
Brazil	43.0	4.2
Singapore	38.0	13.8
South Korea	41.0	22.8
Turkey	50.0	59.9
Hong Kong	44.0	10.3
India	26.0	-4.0

<u>Source</u>: World Bank 1989b, Annex 5, Table 8.

Table II.13

Exports of Engineering Goods, Selected Countries
1965 and 1987
(millions of 1987 US$)

Country	Exports of Engineering Goods 1965	1987
Mexico	45	5,800
Malaysia	98	4,800
Thailand	0	1,400
Turkey	0	700
Philippines	0	300
Jordan	0	130
Tunisia	0	130
Egypt	10	47

Source: World Development Report, EGITALEC, World Bank 1989b, p. 4.

Table II.14

Share of Textile* Exports in the OECD Markets

Country	Share (%) 1970/71	1980/81	1987	1988
Egypt	0.13	0.19	0.25	0.18
Turkey	0.19	0.55	1.92	1.95
Morocco	0.14	0.31	0.56	0.64
Tunisia	0.05	0.53	0.54	0.55

* Textiles includes yarn, fabrics and clothing.

Source: World Bank Trade Reporting System Oct 1990, from World Bank 1991, p. 55, Table 5.6.

Annex II.1: Affiliation of Major Government R&D Institutions

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1. Ministry of Higher Education (11 Universities + Azhar University affiliated with the Ministry of Wakf and Al-Azhar)

2. Ministry of Scientific Research - Academy of Scientific Research and Technology (8 centers)
    including
    - National Research Center
    - Central Metallurgical Research and Development Institute

3. Other Ministries (13 Ministries)
    including
    - Ministry of Industry and Mineral Wealth
        including
        - Tibbin Institute for Metallurgical Studies
        - Electronic Industries R and D Center
        - Engineering and Industrial Design Development Center
        - Food Canning Development Center
        - Plastic Development Center

Source: Mahmoud 1986, pp. 6-7.

Notes

[1] Information on tariff rates for selected commodities 1946-47 and 1958-59 (table 4.2 in Mabro & Radwan 1976, pp. 56-57), shows that with the exception of some fuels (gasoline, and kerosene), and some machines and capital goods (boilers, steam engines, looms and machines for industry, machine tools, parts and components), all other items in the table experienced a rise in basic tariff percentage and/or total percentage rate (textile, sugar, non metallic products, chemical industry, paper industry, beverages & tobacco, leather and leather products, consumer durables and cars, cereals).

[2] Selling price of the factory to the wholesaler.

[3] The Supreme Council later became the Academy of Scientific Research and Technology by a presidential decree in 1971.

[4] The authors admit that few projects were designed totally by Egyptians, yet the contribution of Egyptians in designing plants, and choosing and comparing equipment is still a rich technological experience (p. 189).

[5] Dr. Abdel Rahman points out the military industries as one exception where large advances have been achieved in production, partly related to the development of technology. Both the Ministry of Military Production and the Arab Industrialization Organization have been the source of military, as well as civilian, production with a high level of technology (Abdel Rahman, interview).

[6] According to Mansour (Mansour 1991b), Japanese companies spent 59 billion dollars on R&D; Japan's private sector spent 68 billion dollars on scientific and applied research, including physics, chemistry, life sciences, genetic engineering, mathematics but excluding humanities, which has another budget. In general, 2-3% of national income should be allocated to scientific research. In 1990, the United States spent 129 billion dollars on R&D.

[7] In the seventies, the "universities introduced contract or sponsored research systems" to undertake R&D oriented to serve the production sectors (Mahmoud 1986 p. 38). Universities also get) "funding from production sector companies, ASRT, or international funding agencies" (Mahmoud 1986 p. 39).

[8] At the time of writing this report, the Academy was already advertizing for projects for the Third Five Year Plan 1992-1997.

[9] According to De Vries and Brakel, although innovation was less marked in the clothing industry, several industrial countries were able to continue expanding certain lines of clothing including exports through improving the quality and style (De Vries and Brakel 1983 p. ii).

CHAPTER III

ENGINEERING INDUSTRIES

III.1 Introduction

In this chapter, we focus on the performance of public sector engineering firms. Specifically, our purpose is to examine indicators of technical change, total and partial factor productivity (TFP and PFP), and test the importance of research and development (R&D) in production. We also test for structural change in performance.

Throughout the chapter, we focus on the analysis of technical change, factor productivity, and the role of R&D. We will also examine the behaviour of these factors in different subperiods, and attempt to link the results to policy and historical factors.

We start with a brief overview of the policy and historical background, followed by a discussion of the structure and overall performance of the engineering industry. We next present our econometric model, estimation procedure and data. This is followed by a discussion of the empirical results. A summary of conclusions on technical change, productivity and the role of R&D in the public sector engineering industries will conclude this chapter.

III.2. General Background

The Egyptian engineering industry has been dominated by firms that were founded in the mid-fifties and nationalized as part of the wave of the sixties (World Bank 1989b, p. 2). In recent years, and particularly since the adoption of the Open Door Policy in 1974, there have been gradual additions to private sector capacity (World Bank 1989b p. 5), as a result of private domestic and foreign investment (World Bank 1989b p. 6) in the engineering industry. In general, there were attempts at decentralizing government control of public sector firms (World Bank 1983 p. 219). Despite this "considerable private sector activity" (World Bank 1989b p. 5), the public sector has continued to dominate the engineering industry. The industry also continues to be influenced by deeply rooted policies that reflected the spirit of the sixties. For example, employment policies continue to reflect state support for workers. The prohibition of firing and the relative deterioration of wage levels have led to an overabundance of relatively unmotivated and underskilled labor, at least when compared with their counterparts in the private sector (World Bank 1989b p. 8). Barriers to exit (resistance to plant closures), and entry (lengthy approvals and bureaucratic requirements put on the private sector) have also continued to prevail, throughout the period under study (1975-1989). Moreover, price restrictions continued with "(t)he price controlled items from the public sector engineering industries includ(ing): television sets, washing machines, refrigerators, air conditioners, motorcycles, bicycles, and lamps (light bulbs)" (World Bank 1989b p. 37). Input prices were also controlled.

In addition, trade restrictions continued throughout the seventies and eighties. During the period covered by the research, Egyptian engineering industries have enjoyed "substantial protection from imported finished products in the form of quantity restrictions (banned imports) and tariffs" (World Bank 1989b p. 36). Most of the engineering goods produced in Egypt were included on the 1986 list of banned imports and its update in 1989. The list included more than seventy categories of engineering products, among which were most domestic appliances produced in Egypt, e.g. refrigerators, dishwashers, washing and drying machines, fans, and air conditioners (World Bank 1989b p. 36). The list also included motor vehicles, tractors, motorcycles, fans, sinks, pumps, filing cabinets, generators, motors, converters, and many other items (World Bank 1989b annex 5 table 9 pp. 1-4).

The tariff structure was also a hindrance to imports. Finished goods that could be imported were set at a maximum tariff rate of 110% (World Bank 1989b p. 36). The tariff rate on parts varied depending on the share of domestic value-added in the finished product, and the local availability of the imported part. If domestic value-added exceeded 50%, the rate would be 20-30% on imported parts and 5% on raw materials (World Bank 1989b p. 36). Such trade restrictions prevailed despite the trend to liberalize trade and exchange control regulations in the second half of the seventies. As bilateral trade deals were abolished, the exchange rate was "substantially liberalized" (World Bank 1983 p. 219). Exchange rate liberalization is said to have benefitted engineering firms. "The sharp devaluation of the Egyptian pound (for the public enterprises) and the more gradual devaluation (for the private companies), is causing both private and public manufacturers to seek more domestic sources of inputs, thereby encouraging small private sector feeder industries" (World Bank 1989b p. 38).

While exchange rate liberalization may have eased the functioning of the producing firms, it eventually led to a drop in the real value of the Egyptian pound (an increase in prices - see the sharp increase in prices after 1986 in Table III.2), and accordingly the relationship between the values of these firms' production in current and constant prices.

Figures for the value of output in constant L.E. present a totally different picture from that portrayed by current L.E. figures (see Tables III.1 & III.3 and Fig. III.1 & III.2).

The problem with the fall in the value of the Egyptian pound was magnified in the early eighties. The cut in Arab aid after Sadat's bold measures to make peace with Israel dealt a strong blow to the Egyptian economy at large. The foreign exchange crisis in the eighties was naturally coupled with soaring prices. With engineering products being mostly price controlled, yet including a high import content, they suffered from the evils of an inconsistent policy of constrained liberalization. On the one hand, rigidities prevailed, mostly coming from labor policies, price controls, trade restrictions and a still overvalued exchange rate. On the other hand, attempts at 'opening the door' and offering privileges to an expanding private sector amounted to a severe dualism in the economy. The heavy burden fell on the public sector firms, who suffered from idle capacity partly due to foreign exchange shortages as well as the lack of know-how needed for the maintenance of imported Western machinery.

III.3. Structure

The private sector has been expanding in the engineering industry in the recent years. In 1983, the private sector included 250 small engineering firms which produced 16% of the industry's output (World Bank 1989b, p. 5). The number of unregistered 1 or 2 person engineering workshops was estimated to have been 17,000 in 1983. Between 1983 and 1987, local private investment in engineering grew by 31% annually, and the share of the sub-sector in total private industrial investment increased from 4% to 9%. Over the same period, private foreign investment also increased at an annual rate of 22% (World Bank 1989b, p. 8). The number of private companies established in response to the Open Door Policy reached a total of 29 by the end of 1986 (CAPMAS 1988). In 1987, the World Bank estimates the contribution of private firms to engineering industry output to have reached 25% (World Bank 1989b, p. 5). This contribution is 20% of value-added according to Table III.4, based on 1988 estimates. The 1988 estimate of the number of private sector companies is 250. Finally, while the nominal public investment allocation under the Second Five Year Plan (1986/7-1991/2) equalled the allocation in the First Five Year Plan (1980/81-1985/6), in real terms it has declined (World Bank 1989b, p. 7).

Despite the above, the public sector clearly has continued to play a significant role in the engineering industries. Within the public sector, there are 39 companies[1] in the engineering industries, 19 of which are held by the Engineering Industries Corporation (EIC; now the Engineering Industries Holding Company) of the Ministry of Industry (MOI). These employed 11.27% of the labor force, and produced 11.35% of output in the Ministry of Industry affiliated industries in the fiscal year 1989/1990. The rest of the companies are affiliated as follows: 9 with the Metallurgical Industry Corporation (MIC), another holding company in the MOI; six other engineering companies report to other ministries; and the remaining five are military factories (World Bank 1989b, p. 5).

We have data on the nineteen firms affiliated with the EIC of the Ministry of Industry (see Annex III.1 for a list of the companies and their products). They vary in size, array of products, profitability, and factor intensity. Accordingly, these companies can be classified in a number of ways. A useful criterion in this context is the nature of the product. The World Bank used this to classify EIC firms into 9 main sub-groups (see Annex III.2a-c). This classification will be adopted (with some modification) in the present study whenever relevant. For the purpose of analysis, we also present in this section a brief look at these companies as classified by their share in total EIC inputs and outputs, factor intensity, net profit levels, and R&D activity.

First, using the nature of the product as a categorization criterion, and based on the Ministry of Industry data for 1989/90, we find that transport equipment accounts for the largest share of production (almost 37% of output and value-added), followed by electrical equipment (companies 4,6) (18.4% of output and 16.2% of value-added) and domestic appliances (companies 2,16) (15% of output and 14% of value-added) (see Table III.5). Transport equipment also accounts for the largest share in labor and capital (31% and 29% respectively). The strength of transport equipment comes mainly from el Nasr lel Sayyarat (company 1) which alone accounts for 24% of output, 21.3% of value-added, 18% of labor, and 12.2% of capital (see Table III.6). Electrical equipment (6,4) ranks second in share of output and value-added despite its relatively lower shares in labor and capital (ranks fourth in labor and third in capital). In contrast, process equipment 3,11,12,13,19) accounts for a relatively larger share in inputs than in output and value-added. The lowest shares in inputs and outputs are taken by manufactured and non-manufactured metals and domestic fixtures.

Next, and as mentioned earlier, companies can be classified according to their size in terms of their share in total EIC output, value-added, capital and labor. Roughly speaking, firms 1 and 2 can be termed 'big'[2] firms as they account for the highest percentage shares in outputs and inputs (see Table III.6). Firms 10 to 19 can be termed 'small' firms, and firms 3-9 can be termed 'medium' sized firms.

Finally, companies can be classified according to whether or not they include a separate R&D unit. Accordingly, group one includes eleven companies that undertake R&D activities in separate units. I visited ten of these while the eleventh (Yayat) refused to help (see Annex III.3). Nine released data; one company (Nasr TV) promised to release data but never did. Group 2 includes five companies that do not have a separate R&D unit. Finally, Group 3 includes companies that either claimed not to have a separate R&D unit[3], or could not be contacted (see Annex III.6).

In addition to internal research and development activities, companies supposedly benefit from external research relevant to engineering industries undertaken in research centers affiliated with government organizations. Six out of the ten companies visited mentioned that they benefitted from external research (see Annex III.7). External R&D activities are undertaken at three major bodies: universities (faculties of engineering), the Ministry of Industry and its affiliate institutes, and the Academy of Scientific Research and Technology and its affiliate the

National Research Center. The latter includes three R&D units that were established between 1956-61 and that undertake research on metallurgy, electronics, and mechanical engineering (Mahmoud 1986 p. 26). The Ministry of Industry institutes include the Tibbin Institute for Metallurgical Studies, the Electronic Industries R&D Center, and the Engineering and Industrial Design Development Center. The Electronic Research Center undertakes research on electronics (15% of which is theoretical and 85% applied), provides industrial services and integrated circuits (custom made) (A. Hamdy, interview). The Engineering and Industrial Design Development Center was set up to undertake "product design and develop prototypes for manufacture by local firms, particularly in the engineering sector". It has expanded into industrial design, engineering process design, and capital equipment design, and is now an autonomous unit attached to the Ministry of Industry (Sardar p. 142). In 1991, it was again affiliated with the Nasr TV company (A. Hamdy; interview). In addition, there are a few private organizations "with capability to design plant and equipment for the engineering industry": EGITALEC for industrial projects, ENPPI for petroleum, and ECG for utilities (World Bank 1989b p. 17).

III.4. Performance

In general, the engineering industry as a whole has performed modestly since the sixties. Between 1965 and 1987, the share of the engineering industry in Egypt's GDP did not change. In contrast, this share increased dramatically in other countries during the same time period. In Turkey, this share quadrupled, in Thailand, it tripled, and in Korea, it more than tripled (see Table III.7). In fact, the share of engineering industries in Korea's total industrial production increased from 22.5% in 1975 to 34% in 1985 (Ez El-Din 1991 p. 12). In Egypt, the share of domestic engineering production in local demand for engineering products declined from 30% in the mid seventies to less than 15% in 1989 (World Bank 1989b p. iv).

It is a fact that the period 1982-1987 witnessed some increase in Egyptian engineering goods exports and a decrease in their imports. Data in current US$ million deflated by import and export price indices showed an average annual growth rate of -7.21% for imports and 16.97% for exports. Exports as percentage of imports increased from 0.62% in 1982 to 1.81% in 1987 (see Table III.8). Egypt's total engineering exports also increased between 1965 and 1987 by 370% in terms of 1987 US$ (see Table III.9).

Nevertheless, this performance falls short of being impressive when compared with other countries previously at somewhat similar stages of development (see Table III.9). Mexico's engineering goods exports increased by 12,788.9% between 1965 and 1987 and Malaysia's by 4,798% during the same time period. According to Table III.10, exports of Turkey (in nominal US dollars)[4] increased at an annual rate of almost 60% between 1981 and 1987. For Singapore the rate was 14%, and for South Korea it was 23%. In fact, exports of engineering goods represented 40% of all industrial exports in Korea in 1986 (Ez El-Din 1991 p. 12). Countries like Thailand, Turkey, Philippines, Jordan, and Tunisia had zero engineering goods exports in 1965, yet their exports in 1987 were much greater than the Egyptian figure (see Table III.9).

The situation is described in the World Bank report on engineering industries as:

> Egypt has ... missed an opportunity to join a growing export market. International trade in engineering goods has been growing at around 7% in real terms over the past decade and many developing countries have shared in this growth. Exports of engineering goods for the thirty five 'lower-middle-income' countries (those whose GNP per capita in 1987 ranged between US$ 500 and US$ 2000) rose from almost nothing in 1965 to over US$ 18 billion in 1987. Some of the best performing countries in this group are shown in Table III.10 [table numbering mine]. Even Jordan and Tunisia, with much smaller economies, export over US$ 100 million annually or three to four times more than Egypt (World Bank 1989b p 3).

For companies of the Engineering Industries Corporation (EIC), exports increased by more than 100% in real terms between 1984 and 1989. Imported inputs increased by 14%, and the ratio of exports to imported inputs increased by 80% during the same time period (see Table III.12).

Moreover, our data show modest growth for output and value-added for the EIC companies during the period under study. Between 1975-1989, real output and value-added grew at average annual rates of 5.4% and 2.3% respectively (Table III.13). A much clearer picture is presented when we divide the period under study into two subperiods: 1975-81 and 1982-89. In the first subperiod, output and value-added grew at average annual rates of 20.5% and 9.7%, respectively. Still, this did not keep up with domestic demand. The production of EIC firms satisfied almost 18% of domestic demand in 1975, 13% in 1979, and 14% in 1980 (Table III.15). This performance was better than in the second subperiod, when real output and value-added grew at negative average annual rates of -4.8% and -4.4%, respectively. EIC production satisfied only 10% of domestic demand in 1986 (see Table III.15). In particular, output and inputs declined dramatically in the four years 1986-1989.

Production in real terms declined in the second half of the eighties (Fig. III.2). Between 1986 and 1989, output and value-added in real terms grew at average annual rates of -4.9% and -4.5%, respectively (see Table III.13 and Fig. III.2). There was also a decline in labor input in the eighties, which decreased at an average annual rate of 1.1% after 1986 (Table III.13 and Fig. III.3). While the constant price value of the capital stock continued to increase throughout the period, it increased at its slowest rate between 1986 and 1989 (Table III.13 and Fig. III.4). It is worth noting that the capital price index increased significantly in these four years (Table III.2). Over this period, the ratio of total value-added to total output never exceeded 0.44 (see Table III.16). The average ratio also declined from 0.38 in 1975-81 to 0.33 in 1982-85, and to 0.295 in 1986-89.

Finally, engineering industries have not scored particularly high on measures of comparative advantage. In fact, most engineering industries have been termed "fundamentally non-competitive" (transport equipment, tractors, automobiles, electronic - see Table III.17). Nevertheless, the group includes a few industries that have been identified as competitive (electrical machinery, domestic appliances, metal fabrication, batteries and cables). Even some parts of non-competitive industries (e.g. automobile springs, some lines of truck manufacturing, and railway wagons) are competitive. Private sector data support the general conclusions on the competitiveness (or lack thereof) of transport equipment and electric machinery (World Bank 1989b pp. 10 & 11).

III.4.1.R&D Performance

Of the 19 EIC companies, only eleven have separate R&D units. I visited ten of these as part of this research. Although some of the separate R&D units were established as early as 1960/1 (the rest in the early seventies), no data are available on years prior to the early eighties. Data collected for the present research were compiled by these companies for the first time. We here draw a number of conclusions on the R&D performance of EIC firms in light of this data set, as well as field trips, visits, and interviews.

III.4.1.1. R&D Allocations

The generally modest and declining interest in R&D in engineering is represented in the allocations in the Second Five Year Plan 1986/7-1991/2. Institutional R&D received only 0.7% of total public investment in engineering. Out of this 0.7%, 32.1% was for completion of old projects, 56.7% for rehabilitation, and only 11.2% for expansion and new projects. Viewed from another angle, institutional R&D represented 1.0% of allocations for completion of all engineering projects, 0.9% of allocations for rehabilitation, and only 0.2% of allocations for new projects (see Table III.18).

This modest interest in R&D in engineering firms is confirmed by data on R&D expenditures by firm during the same period (1986-1989). I collected data for 9 out of the 11 firms that possess separate R&D units. On average for the period 1983-1989, R&D represented a small fraction of output. The largest R&D shares were for Koldair (2.9%) and ERISCOM (1.56%), while the smallest were for Sabi (0.01%) and Mikar (0.04%) (Table III.19).

There was some evidence of a declining interest in R&D in half of the firms; the average ratio of R&D expenditures to output was less in 1986-89 than the average for the period 1983-1989. For firms 1, 10 and 11 (Nasr Automotive, Sabi and Steelco), R&D expenditures declined almost continuously during the seven year period (Table III.19). The increase in the average ratio of R&D expenditures to output for the other five firms was rather modest. Nasr lel Sayyarat provides a particularly interesting case as absolute R&D expenditures in constant L.E. declined significantly beginning in 1986, although they had more than doubled between 1980 and 1983 (Table III.19).

III.4.1.2. <u>R&D Activities</u>

In general, most engineering firms started by licensing foreign technology. In-house R&D activities started gradually and at a modest level. R&D units were not active until the seventies or even the eighties for some firms. R&D units were more active in the seventies for Steelco and Koldair, in the eighties for Nasr Sayyarat, Telemasr, Nasr TV, Tarkibat, and in the last six years for Maragel. For at least two firms (Kablat and Koldair), R&D activities were triggered by the emergence of private sector competitors that represented a real threat in the market.

For most firms, R&D activities can be classified into four major areas:

1. Product modification - improvement of function, performance development of existing products, and adaptation research (most companies do this);

2. Product development - first through reverse engineering which implies disassembling the imported product with the purpose of figuring out the technology, and, in a second stage, imitating the technology and hopefully improving on it;

3. Process development - problems of manufacture under license such as fitting and adaptation;

4. Other activities - marketing research, feasibility studies and studying bids (see Annex III.11 for details).

III.4.1.3. <u>Problems and Constraints</u>

R&D units in EIC companies suffer from a number of common problems. One major constraint expressed by most company representatives interviewed was the limited funds accorded to R&D in these firms (despite some companies' claims that their interest in R&D has been expanding). Low R&D funds reflect a lack of (or limited) awareness of the importance of R&D, dealing with it as a residual item, and lumping it with other departments. In doing so, these companies are forgoing the opportunity to keep up with engineering technologies on the world scene. Limited funds mean limited facilities, as well as underpaid R&D employees who must take second jobs. Limited awareness is related to limited understanding of the nature and role of R&D activities. This is reflected in the resentment of technological development by some of the companies' employees outside the research unit, who fear being replaced by machinery under the newly developed technologies.

Moreover, problems of bureaucracy and organization detach research from production (A. Hamdy, interview). Modest research capabilities and "the lack of in-house design facilities" in engineering industries can be attributed to a lack of organization and specific training rather than to a lack of engineers "with the right basic technical education" (World Bank 1989b p. 16). This to a considerable extent affects the morale of already underpaid researchers.

In addition to the above, EIC companies complain of a missing link between government research and engineering firms. Government research units were mostly established as early as the second half of the fifties and during the sixties (see Annex III.10). There is too much rhetoric, yet no tangible results (Mahmoud & A. Hamdy; interviews). For the electronic industries, Nasr TV Board Chairman A. Hamdy explains:

> Research and development activities at the NRC have been academic / theoretical. What the companies need is applied research work: improvement of existing circuiting, adaptation, not developing a circuit from a to z. Accordingly, NRC has not delivered more than 10% of the needs. Companies have relied on the Center for Electronic Research, which in turn has had problems... It is not well organized, is characterized by bad planning, and has had problems of funding (originally UN)" (A. Hamdy; interview and paper).

Even the private external research and design offices (EGITALEC, ENPPI, and ECG) have not fulfilled the R&D potential in their specific design field. They are said to "lack the capacity to cover the growing requirements for such work" (World Bank 1989b p. 17).

III.4.1.4. R&D Impact

In individual cases of intramural R&D activities, there have been some stories of success. The Koldair Board Chairman is proud of the fruitfulness of the company's R&D activities. "Not a single Koldair product has a license. It is all R&D designed from within the company", says Eng. Sawwah, Chairman of the Board. People at Telemasr argue that intramural R&D activities have had an effect on reducing costs of production, and have materialized in the development of new products, e.g., antennas for VHF/UHF transmission and Ballast chokes. Also, Nasr Sayyarat has succeeded in the development of the minibus as a new product.

In addition, R&D activities have brought about significant results with respect to product modification. Researchers at Nasr Lel Sayyarat have succeeded in reducing pollution from top exhaust pumps, expanding the capacity of trucks from 8 to 11 tons, developing buses with 190 horsepower engines instead of 125. In particular, the development and production of buses and trucks is important for import substitution.

Similarly, the work of researchers in Steelco led to the development and local production of metal towers for electricity supply which substituted for the import of steel towers for the ministry of electricity. Also, new non-standardized equipment was developed for cement, sugar and petrochemical factories as substitutes for imported factory equipment. Similarly, the R&D work of Tarkibat (ERISCOM) has saved about three million dollars by locally developing a cement air filter.

Despite the above, the impact of R&D activities relevant to the engineering sub-sector on the whole has been modest compared to needs and expectations. For the electronics industry[5], for example, both elementary research and development & modification have satisfied none of the needs in the field of developing raw materials. According to Hamdy, research has satisfied only 20% of the needs in the field of components; and development activities have satisfied none. In set development, research has satisfied 50% of the need, while development activities fulfilled none. In systems, research fulfilled 10% of potential need and development activities fulfilled 20%. In programming, research and development activities both fulfilled 50% of potential need (A. Hamdy, interview).

In the case of El Nasr TV (with an electronics market share of 40%), R&D from different sources have succeeded by 20-30% in changing the input mix, very little in the development of equipment, by 30% in production system development, by 30% in cost change, and have had a very limited effect on the development of new products. Board Chairman Engineer Ashraf Hamdy says, "We are not technology developers; we are users of technology developed in other countries. We do not have the facilities for manufacturing components" (A. Hamdy, interview).

In line with this, Engineer Said El Naggar, Vice Board Chairman of Nasr Sayyarat explains that "there is no R&D in the strict sense of the term, e.g. how to improve the engine, how to improve efficiency of engine, designing new cylinder head, how to improve by designing new gearbox. However, there are activities such as changing the springs, selecting new gearbox which needs some new modification" (El Naggar, interview).

Companies like Sabi have relied to a great extent on reverse engineering. These R&D activities are mainly attempts at taking the product back to the old standards after licensing. It is argued that "(i)n countries with limited basic technological capacity, Egypt being an example, the alternative to reverse engineering becomes the purchase of technology from more industrialized countries" (World Bank 1989b p. 17).

In light of the above, although there were individual stories of success in some of the engineering firms under study, these were on a limited scale, and have not gone much beyond the initial stages of reverse engineering. There were no real breakthroughs in R&D and their spill-over to the technological development of these firms. The scope exists for expanding the in-house R&D capabilities of engineering firms, and strengthening their links with external R&D bodies. This conclusion is based on qualitative analysis. In the next section, we further examine this issue, and others, using a quantitative approach through econometric estimation.

III.5. Econometric Estimation

In the following section we present the theoretical framework of the study: econometric model, estimation procedure and data. This is followed by a presentation of the empirical results. We estimate levels of total and partial factor productivity (TFP and PFP), and parameters of technical change. We also test for structural change in the eighties. We then present results on R&D based on work done on firms that possess an R&D component. Estimation is done for all Engineering Industry Corporation (EIC) firms taken as a group (pooled cross-section, time series regression). A synthesis of conclusions on productivity, technical change, and the role of R&D will conclude this section.

III.5.1. The Model (Theoretical Framework)

In our analysis we rely on a Cobb-Douglas production function taken in natural log form (ln). Pooling time series and cross section data, output and value-added are separately regressed on labor and capital inputs such that:

$$Q = e^{a} \; L^{b} \; K^{c}$$

or

(1) $\ln Q = a + b \ln L + c \ln K$

where Q = value-added

L = labor

and K = capital (the gross value of fixed assets).

We use the gross value of fixed assets as a proxy for capital, following Griliches (1973).

III.5.1.1. Estimation of Factor Productivity

Estimation of the levels of total factor productivity (TFP) relies on the Cobb-Douglas production function such that:

$$Q = A \ L^b \ K^c$$

Thus,

$$\frac{dQ}{Q} = \frac{dA}{A} + b\frac{dL}{L} + c\frac{dK}{K}$$

or

$$\frac{dA}{A} = \frac{dQ}{Q} - b\frac{dL}{L} - c\frac{dK}{K}$$

where $A = \dfrac{Q}{L^b \ K^c}$ is the index of TFP

and $L^b \ K^c$ is the index of total factor input.

Since b and c represent the elasticity of output (or value-added) with respect to the respective input, we tried using the estimated coefficients of b and c from the Cobb-Douglas estimation of equation (1) for the whole period 1975-89 (Method 1). We also calculated TFP levels with the value of b taken as the average ratio of employment compensation to value-added over the entire 1975-89 period and the value of c equal to (1-b) (Method 2). Method 2 assumes constant returns to scale. This assumption is tested below 9 (Table III.33). For each of the two methods, TFP was calculated twice; once with value-added as the measure of output (VTFP), and once with gross output as the measure of output (QTFP).

In estimating the levels of partial factor productivity, we used ratios of output and value-added to labor, capital and intermediate inputs taken separately and examined changes in these ratios over time.

III.5.1.2. Estimation of Technical Change

We then attempt to estimate neutral and factor-augmenting technical change for the firms under study. Neutral technical change is defined as that which does not change the relative shares of factors assuming other things constant. It causes shifts in the production function leaving marginal rates of substitution untouched and "simply increases or decreases output attainable from given inputs" (Solow, 1957b p. 12). Factor-augmenting technical change is that which changes the relative shares of the respective factors.

In our context, technical change is taken to be a function of time. Accordingly, neutral technical change is represented in the following formulation:

$$Q = e^{a} \quad L^{b} \quad K^{c} \quad e^{dt}$$

thus,

(2a) $\ln Q = a + b \ln L + c \ln K + dt$

where t is a time trend (t = 1, 2,.....15 for 1975, 76,...89).

We also test for a nonlinear time effect in the following formulation:

(2b) $\ln Q = a + b \ln L + c \ln K + dt + gt^{2}$

In line with this, capital-augmenting technical change can be viewed in the following formulation:

$$Q = e^{a} \quad L^{b} \quad K^{c+nt}$$

or

(3) $\ln Q = a + b \ln L + c \ln K + nt \ln K$

Similarly, labor-augmenting technical change can be represented as

$$Q = e^{a} L^{b+mt} K^{c}$$

or

(4) $\ln Q = a + b \ln L + c \ln K + mt \ln L$

Finally, we test for technical change in an equation incorporating all types such that:

(5) $\ln Q = a + b \ln L + c \ln K + dt + nt \log K + mt \ln L$

III.5.1.3. Test for Structural Change

We then attempt to test for structural change in 1982-89, and in the subperiod 1986-89. We use dummy variables to represent the period for which structural change is being tested. Specifically, the equations are:

(6a) $\ln Q = a + b \ln L + c \ln K + d D1$

(6b) $\ln Q = a + b \ln L + c \ln K + d D2$

where D1 is a dummy variable, D1=1 for 1982-89 and 0 otherwise and D2 is a dummy variable, D2=1 for 1986-89 and 0 otherwise.

The reason 1982-89 was singled out is that the end of 1981 marks the end of the Sadat era, and the start of the Mubarak regime. In a country like Egypt, a change in leadership is likely to bring about structural changes. The system tends to be influenced by persons rather than institutions. In fact this is one of the hypotheses we have set out to test in this research. The reason we chose 1986-1989 is that this is the period following the severe devaluation of the Egyptian pound and the adoption of the IMF and World Bank policy prescription.

We also attempt estimation of interaction terms with the structural change dummy variables such that:

(7a) $\ln Q = a + b \ln L + c \ln K + d\, D1 + g\, D1 \ln L + h\, D1 \ln K$

(7b) $\ln Q = a + b \ln L + c \ln K + d\, D2 + g\, D2 \ln L + h\, D2 \ln K$

III.5.1.4 Estimation of the Role of R&D in Production

In trying to account for the role of research and development (R&D) in production, we introduce R&D expenditures as an input in the production function such that:

$$Q = e^{a} \; L^{b} \; K^{c} \; R^{r}$$

Thus,

(8) $\ln Q = a + b \ln L + c \ln K + r \ln R$

where R represents R&D expenditures. (Equations were also estimated using R&D expenditures in 'unlogged' form, but these did not yield statistically significant coefficients.)

We also test for the possible role of lagged R&D (using only one year lag due to the limited number of observations on R&D expenditures), such that:

(9) $\ln Q = a + b \ln L + c \ln K + r \ln R_{t-1}$

where R_{t-1} represents lagged R&D expenditures.

Next, we make use of data on intermediate inputs available only for a limited number of years (1984-1989). We reestimate equation (8) with intermediate inputs incorporated in the production function, such that:

(10) $\ln Q = a + b \ln L + c \ln K + d \ln I + r \ln R$

where I is the value of intermediate inputs

and Q is defined as gross output and not value-added.

We also try

(11) $\ln Q = a + b \ln L + c \ln K + d \ln I + r \ln R_{t-1}$

Finally, we test whether or not the presence of an intramural R&D unit/activity makes a difference in production by introducing a dummy variable for firms that do have such a unit. Accordingly, the equation is:

(12) $\ln Q = a + b \ln L + c \ln K + d D$

where D is a dummy variable, D=1 for firms with intramural R&D activities and 0 otherwise.

In all our regressions, we use pooled time series and cross section data on the Engineering Industries Corporation firms as a group. All regression estimates were calculated using the SHAZAM software package. The period under study was divided into two subperiods: 1975-1981 and 1982-1989. As mentioned before, the change of leadership is the reason behind this subperiod classification.

III.5.2. Hypotheses and Questions

In undertaking the present exercise, we attempt to answer the following questions:

1. Has there been any technical change in the engineering industries (an import-substituting group of industries) and, if any, of what nature?

2. What were the total and partial productivity trends?

3. Has there been any role for R&D in production?

4. Based on the above, can we conclude that the changes in leadership and in macroeconomic policies have influenced the performance of these industries and, if so, in what direction?

5. How different were the "eighties" from the "seventies"? Is the sub-period classification of 1975-1981 vs. 1982-1989 justifiable?

III.5.3. Data

Annual data were collected (by firm) for output, value-added, labor input, and gross value of fixed assets (proxy for capital) for the period 1975-1989. Since the Egyptian accounting system changed from a calendar year to a fiscal year basis starting in 1980, figures for fiscal years after 1980 are taken to refer to the beginning of the year. This implies that the first six months of 1980 are omitted from the data. Data cover 19 firms for 15 years providing a total of 295 observations.

Data on output and value added in current L.E. were deflated using the wholesale price index with 1985 as the base year (see Table III.2 for the price indices). There is no available price index for the output of the engineering industries. The available price index which is closest in coverage is an implicit price index for manufacturing GDP calculated from U.N. published data. However, this index is available only for the 1981-86 period. Price indices which are available for the entire 1975-89 period are the wholesale price index (WPI), the implicit GDP deflator, an import price index, and the industrial product price index. When these are compared to the implicit price index for manufacturing GDP over the 1981-86 period, only the WPI closely matched the implicit price index for manufacturing GDP. Accordingly, I used the WPI to deflate engineering and textile industry output and value-added over the entire 1975-89 period.

Data on intermediate inputs (only available starting in 1984) were deflated using a weighted average of the import price index and the WPI, with the weights based on the share of imported to total intermediate inputs (see Table III.20). Labor input was measured in thousands of persons.

Gross fixed capital stock includes land, buildings, machinery, tools, offices, infrastructure, transportation and delivery means. Data on fixed assets and depreciation were available in current L.E. thousands, and were interpreted to be at book value. Interpreting the initial capital stock and depreciation data as being at current prices led to negative gross investment at constant prices (a physical impossibility) both for the industry and for the individual firms. The data on book value capital stock and depreciation were used to generate current price gross investment. The latter was deflated by the capital price index[6] to obtain constant price gross investment. The gross fixed capital stock series was then generated using the gross stock assumption on the constant price gross investment data. Under the gross stock assumption, the machine is said to provide the same services over its lifetime with no depreciation during that period; after its lifetime, the machine depreciates completely. The capital stock is thus a moving sum of constant price gross investment over the lifetime of the capital, T, taken to equal 8 years. The value of T was chosen to be consistent with the book value capital stock and depreciation data.

Data were also collected first hand on R&D expenditures by firm for selected firms (9 firms for 7 years). Data cover expenditures on R&D capital and/or labor (see Annex III.6 for a translation of the interview schedule). Data in current L.E. were deflated using an 'R&D price index' constructed as a weighted average of the capital price and the wage index (with weights based on the relative shares of capital and labor in R&D expenditures) (see Table III.19). It must be noted that (despite any crudeness or arbitrariness that might have unintentionally occurred in data articulation) this data set represents the first of its kind for this industry in Egypt.

III.5.4. Empirical Results

In this section, we present the empirical estimation results. This begins with estimation of total and partial factor productivity levels. We next estimate technical change and test for structural change after 1982 and 1986. We also test for constant returns to scale and examine the role of R&D in production.

III.5.4.1 Factor Productivity

Our results for total factor productivity (TFP) show an increase in the overall TFP level in the engineering industries between 1975-1982, followed by a decline throughout the rest of the eighties (except for a modest rise in 1987) for both methods and both TFP measures (VTFP and QTFP) (Tables III.21-26 and Fig. III.5 & III.6). No matter how calculated, the level of TFP in 1981 was always higher than in 1975, and was always lower in 1989 than in 1982. In addition, the 1989 level of TFP measured using Method 2 was lower than the 1975 level as was VTFP using Method 1.

Although the average level of TFP measured by QTFP was higher in 1982-89 than in 1975-81 (Tables III.22 & 25), the averages for the last four years were lower than the 1982-89 averages, and even lower than the 1975-81 average using Method 2. Average TFP levels (both QTFP and VTFP) were always highest in the subperiod 1982-85. Average levels of VTFP (and QTFP using Method 2) were lowest in the 1986-89 subperiod (see Tables III.22 & 25).

Our conclusions on partial factor productivity are generally similar to those on TFP. Labor and capital productivity followed the same trend: a rise from 1975 until 1982-83, after which there was a general decline until 1989 (despite a modest rise in 1987) (see Tables III.27-29 and Fig. III.7 & III.8). These large declines were due mainly to large drops in value-added and output after 1984. Average labor productivity levels were higher in 1982-89 than in 1975-81, yet again the average for the last four years was less than the average for the whole of 1982-89. Average levels of capital productivity were lower in 1982-89 than in 1975-81, and were lowest in the last four years 1986-89.

As with TFP, the levels of partial factor productivity (PFP) were always higher in 1981 than in 1975. They were also significantly lower in 1989 than in 1982 (Tables III.27-29). Even for intermediate inputs, the level of productivity was much lower in 1989 than in 1984.

Basically, our measurements of TFP and PFP show that productivity levels can be represented by an 'inverted U' pattern that peaks around 1983-84, and clearly falls in the last four years (Fig.III.5-III.8). This result is of particular interest when we interpret the regression estimates of technical change and the tests for structural change.

III.5.4.2. Technical Change

The regression results can be interpreted as trying to fit the inverted U pattern of productivity. In Table III.30, the intercept in equation 1 represents the average ln of TFP (Method 1). Since actual TFP follows the inverted U pattern, the regression is essentially trying to fit the inverted U with a constant. This does not provide a good fit since the residuals will follow the inverted U pattern. When the time variable, t, is added (equation 2a), it is equivalent to trying to fit the inverted U pattern with a constant and a linear time trend. This still cannot represent this pattern since the variable t is always increasing and, thus, cannot fit both rising and falling TFP. As a result, the coefficient of t is not significant. When both t and t^2 are included (equation 2b), both coefficients are significant with a positive coefficient for t and a negative coefficient for t^2. These values imply an inverted U which peaks around 1983, fitting the TFP pattern over time.

Results of estimating factor augmenting technical change for 1975-89 can also be interpreted along the same lines. Since both t and lnK increase throughout the time period, the variable tlnK is increasing and cannot fit the inverted U pattern of TFP change, and the coefficient of tlnK is not significant. On the other hand, even though labor input declines after 1984, the variable tlnL does not decline. Therefore this variable also cannot fit the inverted U. When all three variables: t, tlnK and tlnL are included, a good fit to the inverted U is possible. tlnK has a negative coefficient to capture the downward movement in TFP after 1984, tlnL has a positive coefficient to capture the increase before 1984, and t has to have a large positive coefficient to make the combination fit the inverted U.

Note that the R^2 measure, described in Buse (1973), sometimes decreases as more explanatory variables are added to the equation. This is due to its sensitivity to changes in the covariance parameter estimates as well as to the residuals. Clearly, it is not exactly analogous to the R^2 measure from OLS regression and should be interpreted with caution.

Estimation results for the subperiods can be interpreted in the same way. In the first subperiod, 1975-81, TFP rises. Since the variables t, tlnK and tlnL all rise in this subperiod, they each have significant positive coefficients when introduced separately (Table III.31). When introduced together, however, they are not significant, because they tend to be collinear. When t^2 is introduced together with t, its coefficient is not significant since it is not needed to fit the pattern of rising TFP.

Over the second subperiod, 1982-1989, TFP is rising in the first three years and then falling, with the drop accelerating in the last three years. This pattern is fit well by negative coefficients of t, tlnK, and tlnL when they are introduced individually (Table III.32). But when all three are introduced, none is significant, and neither is the coefficient of t^2 when it is introduced together with t.

The above interpretation of the regression results suggests that they are essentially fitting the pattern of changes in TFP. The regression results do not tell us whether the changes in TFP came from changes in technology or from other factors which could affect TFP, such as a shortage of imported spare parts or intermediate inputs or a drop in demand coupled with a fixed labour force. Thus, these results need to be interpreted with caution.

Finally, the test for constant returns to scale (CRS) based on equation 1 was always accepted; production can be characterized by CRS for the whole period, as well as for the two subperiods (see Table III.33). On the one hand, this provides support for method 2 used for calculating TFP, which assumes constant returns to scale. In addition, it helps to explain why the TFP measures resulting from methods 1 and 2 are similar, since the regression coefficients used as weights in method 1 do not deviate significantly from CRS, which is assumed in Method 2.

III.5.4.3. Structural Change

Tests for structural change (equations 6a, 6b, 7a, & 7b) between the 1975-81 and 1982-89 subperiods showed positive change after 1982, as the coefficient of the dummy variable for the latter subperiod was positive and significant. The same result was also found when the dummy variable was interacted with the lnL and lnK variables, as the coefficients of the interaction terms were positive and significant when they were introduced separately (Table III.34). It is interesting to note, however, that when the same tests were performed for the 1975-85 and 1986-89 subperiods, the results were different. These tests indicated negative structural change in the 1986-89 subperiod, since the coefficients of the dummy variable and the interaction terms were negative and significant when these variables were introduced separately (Table III.35). It seems that productivity improvements in the early eighties were overcome by a severe setback in the 1986-89 period.

These tests can also be viewed in terms of the TFP trends. The subperiod 1982-89 includes the TFP peak as well as the decline. The significant positive coefficients on the dummy in all forms reflects an average level of TFP higher in 1982-89 relative to 1975-81. On the other hand, the 1986-89 subperiod features rapidly declining TFP and an average level lower than that in 1975-85, thus the significant negative coefficients for the dummy variable.

III.5.4.4. The Role of R&D

In an attempt to estimate the role of R&D in production (equations 8-11), we draw a few conclusions based on the limited amount of R&D data available to us (1983-1989). First, a dummy variable is introduced for firms that possess an R&D unit and/or undertake intramural R&D activities. The coefficient of this variable has significant positive values for 1975-89 and for 1982-89 and a positive but insignificant value for 1975-81 (Tables III.36-38). This suggests that on average these firms have a higher constant term and, hence, a higher level of productivity than firms which do not carry out R&D, especially in the 1982-89 subperiod. There is a problem with the causality interpretation of these results, however. It could either be that the R&D is causing the higher TFP, or that the higher TFP is causing the R&D, since firms which have higher productivity may be able to afford to carry out R&D. The results are consistent with either interpretation; and the best that can be said is that they do not contradict the hypothesis that R&D causes increased TFP.

Next, we include the levels of current and lagged R&D input (in log form) in regression equations restricted to those firms which reported R&D expenditures. We detect a significant positive coefficient for both the current and lagged lnR&D input variables when they are introduced separately (see Tables III.39-40). The fit is somewhat better with the lagged R&D variable, suggesting that the effect of R&D on productivity is larger after a one year lag. When the R&D variable is included together with a linear time trend the coefficient for the time trend is negative, the coefficient for the R&D variable is larger and the fit improves (see Tables III.49-40). The negative coefficient for the time trend is probably picking up the declining TFP over the 1983-89 subperiod, allowing a positive effect to be measured for the R&D variable. These results are consistent with the interpretation that R&D helped to partially offset the productivity decline which occurred during the latter part of the subperiod.

Similar results are obtained in Tables III.41 and 42, when ln output is the dependent variable and intermediate inputs are included as inputs. The coefficient for intermediate inputs is large and significant. This supports the earlier discussion of the importance of the ability to obtain intermediate inputs in explaining output changes and the potential drag on TFP. Since there is no R&D data prior to 1983, is not possible to estimate the contribution of R&D to the TFP increase prior to 1984.

Finally, although these results refer only to the nine firms for which R&D data are available, they could still reflect both cross section and time series effects, especially since three of the firms have much higher R&D/output ratios than the others.

III.5.4.5. Summary

To sum up, in light of the above results a few conclusions can be drawn about the performance of EIC firms. There was a positive trend in productivity between 1975-81, and a decline between 1986-89, with a peak occurring around 1983-84. Regression results which included indicators of technical change were consistent with this pattern. While average levels of some productivity measures (labor productivity and QTFP) were higher in 1982-89 than in 1975-81, they all declined in the 1986-89 subperiod, sometimes reaching a lower value in 1986-89 than in 1975 (QTFP Method 1). Average levels of VTFP and capital productivity also declined after 1982, and were lowest in 1986-89. For most indicators of factor productivity for EIC firms, average levels were lowest in the last four years 1986-89, a result which is consistent with the finding of significant negative structural change in this subperiod.

While regression results on neutral and factor augmenting technical change were consistent with productivity trends, one should be careful not to interpret productivity changes as necessarily caused by technical change. Rather than reflecting changes in technology (which is implied by the term technical change), TFP changes could have been caused by other factors. It is not unlikely that productivity trends reflected changes in outputs relative to inputs which are the result of changes in the external environment discussed earlier in the chapter. Among these are exchange rate changes, controlled input prices, the inability to drastically reduce labor (despite attempts at relaxing labor laws which allowed some decline in labor input after 1983), and the inability to 'lay off' capital in response to a slower market in the eighties (see Tables III.3 and III.27).

Despite the above, negative capital augmenting technical change in the eighties, in particular, does not seem implausible. The fact that most, if not all, machinery used in production was imported, meant that the level of local technological capability could fall short of the requirements for the maintenance, development, and efficient utilization of existing machinery. In an environment which made it difficult to obtain spare parts or foreign technical assistance, a decline in productivity might be expected. An analysis of the extent to which technical factors contributed to TFP change, particularly after 1984, would be highly useful. This will be the subject of future research.

Finally, our results suggest that R&D played a positive role in production for EIC firms. Interestingly enough, this role is found at a time of declining productivity. This lends support to the interpretation that increased R&D leads to increased productivity rather that the interpretation that increased productivity leads to more R&D, since the latter hypothesis implies that declining productivity should lead to less R&D. A second result which supports the hypothesis that R&D causes increased productivity, is the improved fit when the lagged R&D variable replaced the current R&D variable. An increase in productivity in this period could not cause an increase in R&D in the previous period. This evidence suggests a positive role for R&D and calls for an expanded line of research in which the role of R&D can be further analyzed for more firms and in varying time periods.

III.6. Conclusions

The performance of EIC companies during the period 1975-1989 can be represented by an inverted U pattern. The second half of the seventies witnessed an improvement that continued until around 1983-84, after which there was a deterioration, becoming particularly evident after 1986. At least until 1981 indicators of TFP and PFP were increasing, but after 1982 these indicators declined. After 1986, there was negative structural change, and a further decline in TFP and PFP levels.

In trying to account for this pattern of productivity changes, a combination of factors are considered. On the one hand, the rapid expansion in domestic demand in the seventies meant high rates of capacity utilization. On the other hand, the supply side was characterized by a generation of well trained and educated personnel. These represented the fruit of the investment in science and technology in the sixties, or the 'output of domestic R&D input'. While machinery was imported from the West (representing the output of foreign R&D input), it was still new and in good shape. On the policy level, this period witnessed the start of foreign exchange liberalization and a generally positive attitude in the whole economy. There were even attempts at providing firms with more autonomy at that time.

Unfortunately, this favorable environment did not last very long. The consequences of the limited awareness of the importance of science and technology typical of the seventies were beginning to be felt in the eighties. The lack of know how required for the maintenance of depreciating machinery was not a minor deterrent. The emergence of idle capacity was aggravated by a decline in domestic demand. The cut in Arab aid was the first serious blow dealt to the economy, and the decline in workers' remittances from other countries later in the eighties lead to an additional restriction on domestic demand. These effects were exacerbated by soaring prices. The situation was made more difficult by the foreign exchange crisis, continued trade and price controls, and of course the persistence of old employment policies making excess labor a heavy burden on firms, despite attempts at relaxing labor laws.

In fact, the consequences of the open door policy started showing up with the start of the eighties. Policies which favored the private sector meant its emergence at the expense of a gradually declining public sector that suffered from constrained liberalization. This dualism certainly did not favor the public sector. The situation was magnified by unfavorable external circumstances: the declines in aid, remittances, Suez Canal and tourism earnings, and the adoption of the World Bank and IMF prescription, with more attention directed to the private sector. It is no surprise that the subperiod 1986-89 generally witnessed the lowest levels of total and partial factor productivity for EIC firms. While some firms may have done relatively better than others, and despite sporadic stories of success on the technological level, one can safely assert that by 1990, EIC firms were performing at a lower level than in the seventies.

Finally, the above exposition provides a basis for answering questions raised in section III.5.2. First, on the question of technical change and productivity trends, we have found these to be best represented by an inverted U pattern peaking around 1983. The decline in productivity after 1983 was probably slowed by some positive role of R&D in production. On the effects of changes in leadership and macroeconomic policies on performance, we argue that such effects were important causes of productivity decline. Policies and leadership of the sixties were reflected in the performance of the seventies; policies and leadership of the seventies were reflected in the performance of the eighties. The eighties were certainly different from the seventies. While the subperiod division of 1975-81 and 1982-89 identified significant differences, a better classification might be 1975-81, 1982-85 and 1986-89, in light of the acceleration of the decline in productivity indicators in 1986-89.

In the following chapter, we look at the performance of textiles firms affiliated with the Textile Industries Corporation (TIC) during the same time period, 1975-1989. This will pave the way for general conclusions to follow in the last chapter.

Table III.1

Total Output, Value-Added, Capital and Labor for EIC Firms

(Output, Value-added and Capital in thousands of current L.E., Labor in thousands of persons)

Year	Output	Value-Added	Capital	Labor
1975	156,200	66,450	95,158	58.90
1976	179,900	78,700	100,712	59.50
1977	245,600	106,200	111,296	61.30
1978	295,400	106,500	129,396	63.10
1979	380,500	142,200	151,239	62.60
1980	543,403	182,909	181,623	64.13
1981	679,468	204,687	209,646	66.58
1982	880,554	272,375	252,221	66.45
1983	995,695	332,402	280,400	70.06
1984	1,076,677	399,777	333,170	70.09
1985	1,102,299	347,307	418,150	69.20
1986	1,165,095	367,320	501,710	68.05
1987	1,614,596	438,426	562,482	67.79
1988	1,675,883	454,109	617,000	66.55
1989	1,810,765	579,970	690,167	65.84

Source: Ministry of Industry Performance Evaluation Reports, various issues.

Table III.2

Wholesale Price Index, Wage Index, and Capital Price Index

(1985=100)

Year	Wholesale Price Index	Wage Index	Capital Price Index
1975	32.460	19.096	45.793
1976	34.990	20.287	47.944
1977	38.230	25.000	57.215
1978	43.880	47.938	69.070
1979	48.170	35.325	68.020
1980	58.620	45.998	81.660
1981	63.300	54.355	85.729
1982	69.230	64.763	92.910
1983	80.230	77.464	95.890
1984	88.350	92.084	97.800
1985	100.000	100.000	100.000
1986	117.300	102.359	114.768
1987	133.300	116.321	130.422
1988	168.000	146.913	164.723
1989	214.000	187.020	209.693

Source: Wholesale price indices are from various issues of the *International Financial Statistics* of the International Monetary Fund. Capital price and wage indices for public sector firms were computed by T. Moursi from CAPMAS unpublished data compiled by L. Abdellatif.

Table III.3

Total Output, Value-Added, Capital, and Labor for EIC Firms

(Output, Value-added and Capital in thousands of constant 1985 L.E, Labor in thousands of persons)

Year	Output	Value-Added	Capital	Labor
1975	481,208	204,713	233,997	58.90
1976	514,147	224,921	241,187	59.50
1977	642,427	277,792	256,367	61.30
1978	673,200	242,707	278,506	63.10
1979	789,911	295,204	297,594	62.60
1980	926,992	312,025	327,110	64.13
1981	1,073,409	323,360	341,280	66.58
1982	1,271,925	393,435	386,500	66.45
1983	1,241,051	414,311	376,468	70.06
1984	1,218,650	452,492	427,532	70.09
1985	1,102,299	347,307	502,617	69.20
1986	993,261	313,151	568,801	68.05
1987	1,211,250	328,902	606,876	67.79
1988	997,549	270,303	618,865	66.55
1989	846,152	271,014	638,718	65.84

Source: Based on data in current L.E. thousands presented in Table III.1. Data on Output and Value-Added were deflated by the wholesale price index; data on Capital were constructd using deflated gross investment and the gross stock assumption, T=8. Price indices are presented in Table III.2 above.

Table III.4

Ownership Structure of Textiles and Engineering Industries (1988)

	Public sector share in industry value-added	Private sector share in industry value-added	# of companies Public	Private*
Textiles			30	600
Spinning	100	0	100	0
Weaving	70	30	n/a	n/a
Garments	35	65	n/a	n/a
Engineering Industries	80	20	30**	250
Total (including other industries)	70	30	177	over 4000

Source: World Bank 1989a, Table 1 p. 33.

Notes:
* employing more than 10 employees
** 19 of which are affiliated with the Ministry of Industry (In total the MOI comprises 117 out of 182 public sector enterprises.)

Table III.5

Percentage Share of Sub-Groups of Firms
in EIC Output and Inputs 1989/90

(Based on values in thousands of constant 1985 L.E.,
Labor in thousands of persons)

Sub-Group	Output	Value-Added	Capital	Labor
Process Equipment	12.20	12.72	15.80	22.15
Other Non-electric Machinery	1.56	2.51	4.93	3.75
Transport Equipment	36.84	36.56	29.13	30.94
Electrical Equipment	18.40	16.22	16.96	10.74
Consumer Electronic	12.29	13.47	7.97	8.53
Manufactured Metals	2.52	2.65	2.46	2.99
Domestic Appliances	14.78	13.87	18.26	16.11
Domestic Fixtures	1.41	2.00	4.49	4.80

Source: Calculated based on the Ministry of Industry Reports; (World Bank classification).

Notes:

Process Equipment:	Firms 3,11,12,13,19
Other Non Electric Machinery:	Firm 10
Transport Equipment:	Firms 1,8,9,17,18
Electrical Equipment:	Firms 4,6
Consumer Electronics:	Firms 5,7
Manufactured Metals:	Firm 15
Domestic Appliances:	Firms 2,16
Domestic Fixtures:	Firm 14

Table III.6

Percentage Share of Firms in Total EIC Outputs and Inputs
1989/90

(Based on values in thousands of constant 1985 L.E.,
Labor in thousands of persons)

Firm	% share of EIC Output	% share of EIC Capital	% share of EIC Labor	% share of EIC Value-Added
1	24.03	12.17	18.06	21.27
2	11.91	16.23	12.68	10.52
3	5.07	6.38	8.05	4.06
4	12.20	7.83	4.91	9.62
5	6.11	2.75	4.42	6.01
6	6.21	9.13	5.83	6.60
7	6.18	5.22	4.11	7.46
8	5.44	3.48	4.76	6.23
9	4.77	10.14	4.58	5.71
10	1.56	4.93	3.75	2.51
11	2.02	2.32	3.95	2.39
12	2.73	2.90	5.71	2.70
13	1.32	1.88	2.86	2.00
14	1.41	4.49	4.80	2.00
15	2.52	2.46	2.99	2.65
16	2.87	2.03	3.43	3.35
17	1.69	1.59	2.43	1.76
18	0.91	1.74	1.12	1.60
19	1.06	2.32	1.58	1.59

Source: Based on Ministry of Industry data.

Table III.7

Contribution of Engineering Industries to GDP in Selected Countries

Country	% engineering value-added in GDP 1965	1987
Zimbabwe	2	3
Egypt	2	2
Thailand	1	3
Turkey	1	4
Korea	2	7

Source: World Bank 1989b Table 2.3 p. 4.

Table III.8

Egypt's Trade in Engineering Goods

(millions of 1985 US $)

	1982	1983	1984	1985	1986	1987
Imports	4,851	4,733	4,952	4,273	3,623	3,101
Exports	30	25	20	79	57	56
Export/ Import Ratio(%)	0.62	0.53	0.40	1.85	1.57	1.81
Average Annual Growth Rates (1982-1987)						
Imports	-7.21%					
Exports	16.97%					

Source: Data in millions of current US $ was deflated using import and export price indices from World Tables (see Table III.11 below).

Table III.9

Exports of Engineering Goods from Selected Countries

(millions of 1987 US $)

Country	1965	1987	%increase*
Mexico	45	5,800	12,700
Malaysia	98	4,800	4,800
Thailand	0	1,400	
Turkey	0	700	
Philippine	0	300	
Jordan	0	130	
Tunisia	0	130	
Egypt	10	47	370

Source: World Bank 1989b Table 2.2 p. 4.

Table III.10

International Growth of Engineering Exports
1970-80 and 1981-87

(percent growth)

	1970-80	1981-87
Developed Countries		
France	20.0	5.1
Germany	18.3	8.5
Japan	25.0	11.1
United Kingdom	17.5	3.5
United States	16.6	3.9
Developing countries		
Brazil	43.0	4.2
Singapore	38.0	13.8
South Korea	41.0	22.8
Turkey	50.0	59.9
Hong Kong	44.0	10.3
India	26.0	-4.0
Egypt*	n.a.	3.8

Source: World Bank 1989b Annex 5 Table 8.

*Data is for the whole engineering sub-sector. The growth rate is calculated between 1982 and 1987, and was calculated based on data in millions of current US $.

Table III.11

Import and Export Price Indices for Egypt

(1985=100)

Year	Import Price Index	Export Price Index
1975	70.439	72.756
1976	69.011	74.013
1977	73.407	76.109
1978	84.505	72.840
1979	100.000	88.346
1980	110.989	132.603
1981	108.901	141.907
1982	102.747	128.580
1983	102.967	125.646
1984	101.758	120.282
1985	100.000	100.000
1986	104.066	76.025
1987	109.890	83.820
1988	127.143	94.298
1989	137.912	85.999
1990	173.187	101.003

Source: World Bank, World Tables, various issues.

Table III.12

Total Exports and Imported Inputs of EIC Firms

(thousands of constant 1985 L.E.)

	Exports	Imports	Export/Import Ratio
1984	80,779	503,061	0.1606
1985	86,288	535,337	0.1612
1986	242,870	502,386	0.4834
1987	304,048	913,996	0.3327
1988	136,461	530,033	0.2575
1989	165,663	573,677	0.2888

Source: Data in current L.E. thousands from Ministry of Industry Performance Evaluation Reports, various issues, was deflated by export and import price indices provided in Table III.11 above.

Table III.13

Average Annual Growth Rates of Total Output, Value-Added, Capital and Labor for EIC Companies

(Values based on data in thousands of constant 1985 L.E., Labor in thousands of persons)

	Output	Value-Added	Capital	Labor
1975-89	5.42	2.31	12.35	0.84
1975-81	20.51	9.66	7.64	2.17
1982-89	-4.78	-4.45	9.32	-0.13
1982-85	-4.45	-3.91	10.01	1.38
1986-89	-4.94	-4.49	4.10	-1.08

Source: Calculated Based on Data in Table III.3 above.

Table III.14

Supply and Demand for Engineering Goods, Selected Years

(Supply by the whole engineering sector including EIC companies; millions of constant 1980 L.E.)

Year	Domestic Output	Imports	Exports	Apparent Consumption
1975	436	1,158	12	1,582
1979	745	2,766	8	3,503
1980	797	3,042	5	3,835
1986	814	4,917	40	5,691
Average Annual Growth Rates, %, 1975-1986	5.84	14.05	11.57	12.34

Source World Bank 1989b, Table 2.1.

Table III.15

Supply and Demand for Engineering Goods, Selected Years

(Supply by EIC companies only, millions of 1980 L.E)

	Output	Demand	Output/Demand (%)
1975	282.2	1,582	17.842
1979	463.1	3,503	13.221
1980	543.4	3,835	14.170
1986	582.5	5,691	10.236

Source: Table III.14 above and Ministry of Industry data set.

Table III.16

The Ratio of Total Value-Added to Total Output for All EIC Firms (Degree of Processing)

(Based on values in thousands of constant 1985 L.E.)

	Value-Added/ Output	Average Value-Added/Output	
		1975-89	0.345
1975	0.425	1975-81	0.381
1976	0.437		
1977	0.432		
1978	0.361		
1979	0.374		
1980	0.337		
1981	0.301		
		1982-89	0.313
1982	0.309	1982-85	0.332
1983	0.334		
1984	0.371		
1985	0.315		
1986	0.315	1986-89	0.295
1987	0.272		
1988	0.271		
1989	0.320		

Source: Based on Data in Table III.3 above.

Table III.17

Domestic Resource Costs (DRC) for Engineering Industries, Egypt 1963-4, 1979

	Basic Metals[1]	Transport Equipment[1]	Auto- mobiles[2]	Electric Machinery[3]	China &Glass[3]
1963-4			1.13		
1979	-27.56	-6.4		0.59	-3.93

[1]Average Rate of Interest (ARI) 6%. Source: World Bank 1983, p. 280.

[2]Average Rate of Interest 10%. Source: Hansen and Nashashibi 1975, p. 303. At 5% ARI, DRC is 0.827 and this industry is deemed competitive.

[3]Average Rate of Interest 6%. Source: World Bank 1983, p. 280.

Note: See Annex I.1. for the definition of DRC.

Table III.18

Public Investments in Engineering by Sub-Group
Under the Second Five Year Plan (1986/7-1991/2)

(thousands of current L.E.)

	Completion	Replacement/ Rehabilitation	Expansion/ New	Total
Process equipment	150,584	464,919	492,688	1,108,191
Other non-electrical equipment	124,511	433,840	113,500	671,851
Transport equipment	34,000	34,690	23,289	91,979
Electrical equipment	17,000	20,000	16,850	53,850
Consumer electronics	70,000	16,363	17,285	103,648
Manufactured metals	43,200	43,160	163,514	249,874
Domestic appliances	1,644	11,240	15,260	28,144
Domestic fixtures	0	0	0	0
Precision instruments	0	0	0	0
Vocational training	7,392	3,679	310	11,381
Institutional (R&D, information, etc.)	5,170	9,120	1,800	16,090
Infrastructure (railways, water, roads)	84,005	4,600	0	88,605
Total	537,506	1,041,611	844,496	2,423,613

Source: World Bank 1989b, Annex 5, Table 3.

Table III.19

R&D Expenditures by EIC Firm (Companies Visited)

Year	R&D Expenditures (thousand current L.E.)	R&D Price Index (1985=100)	R&D Expenditures (thousand constant 1985 L.E.)	R&D/ Output (%)
Firm 1 (Nasr Lel Sayyarat)				
1980	480.50	62.91	763.82	0.32
1981	541.67	61.28	883.91	0.36
1982	739.36	71.36	1,036.03	0.30
1983	1,422.94	88.30	1,611.55	0.51
1984	1,119.99	94.00	1,191.42	0.41
1985	884.98	100.00	884.98	0.31
1986	1,030.03	105.31	978.11	0.39
1987	979.07	118.14	828.76	0.25
1988	989.51	148.88	664.62	0.24
1989	1,067.44	189.19	564.23	0.28
Firm 4 (Kablat)				
1983	97.92	95.00	103.08	0.09
1984	100.00	97.52	102.54	0.08
1985	105.25	100.00	105.25	0.08
1986	155.00	114.28	135.63	0.11
1987	200.10	129.96	153.97	0.12
1988	310.00	164.32	188.65	0.18
1989	420.00	209.30	200.66	0.19
Firm 5 (Telemasr)				
1983	39.70	77.46	51.25	0.04
1984	48.00	92.08	52.13	0.04
1985	48.50	100.00	48.50	0.05
1986	49.50	102.36	48.36	0.07
1987	88.00	116.32	75.65	0.10
1988	94.00	146.91	63.98	0.11
1989	102.00	187.02	54.54	0.11

Table III.19 (continued)

Year	R&D Expenditures (thousand current L.E.)	R&D Price Index (1985=100)	R&D Expenditures (thousand constant 1985 L.E.)	R&D/ Output (%)
Firm 10 (Sabi)				
1983	1.96	77.46	2.52	0.01
1984	2.05	92.08	2.22	0.01
1985	2.25	100.00	2.25	0.01
1986	2.17	102.36	2.12	0.01
1987	1.94	116.32	1.67	0.01
1988	0.36	146.91	0.24	0.00
1989	0.78	187.02	0.42	0.00
Firm 11 (Steelco)				
1983	33.50	77.46	43.25	0.19
1984	35.50	92.08	38.55	0.19
1985	35.00	100.00	35.00	0.16
1986	34.40	102.36	33.61	0.18
1987	32.00	116.32	27.51	0.14
1988	31.00	146.91	21.10	0.12
1989	28.00	187.02	14.97	0.09
Firm 13 (El Tarkibat, ERISCOM)				
1983	145.15	77.46	187.38	1.76
1984	177.60	92.08	192.87	1.40
1985	166.05	100.00	166.05	1.25
1986	276.10	102.36	269.74	2.43
1987	370.35	116.32	318.39	1.31
1988	286.30	146.91	194.88	1.28
1989	306.90	187.02	164.10	1.48
Firm 16 (Koldair)				
1983	515.50	79.31	650.01	2.19
1984	536.00	92.66	578.49	2.00
1985	550.00	100.00	550.00	1.70
1986	571.00	103.60	551.16	2.27
1987	1,359.00	126.19	1,076.93	3.27
1988	1,712.00	159.38	1,074.16	3.31
1989	2,738.00	202.89	1,349.49	5.56

Table III.19 (continued)

Year	R&D Expenditures (thousand current L.E.)	R&D Price Index (1985=100)	R&D Expenditures (thousand constant 1985 L.E.)	R&D/ Output (%)
Firm 17 (Mikar)				
1983	4.75	77.46	6.13	0.03
1984	4.90	92.08	5.32	0.03
1985	5.00	100.00	5.00	0.03
1986	7.00	102.36	6.84	0.04
1987	16.49	116.32	14.18	0.08
1988	12.87	146.91	8.76	0.06
1989	8.64	187.02	4.62	0.03
Firm 19 (Maragel)				
1983	28.50	77.46	36.79	0.94
1984	29.50	92.08	32.04	0.48
1985	30.50	100.00	30.50	0.42
1986	31.01	102.36	30.30	0.40
1987	41.35	116.32	35.55	0.47
1988	51.69	146.91	35.18	0.50
1989	62.03	187.02	33.17	0.37

Source: Data on R&D for Firm 1 were collected first hand. This data set is based on details of R&D activities of the Company provided by professionals at the Company's Computer and Information Centre. I collected this information after several field trips to the Company's Headquarters in Helwan, Egypt. The sessions with technical personnel at the Computer and Information Center and the Accounting Department of the Company were particularly useful. R&D data for other firms were also collected first hand. R&D figures in current L.E. were deflated using the R&D price index calculated as a weighted average of wage and capital price indexes, or as a wage index when expenditures are only R&D wages. R&D/output is calculated as a percentage of output in thousands of constant 1985 L.E.

Table III.20

Total Intermediate Inputs for EIC Firms

(thousands of constant 1985 L.E.)

Year	Total Inputs	Output/ Inputs	Value-Added/ Inputs	Imported/ Total Inputs
1984	685,800.084	1.78	0.66	0.76
1985	710,917.530	1.55	0.49	0.75
1986	699,932.063	1.42	0.45	0.69
1987	880,731.491	1.38	0.37	0.97
1988	757,873.322	1.32	0.36	0.63
1989	759,862.785	1.11	0.36	0.63

Source: Data was collected from Ministry of Industry Performance Evaluation Reports, various issues. Data on intermediate inputs is deflated by a weighted average of import and wholesale price indices, weighted by the ratio of imported inputs to total inputs. The ratio of imported to total intermediate inputs is calculated based on figures in current L.E.

Table III.21

Total Factor Productivity Levels for EIC Firms 1975-89

(Method 1)*

	Qtfp	Vtfp
1975	929.62	395.47
1976	978.04	427.86
1977	1,174.97	508.07
1978	1,179.08	425.09
1979	1,373.14	513.17
1980	1,545.67	520.27
1981	1,716.29	517.03
1982	1,982.66	613.28
1983	1,857.94	620.25
1984	1,773.84	658.64
1985	1,566.24	493.48
1986	1,393.98	439.49
1987	1,681.67	456.64
1988	1,401.46	379.75
1989	1,191.70	381.69

* Regression coefficients are used for b and c, b=0.872, c=0.218, from Table III.30.

Table III.22

Average TFP Levels for EIC Firms in Different Sub-Periods

(Method 1)

Sub-Period	Qtfp	Vtfp
1975-81	1,270.97	472.42
1982-89	1,606.19	505.40
1982-85	1,795.17	596.41
1986-89	1,417.20	414.39

<u>Source</u>: Based on Table III.21.

Table III.23

Index of Total Factor Productivity for EIC Firms 1975-89

(Method 1)

	Qtfp	Vtfp
1975	100.00	100.00
1976	105.21	108.19
1977	126.39	128.47
1978	126.84	107.49
1979	147.71	129.76
1980	166.27	131.56
1981	184.62	130.74
1982	213.28	155.07
1983	199.86	156.84
1984	190.81	166.54
1985	168.48	124.78
1986	149.95	111.13
1987	180.90	115.47
1988	150.76	96.02
1989	128.19	96.51

Source: Based on Table III. 21.

Table III.24

Total Factor Productivity Levels for EIC Firms 1975-89

(Method 2)*

	Qtfp	Vtfp
1975	104.49	44.45
1976	109.36	47.84
1977	130.47	56.42
1978	129.11	46.55
1979	146.85	54.88
1980	162.11	54.56
1981	180.34	54.33
1982	200.34	61.97
1983	193.29	64.53
1984	177.48	65.90
1985	148.33	46.74
1986	126.24	39.80
1987	149.06	40.47
1988	122.57	33.21
1989	102.78	32.92

* b is the average ratio or employee compensation to value-added and c equals 1-b, b = 0.474, c = 0.526.

Table III.25

Average TFP Levels for EIC Firms in Different Sub-Periods

(Method 2)

Sub-Period	Qtfp	Vtfp
1975-81	137.53	51.29
1982-89	152.51	48.19
1982-85	179.86	59.78
1986-89	125.16	36.60

Source: Based on Table III.24.

Table III.26

Index of Total Factor Productivity for EIC Firms 1975-89

(Method 2)

	Qtfp	Vtfp
1975	100.00	100.00
1976	104.65	107.62
1977	124.86	126.91
1978	123.55	104.71
1979	140.53	123.46
1980	155.13	122.75
1981	172.58	122.21
1982	191.72	139.40
1983	184.97	145.16
1984	169.85	148.24
1985	141.95	105.13
1986	120.81	89.53
1987	142.65	91.05
1988	117.30	74.71
1989	98.36	74.05

Source: Based on Table III.24.

Table III.27

Levels of Partial Factor Productivity for EIC Firms 1975-89

	O/L	V/L	O/K	V/K	O/I	V/I
1975	8,169.91	3,475.61	2.06	0.87	n/a	n/a
1976	8,641.12	3,780.19	2.13	0.93	n/a	n/a
1977	10,480.06	4,531.69	2.51	1.08	n/a	n/a
1978	10,668.77	3,846.39	2.42	0.87	n/a	n/a
1979	12,618.38	4,715.73	2.65	0.99	n/a	n/a
1980	14,454.90	4,865.51	2.83	0.95	n/a	n/a
1981	16,122.10	4,856.72	3.15	0.95	n/a	n/a
1982	19,141.09	5,920.77	3.29	1.02	n/a	n/a
1983	17,714.11	5,913.66	3.30	1.10	n/a	n/a
1984	17,386.93	6,455.88	2.85	1.06	1.78	0.66
1985	15,929.18	5,018.89	2.19	0.69	1.55	0.49
1986	14,596.05	4,601.78	1.75	0.55	1.42	0.45
1987	17,867.68	4,851.77	2.00	0.54	1.38	0.37
1988	14,989.47	4,061.65	1.61	0.44	1.32	0.36
1989	12,851.64	4,116.25	1.32	0.42	1.11	0.36

Table III.28

Average Levels of Partial Factor Productivity for EIC Firms in Different Sub-Periods

Sub-Period	O/L	V/L	O/K	V/K	O/I	V/I
1975-81	11,593.61	4,295.98	2.53	0.95	n/a	n/a
1982-89	16,309.52	5,117.58	2.29	0.73	n/a	n/a
1982-85	17,542.83	5,827.30	2.91	0.97	1.66*	0.57*
1986-89	15,076.21	4,407.86	1.67	0.49	1.31	0.38

<u>Source</u>: Based on Table III.27.

Table III.29

Indices of Partial Factor Productivity For EIC Firms

	O/L	V/L	O/K	V/K	O/I	V/I
1975	100.00	100.00	100.00	100.00	n/a	n/a
1976	105.77	108.76	103.66	106.60	n/a	n/a
1977	128.28	130.39	121.85	123.86	n/a	n/a
1978	130.59	110.67	117.54	99.61	n/a	n/a
1979	154.45	135.68	129.07	113.39	n/a	n/a
1980	176.93	139.99	137.80	109.03	n/a	n/a
1981	197.34	139.74	152.94	108.30	n/a	n/a
1982	234.29	170.35	160.03	116.36	n/a	n/a
1983	216.82	170.15	160.30	125.79	n/a	n/a
1984	212.82	185.75	138.61	120.98	100.00	100.00
1985	194.97	144.40	106.64	78.98	87.26	74.04
1986	178.66	132.40	84.91	62.93	79.86	67.81
1987	218.70	139.59	97.05	61.95	77.39	56.60
1988	183.47	116.86	78.38	49.93	74.07	54.06
1989	157.30	118.43	64.42	48.50	62.67	54.06

Source: Based on Table III.27.

Table III.30

Technical Change for EIC Firms 1975-1989

constant	lnK	lnL	t	t^2	tlnK	tlnL	R^2
Equation (1)							
6.25	0.218	0.872					0.5813
(9.58)	(2.92)	(10.41)					
Equation (2a)							
6.45	0.19	0.88	0.006				0.5647
(8.51)	(2.06)	(9.39)	(0.63)				
Equation (2b)							
5.28	0.305	0.732	0.109	-0.007			0.5429
(7.05)	(3.45)	(8.02)	(4.34)	(-4.67)			
Equation (3)							
6.37	0.20	0.86			0.00037		0.5566
(7.87)	(2.05)	(9.08)			(0.37)		
Equation (4)							
6.30	0.21	0.82				0.0025	0.5241
(8.52)	(2.52)	(8.87)				(0.30)	
Equation (5)							
1.59	0.77	0.395	0.51		-0.058	0.05	0.5653
(1.02)	(4.15)	(2.18)	(3.65)		(-3.60)	(2.68)	

Notes: The regressions are based on pooled cross-section, time series data for 19 firms, 15 time periods (1975-1989). The dependent variable is ln value-added. The CORCOEF option is not used (see note to Table III.31). Numbers in parentheses are t-statistics.

Table III.31

Technical Change for EIC Firms 1975-1981

constant	lnK	lnL	t	t^2	tlnK	tlnL	R^2
Equation (1)							
*2.77	0.625	0.481					0.7624
(2.43)	(4.62)	(3.65)					
Equation (2a)							
*4.08	0.46	0.61	0.038				0.7024
(3.51)	(3.27)	(4.52)	(2.63)				
Equation (2b)							
*4.06	0.454	0.61	0.061	-0.003			0.7032
(3.48)	(3.24)	(4.52)	(1.45)	(-0.59)			
Equation (3)							
*4.21	0.44	0.61			0.0039		0.7021
(3.54)	(3.08)	(4.49)			(2.53)		
Equation (4)							
*3.84	0.499	0.485				0.025	0.7053
(3.16)	(3.46)	(3.73)				(1.94)	
Equation (5)							
*1.88	0.71	0.43	0.52		-0.056	0.04	0.7106
(0.93)	(2.98)	(2.06)	(1.48)		(-1.36)	(0.99)	

Notes: The regressions are based on pooled cross-section, time-series data for 19 firms, 7 time periods (1975-1981). The dependent variable is ln value-added. The numbers in parentheses are t-statistics. *The CORCOEF option is used for all equations. The CORCOEF option estimates the correlation coefficient, rho_i, using an alternative method described by Kmenta (1986 p. 619, equation 12.26). This method confines the estimate of rho to the interval [-1, +1] (Shazam Manual, p. 122) and is used when the initial estimate lies outside this range. It is based on the formula:

$$\hat{rho}_i = \frac{\sum_{t=2}^{T} e_{it} \times e_{i,t-1}}{\sum_{t=2}^{T} e^2_{i,t-1}}$$

Table III.32

Technical Change for EIC Firms 1982-1989

	constant	lnK	lnL	t	t^2	tlnK	tlnL	R^2
Equation (1)	* 7.85	0.04	1.04					0.6239
	(11.55)	(0.54)	(9.60)					
Equation (2a)	5.98	0.29	0.71	-0.067				0.5911
	(7.83)	(3.22)	(5.98)	(-4.28)				
Equation (2ba)	5.86	0.30	0.69	-0.043	-0.003			0.5884
	(7.69)	(3.37)	(6.00)	(-0.90)	(-0.59)			
Equation (3)	5.68	0.32	0.71			-0.007		0.6131
	(7.33)	(3.53)	(6.04)			(-4.26)		
Equation (4)	6.38	0.21	1.01				-0.058	0.6927
	(9.19)	(2.68)	(10.20)				(-4.01)	
Equation (5)	5.28	0.36	0.79	0.06		-0.01	-0.02	0.6301
	(4.10)	(2.43)	(4.32)	(0.24)		(-0.41)	(-0.66)	

Notes: The regressions are based on pooled cross-section, time-series data for 19 firms, 8 time periods (1982-1989). The dependent variable is ln value-added. The numbers in parentheses are t-statistics. *The CORCOEF option is used for this equation.

Table III.33

Test for Constant Returns to Scale, EIC Firms

Period	Option	T	D.F.	F	D.F.	Conc.
1975-89	No option	1.6326	282	2.6654	1,282	Accept
1975-81	CORCOEF	1.9452	130	3.7837	1,130	Accept
1982-89	CORCOEF	1.1775	149	1.3866	1,149	Accept

Note: Tests are based on equation (1).

Table III.34

Test for Structural Change for all EIC firms, 1982-89

constant	lnK	lnL	D1	D1lnK	D1lnL	R^2
Equation (6a)						
6.80	0.15	0.94	0.139			0.6037
(10.09)	(1.87)	(11.01)	(2.50)			
6.86	0.14	0.94		0.014		0.6026
(9.99)	(1.75)	(10.96)		(2.43)		
6.61	0.176	0.86			0.0997	0.5967
(9.86)	(2.29)	(10.34)			(2.19)	
Equation (7a)						
5.81	0.27	0.82	1.55	-0.16	0.16	0.6000
(5.96)	(2.32)	(6.77)	(1.48)	(-1.37)	(1.23)	

Notes: D1 = 1 for 1982-1989, 0 otherwise. The dependent variable is ln value-added. The numbers in parentheses are t-statistics. All equations are estimated without the CORCOEF option.

Table III.35

Test for Structural Change for all EIC firms, 1986-89

constant	lnK	lnL	D2	D2lnK	D2lnL	R^2
Equation (6b)						
5.03	0.37	0.66	-0.22			0.5422
(7.49)	(4.76)	(7.90)	(-3.85)			
5.01	0.37	0.66		-0.022		0.5378
(7.46)	(4.77)	(7.90)		(-3.79)		
5.56	0.30	0.75			-0.14	0.4914
(8.37)	(3.95)	(8.77)			(-2.80)	
Equation (7b)						
4.97	0.38	0.64	-0.09	-0.02	0.05	0.5421
(6.97)	(4.56)	(8.72)	(-0.08)	(-0.15)	(0.34)	

Notes: D2=1 for 1986-1989, 0 otherwise. The dependent variable is ln value-added. The numbers in parentheses are t-statistics. All equations are estimated without the CORCOEF option.

Table III.36

Does the Presence of an R&D Unit Make a Difference, 1975-89?

dependent variable	constant	lnK	lnL	DRD	R^2
Equation (11)					
*ln output	6.34	0.27	0.98	0.37	0.6781
	(11.37)	(4.49)	(14.62)	(3.41)	
Equation (11)					
ln value-added	5.26	0.297	0.81	0.38	0.6337
	(7.51)	(3.81)	(9.90)	(3.36)	

Notes: DRD=1 for firms that have separate R&D units (firms 1,4,5,7,10,11,13,16,17,18 and 19), 0 otherwise. The numbers in parentheses are t-statistics. *The CORCOEF option is used for this equation.

Table III.37

Does the Presence of an R&D Unit Make a Difference, 1975-81?

dependent variable	constant	lnK	lnL	DRD	R^2
Equation (11)					
*ln output	3.82	0.57	0.70	0.22	0.7063
	(4.15)	(5.40)	(6.57)	(1.92)	
Equation (11)					
*ln value-added	2.80	0.61	0.50	0.12	0.7410
	(2.45)	(4.48)	(3.69)	(1.06)	

Notes: DRD=1 for firms that have separate R&D units (firms 1,4,5,7,10,11,13,16,17,18 and 19), 0 otherwise. The numbers in parentheses are t-statistics. *The CORCOEF option is used for this equation.

Table III.38

Does the Presence of an R&D Unit Make a Difference, 1982-89?

dependent variable	constant	lnK	lnL	DRD	R^2
Equation (11)					
*ln output	7.64	0.13	1.23	0.34	0.8942
	(12.71)	(2.05)	(20.62)	(3.24)	
Equation (11)					
*ln value-added	6.76	0.12	1.02	0.49	0.8999
	(9.00)	(1.47)	(12.63)	(4.25)	

Notes: DRD=1 for firms that have separate R&D units (firms 1,4,5,7,10,11,13,16,17,18 and 19), 0 otherwise. The numbers in parentheses are t-statistics. *The CORCOEF option is used for these equations.

Table III.39

The Role of R&D in Production 1983-89

constant	lnK	lnL	lnR	t	R2
Equation (8)					
*8.03	-0.003	1.13	0.05		0.8959
(6.74)	(-0.020)	(7.84)	(1.96)		
*6.11	0.238	0.886	0.064	-0.055	0.9060
(4.83)	(1.63)	(5.65)	(3.396)	(-2.98)	

Notes: Estimates for 9 firms which reported R&D expenditures. The dependent variable is ln value-added. The numbers in parentheses are t-statistics. *The CORCOEF option is used for these equations.

Table III.40

The Role of Lagged R&D in Production 1984-89

constant	lnK	lnL	lnlaggedR	t	R2
Equation (8)					
8.76	-0.08	1.16	0.05		0.9164
(9.38)	(-0.74)	(9.57)	(1.88)		
5.79	0.28	0.81	0.085	-0.095	0.9311
(7.16)	(3.06)	(7.26)	(6.61)	(-6.95)	

Notes: Estimation for the 9 firms which reported R&D expenditures, data for firms from 1984-89, R&D data from 1983-88). The dependent variable is ln value-added. The numbers in parentheses are t-statistics. All equations are estimated without the CORCOEF option.

Table III.41

The Role of R&D in Production with Intermediate Inputs Included In the Production Function 1984-89

constant	lnK	lnL	lnI	lnR	t	R^2
*6.59	-0.299	0.66	0.61			0.9394
(6.78)	(-2.97)	(4.88)	(10.48)			
Equation (10)						
*5.29	-0.11	0.54	0.56	0.02		0.9486
(5.17)	(-1.07)	(3.61)	(8.98)	(1.03)		
2.67	0.095	0.11	0.696	0.037	-0.09	0.9754
(4.17)	(1.40)	(1.14)	(22.64)	(3.2)	(-8.57)	
*2.83	0.12	0.17	0.64	0.046	-0.085	0.9671
(4.23)	(1.73)	(1.69)	(16.42)	(3.62)	(-7.78)	

Notes: Estimation for the 9 firms which reported R&D expenditures, data from 1984-89. The dependent variable is ln output. The numbers in parentheses are t-statistics. *The CORCOEF option is used for these equations.

Table III.42

The Role of Lagged R&D in Production with Intermediate Inputs Included in the Production Function 1984-89

constant	lnK	lnL	lnI	lnR	t	R^2
Equation (11)						
*5.33	-0.13	0.51	0.57	0.04		0.9425
(5.14)	(-1.23)	(3.45)	(9.67)	(1.61)		
2.10	0.16	0.04	0.69	0.05	-0.095	0.9735
(3.27)	(2.35)	(0.38)	(22.96)	(4.14)	(-8.77)	

Notes: Estimates are for the 9 firms which reported R&D expenditures, data for firms from 1984-89, R&D data from 1983-88. The dependent variable is ln output. The numbers in parentheses are t-statistics. *The CORCOEF option is used for this equation.

Fig III.1

EIC Output and Value Added (Current L.E.'000)

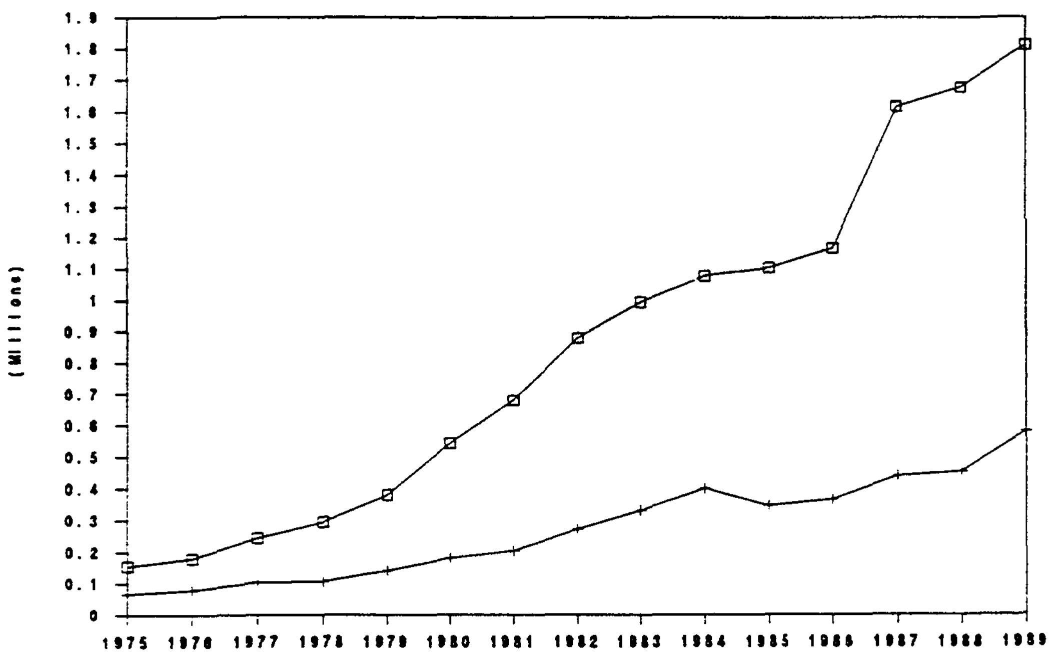


Fig III.2

EIC Output and Value Added (Constant L.E.'000)

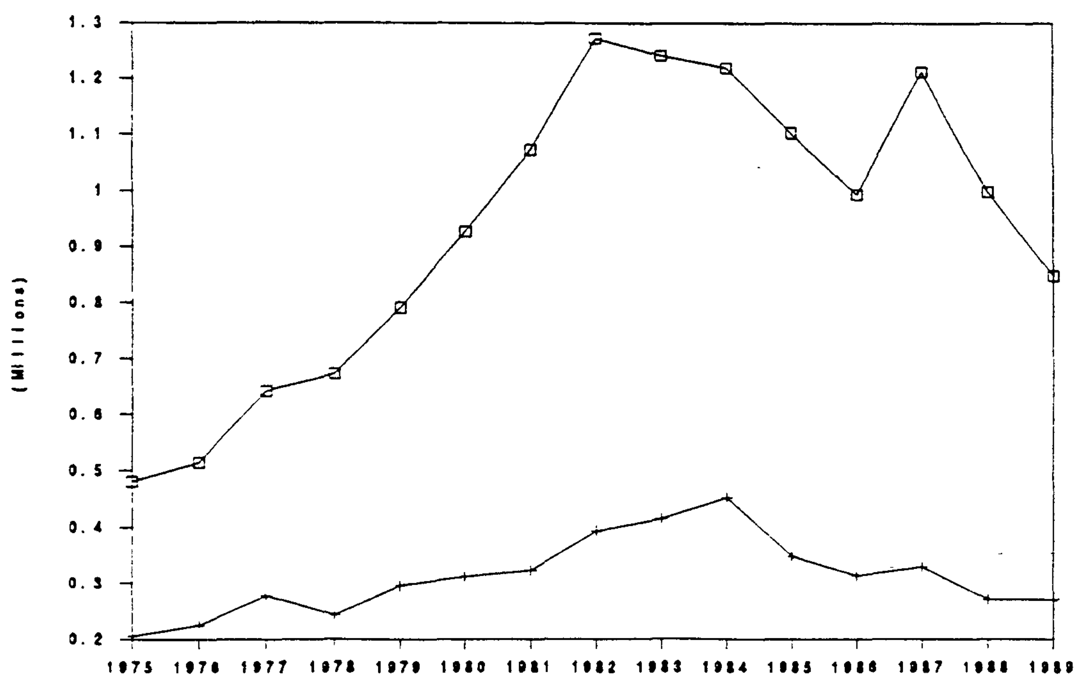


Fig III.3

Total EIC Labor (Thousands of Persons)

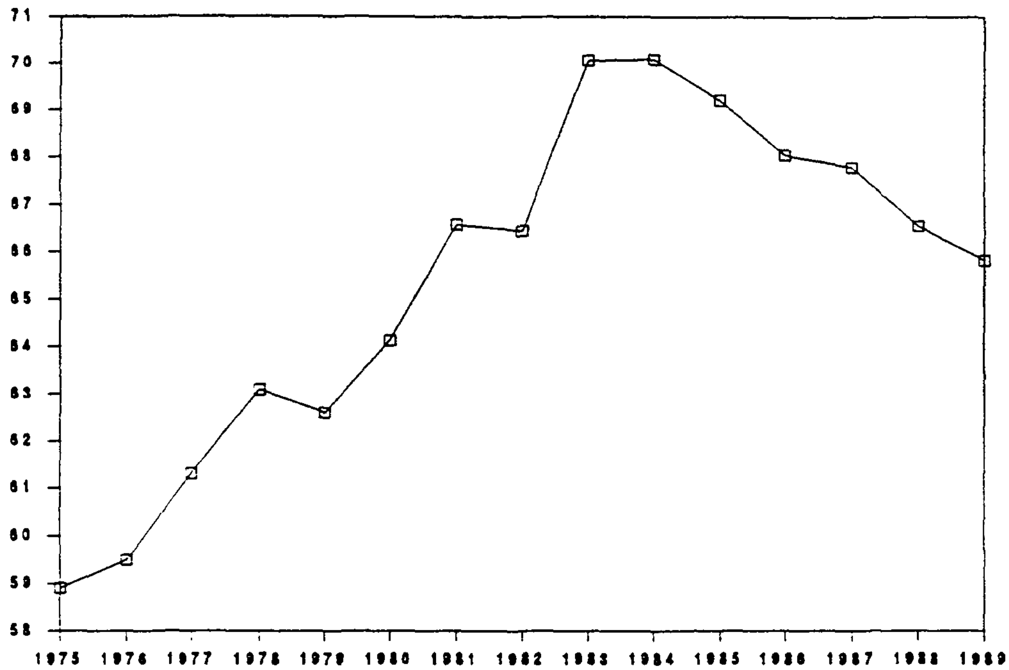


Fig III.4

EIC Capital Stock (Constant L.E.'000)

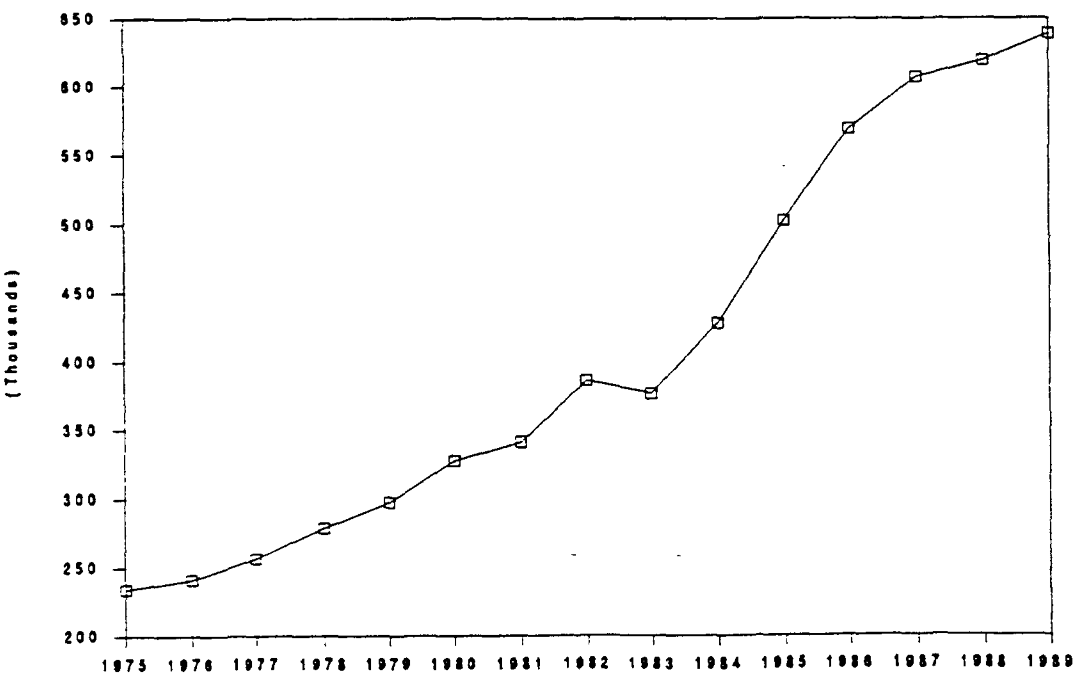


Fig III.5

Total Factor Productivity, EIC (Method 1)

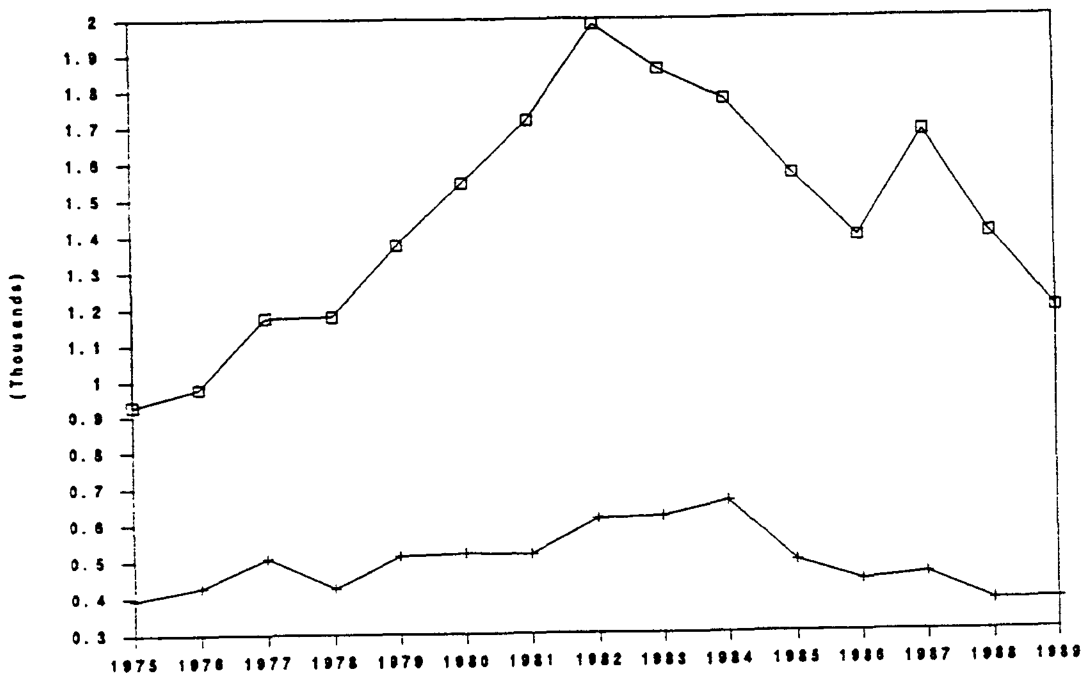


Fig III.6

Total Factor Productivity, EIC (Method 2)

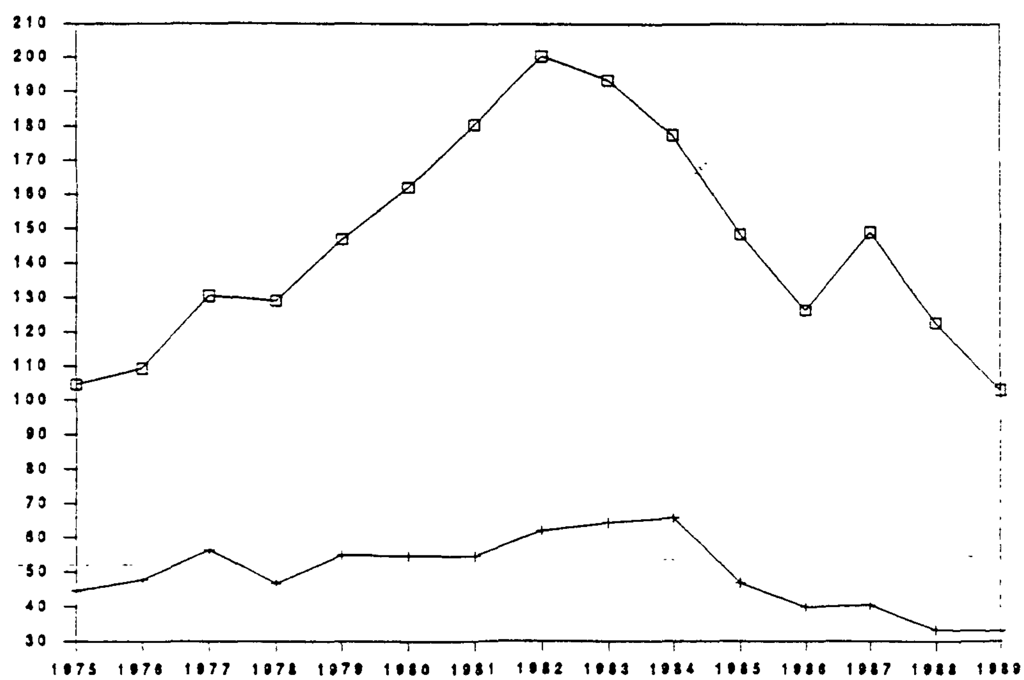


Fig III.7

Labor Productivity for EIC Firms

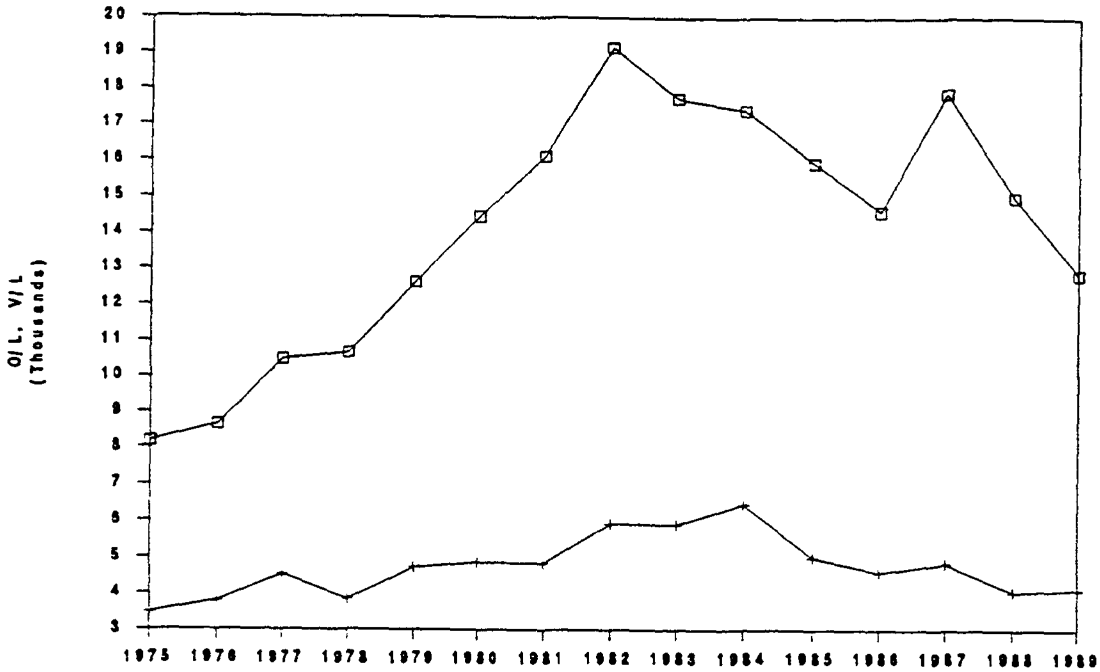
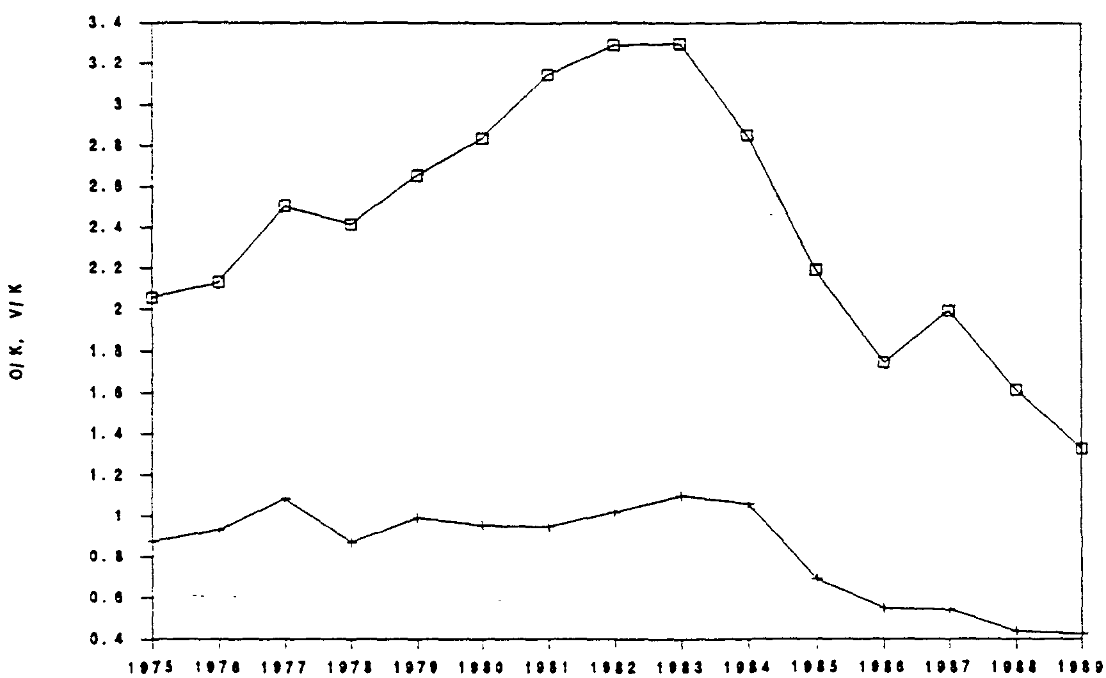


Fig III.8

Capital Productivity for EIC Firms



ANNEXES

Annex III.1: Engineering Companies Affiliated with the Engineering Industries Corporation (EIC) and their Principal Products or Main Activities

1. El Nasr Lel Sayyarat
Main products:
-passenger cars
-trucks
-buses
-tractors
-engines.

2. Al Delta Al Senaeya (Ideal)
Main products:
-refrigerators
-full automatic washing machines
-vacuum cleaners
-steel furniture.

3. Tersanat Al Iskandareya
Main activities:
-building all kinds of cargo vessels up to 35000 thousand tons
-repairing all kinds of vessels up to 85000 thousand tons
-building heavy steel structures and drilling rigs.

4. Al Kablat Al Kahrabaeya
Main products:
-electric wires and cables
-armoured cables
-telephone cables
-enamelled wires.

5. Al Arabeya Lel Radio Al Transistor (Telemasr)
Main products:
-TV sets, black/white and colored
-video cassette Recorders
-radio cassettes mono and stereo
-car radio cassettes
-household appliances
-ballast chokes

6. Al Nasr Lel Agheza Al Electroneya (Philips)
Main products:
-incandescent and florescent lamps
-radios, recorders
-TV sets, black/white, and colored
-refrigerators
-household appliances

7. Al Nasr Lel Television
Main products:
-TV sets, black/white, and colored
-electrical and electronic components and apparatus
-VCR's and tapes
-radio cassettes
-electric fans
-TV picture tubes

8. Al Masreya Lemohemmat Al Sekak Al Hadideya (Semaf)
Main products:
-railway wagons
-railway passenger coaches
-tram cars

9. Al Masreya Lesenaat Wasael AL Nakl Al Khafif
Main products
-bicycles
-motorcycles
-utility car bodies
-tubes

10. Al Masreya Lelsenaat Al Mekanikeya (Sabi)
Main products:
-locks, padlocks hinges
-cremons, taps, valves and fittings
-abrasive paper
-grinding wheels
-spark plugs

11. Al Mashrouaat Al Handasseya (Steelco)
Main products
-steel bridges
-river barges
-steel sheds, structures, towers and hangers
-steel equipment for industry
-cranes

12. Al Masreya Lel Inshaat (Metalco)
Main products:
-manufacturing and installing metallic structures
-planning estimating designing structural and industrial projects
-fixed and movable bridges, fuel tanks , electric lighting columns, towers and overhead cranes

13. Al Tarkibat Wal Khadamat Al Senaeya (Eriscom)
Main activities:
-installation of mechanical and electrical equipment for industrial factories
-maintenance services for factories

14. Al Kahira Lel Montagat Al Maadaneya
Main products:
-sanitary ware
-enameled house ware
-cast iron products
-sanitary pipes
-bath tubs
-printed tin containers

15. Iskandareya Lel Montagat Al Maadaneya
Main products:
-household utensils
-cooking stoves with oven and butane gas cookers
-gas heaters for water
-washing machines
-barrels
-small containers
-nails, screws and nuts
-traffic signals
-car mufflers and exhaust pipes

16. Al Nasr Lel Handassa Wal Tabrid (Koldair)
Main products:
-manufacturing and installation of central air conditioning, refrigeration, heating, ventilation and humidification equipment and systems
-air conditioning window units and split units
-deep freezers
-automatic washing machines
-water and bottle coolers
Main activities divided into two divisions:
1. factories: a. custom made (no research)
   b. mass production (R&D)
2. contracting (R&D undertaken related to design, use of less costly inputs and better quality output):
   a. quotation (no R&D)
   b. design
   c. application
   d. testing

17. Misr Lel Handassa Wal Edad (Mikar)
Main products:
-buses, trailers and semi-trailers
-mobile tanks and containers
-refrigerated trucks

18. El Yayat Wa Wasael Al Nakl
Main products:
-leaf springs
-helical springs (all dimensions)
-brake linings and clutch facings

19. Al Nasr Lesenaat Al Maragel Al Bokhareya
Main products:
-boilers from 1/2 ton/hr up to 12 ton/hr
-all pressure vessels for engineering petroleum, food and chemical industries

Source: Information collected during interviews held at companies' headquarters; also from Engineering Industries Corporation (EIC), Brochure.

Annex III.2: Classification of EIC firms According to Nature of Product (World Bank Classification)

(a) Process equipment (non electrical goods): boilers, nuclear reactors, paper mill and pulp mill machinery, food processing machinery, mineral crushing, sorting, heating and cooling equipment, pumps and centrifuges, calendaring, etc. (SITC 711.1, 711.2, 711.7, 718.1, 718.3, 718.5, 719.1, 719.2, 719.6)

(b) Other non electrical equipment: specialized machines, agricultural, office, metalworking, textile, leather machines, power generation machinery, etc. (SITC 711 (less those above), 712, 714, 715, 717, 718, 719 (less those above).

(c) Transport equipment: vehicles (rail, road) ships, boats, and aircraft. (SITC 731-735)

(d) Electrical equipment: electric power machinery and switch gear, electricity distribution equipment, electric apparatus for medical use, other electrical equipment and apparatus (SITC 722, 723, 726, 729)

(e) Consumer electronics: television, radio, telecommunication equipment (SITC 724.1, 724.2, 724.9)

(f) Manufactured metals: steel structures, metal containers, wire products, mails, screws, hand tools, cutlery and other household metal equipment (SITC 691-698)

(g) Domestic appliances (electrical): refrigerators, washing machines, appliances, electrical space heating, food processing, water heaters (SITC 719.4, 725.0,1,2,3,5)

(h) Domestic fixtures : sanitary, plumbing, heating fixtures (SITC 812.1-812.4)

Source: World Bank (1989b), annex 1.

Annex III.3.: EIC Companies in Subcategories According to World Bank Classification

(a) Process equipment (19,11,12,13,3)
Maragel
Steelco
Metalco
Eriscom
Tersana

(b) Other non electrical equipment (10)
Sabi

(c) Transport equipment (18,17,9,8,1)
Yayat
Mikar
Nakl Al Khafif
Semaf
Nasr Lel Sayyarat

(d) Electrical equipment (6,4)
Qanalectron
Philips
Kablat

(e) Consumer electronics (7,5)
Nasr TV
Telemasr

(f) Manufactured metals (15)
Iskandareya Lel Montagat

(g) Domestic appliances (16,2)
Koldair
Ideal

(h) Domestic fixtures (14)
Kahira Lel Montagat

Source: World Bank (1989b), annex 1

Annex III.4: Grouping of EIC Companies into 5 Subgroups (Modified Version of World Bank Classification)

A. (a) Process equipment (19,11,12,13,3)
Maragel
Steelco
Metalco
Eriscom
Tersana

B. (c) Transport equipment (18,17,9,8,1)
Yayat
Mikar
Nakl Al Khafif
Semaf
Nasr Lel Sayyarat

C. (d) Electrical equipment (6,4) and (b) Other non electrical equipment (10)
Philips
Kablat
Sabi

D. (e) Consumer electronics (7,5) and (g) Domestic appliances (16,2)
Nasr TV
Telemasr
Koldair
Ideal

E. (f) Manufactured metals (15) and (h) Domestic fixtures (14)
Iskandareya Lel Montagat
Kahira Lel Montagat

Source: My modification to World Bank Classification in Annex III.2.

Annex III.5: Classification of EIC Firms According to Their Shares in Output, Capital, Value-Added, and Labor and Net Profits in 1989

'Big' firm : share > 10%
'Medium'firm : share 5-10%
'Small' firm : share < 5%

---

a. According to share in output:

Big: 1,2,4
Medium: 3,5,6,7,8
Small: Rest

---

b. According to share in value-added:

Big: 1,2
Medium: 4,5,6,7,8,9
Small: Rest

---

c. According to share in capital:

Big: 1,2,9
medium: 3,4,6,7
small: Rest

---

d. According to share in labor:

Big: 1,2
medium: 3,6,12
small: Rest

---

e. According to net profit

---

high profit:	> 20,000 (thousand L.E.)	1
medium profit:	10-20,000	4
low profit:	1-10,000	5,6,9,13,15,18,19
losing firms:		2,3,7,8,10,11,12, 14,16,17

Overall: 'Big' includes Firms 1,2
'Small' includes Firms 10-19
'Medium' includes Firms 3-9

Source: My classification based on data on outputs, inputs, and profits provided in Ministry of Industry, Egypt, Report on Performance Evaluation 1989/90.

Annex III.6: Translated Interview Schedule
[Original in Arabic]

The Impact of Research and Development on Productivity Change In Public Sector Engineering Industries

Company Name:
Address and Telephone no.:
Date of Establishment:
Director:
Production Activities:

Date of filling out Schedule:

General Questions: (annual time series)

Years

1. Sales (value)
2. Investment Expenditures
3. New Investments
4. Depreciation rate (for equipment)

Questions Related to R&D:

1. Is there a separate R&D department in the company?

Yes No

If yes;
  a. When was it established?
  b. Activities:
    - Theoretical research
    - Applied research
    - Management development systems
    - Other
  c. Was there a specific time period when the department was more active?
    - Sixties
    - Seventies
    - Eighties
    - Other (a specific date)
  d. Size (and extent) of benefit from extramural research (before the unit was established)

2. Extramural Research

   What are the sources of this research (please mention names)
   - Research centers
   - Universities
   - Consultancy firms
   - other (specify)

3. Research and Development Expenditures: (annual time series)

   Years

   a. R&D dept. within company
   b. Consultancy firms
   c. Research centers
   d. Universities
   e. Other (specify)

   Total

4. Details of Research and Development Expenditures (annual time series)

   Years

   a. Salaries of research engineers & technicians
   b. Equipment (value of assets)
   c. Raw materials
   d. Payments to consultants
   e. Other (specify)
   f. Research personnel
      i. Engineers
      ii. Technicians

5. External Sources of Research Funding (annual time series)

   Years

   a. Ministry of Industry
   b. Cabinet
   c. Other government agencies
   d. Foreign sources
   e. Other (specify)

6. Impact of Research and Development on Production

	Yes	No
a. Change in input mix		
b. Development of machinery		
c. Development of production systems		
d. Change in cost		
e. Increase in production		
f. Development of new product		
g. Other (specify)		

Annex III.7: Classification of EIC Firms According to Whether Company Has Separate R&D Unit

Group 1: Companies that have separate R&D units (11)

1. Nasr Lel Sayyarat	Intramural data
4. Kablat	Intramural data
5. Telemasr	Intramural data Extramural data
7. Nasr TV	
10. Sabi	Intramural data
11. Steelco	Intramural data Extramural data
13. Eriscom	Intramural data
16. Koldair	
17. Mikar	Intramural data Extramural data
18. El Yayat	
19. Maragel	Intramural data

Group 2: Companies that have no R&D unit (5)

2. Ideal
3. Tersanat Al Iskandareya
6. Philips
8. Semaf
12. Metalco

Group 3: Companies that claimed to have no R&D or refused contact (3)

9. Nakl el Khafif	claimed to have no R&D
14. Kahira Montagat	contacts unfruitful
15. Iskandareya Montagat	contacts unfruitful

<u>Annex III.8</u> : EIC Companies and External Research

1. Nasr Sayyarat: plan of an agreement with Faculty of Engineering, Cairo University.

5. Telemasr: NRC, Academy, Ain Shams and Cairo University, Engineering and Design Development Center.

7. Nasr TV: NRC, Academy (Committee on Electronic Research), Faculty of Engineering, Cairo university, Helwan University, Menoufia University
(Hamdy: "20% of what we use comes from external research, the other 80% comes from internal research.")

11. Steelco: Tibbin Institute, Engineering and Design Development Center.

13. Tarkibat: NRC, Felezat, Engineering and Design Development Center, Institute of Technology, Faculties of Engineering

17. Mikar: Faculty of Engineering, Dept of Mechanics, Cairo University

4. Kablat: n.a.

10. Sabi: n.a.

16. Koldair:n.a.

19. Maragel: n.a.

<u>Source</u>: Interviews held at companies' headquarters.

Annex III.9: Details of R&D data Released by Engineering Firms

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1. Nasr Lel Sayyarat:
   a. Data on expenditures of the unit for R&D and design, including:
      - salaries
      - service expenditures
      - current expenditures, e.g., depreciation, research equipment, fringe benefits for personnel
   b. Expenses on research done on each product at the station: trucks, buses, tractors, trailers, cars, engines.

4. Kablat:
   R&D data is on salaries and equipment of the first unit (General Unit of Research and Laboratories).

5. Telemasr:
   R&D data is on salaries of research staff. Also data was provided on extramural research.

10. Sabi:
   R&D data is on salaries of research and design staff.

11. Steelco:
   R&D data is on salaries of research staff. Also data was provided on extramural research.

13. Eriscom:
   R&D data is on salaries of research staff.

16. Koldair:

R&D data is on salaries and equipment of the research units in:

factories (mass production): product design and development of existing products.

contracting: design, application and testing (systems development, development of human comfort).

[R&D figures were provided as a total for research in the product and contracting divisions (salaries, computer, prototype factory, books). Also data was provided on extramural research.]

17. Mikar

Data on salaries of research personnel.

19. Maragel

Data on salaries of research personnel.

<u>Source</u>: Interviews held at companies' headquarters.

Annex III.10: EIC Companies: R&D Units, and External R&D Bodies

A. A Summary Table of the Dates of Establishment of Engineering Companies and their R&D Units:

	company	R&D unit	Period when most active
Nasr Sayyarat	1962	1975	end of 70's, throughout 80's
Kablat	1961	1960's	second half of 80's
Telemasr	1962	1962	80's
Nasr TV	1959	1960's	60's, 1980-86
Sabi	n.a.	n.a.	n.a.
Steelco	1961	1971	70's
Tarkibat	n.a.	n.a.	80's (last 10 years)
Koldair	1961	1960's	70's
Mikar	n.a.	n.a.	n.a.
Maragel	1965	1970's	80's (last 6 years)

B. Notes on EIC Companies and their R&D Units:

1. Nasr Lel Sayyarat:
The company engaged in licensing for the first 10 years after it was established in 1962. The R&D unit served as an information centre for 2-3 years after it was established in 1975. The unit became more active at the end of the 70's and activity has been increasing throughout the 80's.

4. Kablat:
The company was nationalized in 1961. R&D labs were established at the beginning of 60's. A project was begun around 10 years ago. In the last 3-4 years, the emergence of 2 private sector competitors has encouraged R&D activities.

5. Telemasr:
The company and the R&D unit were established in 1962. Activities increased in the 80's.

10. Sabi: (n.a.)

11. Steelco:
The company was nationalized in 1961. The R&D unit was established in 1971.

13. Tarkibat:
The company was established in the 80's. There is no separate internal R&D unit.

16. Koldair:
The company was nationalized in 1961. R&D activities started in the 1960's (design of new products, development of existing products, prototypes, testing). In the 60's, components were obtained from the Eastern block; in the 70's, from the US. In the 70's, the Open Door Policy led to more competition. This stimulated interest in design. "In the coming years, competition is even more, thus we have to shape up" says Eng. Soliman.

17. Misr Lel Handassa Wal Edad (Mikar): (n.a.)

19. Al Nasr Lesenaat Al Maragel Al Bokhareya
The company was established in 1965. There is a separate R&D and design unit which was established in the 70's.

<u>Source</u>: Interviews held at companies' headquarters

C. A Note On External R&D Bodies:

Summary table:

Institution:		Date of establishment	Time when most active
Universities		n.a.	n.a.
MOI			
	Tibbin	n.a.	
	Electronic	59/60	60s, 80-86
	Eng. & Ind. Design & Dev Center (EIDDC)	68	60s, 80-86, 91
Academy/NRC			
	Metallurgy	56-61	
	Electronics	56-61	
	Mechanical eng	56-61	

Notes:

Center for Electronic Research:
The center was active in the 60's, slowed down in the 70's, was very active in the early 80's, and slowed down again in 1986.

EIDDC:
It was active in the 60's, slowed down in the 70's, became active again in the early 80's, was very active in 1986, then slowed down again, and just started to pick up in 1991.

Academy/NRC:
"Since 1975, however, the situation has changed significantly. ... (R)esearch reorientation effort.. priority areas including industry. NRC encouraged client-oriented contract research with public and private sector organizations. (Mahmoud 1987 pp. 17-19)

Source: Mahmoud (1987); also information gathered during interviews held at companies' headquarters.

Annex III.11: Definition of Research and Development (R&D):

R&D refers to the "systematic investigation carried out in the natural and engineering sciences by means of experiment or analysis to achieve a scientific or commercial advance". Research is defined as "original investigation undertaken on a systematic basis to gain new knowledge". Development refers to "the application of research findings or other scientific knowledge for the creation of new or significantly improved products or processes. If successful, development will usually result in devices or processes which represent an improvement in the state of the art and are likely to be patentable."

Formally, R&D referred to in the present context excludes :

1. market research sales promotion
2. quality control
3. research in social sciences or humanities
4. prospecting, exploring or drilling for, or producing minerals, petroleum or natural gas
5. commercial production of a new or improved material, device, or product or the commercial use of a new or improved process
6. style changes, or routine data collection.

(Statistics Canada 1985 p. 13)

Resources for research and development may be measured in two ways: as financial expenditures and as personnel engaged in R&D. Since the latter is included in the former, expenditure on R&D is considered more indicative of R&D resources. Including the two measures would involve double counting (Statistics Canada 1984 p. 11).

Research and Development expenditures may be classified into two types: extramural and intramural. Extramural expenditures are funds expended by one statistical unit for R&D which was performed by another unit. Intramural expenditures refer to all expenditure on R&D performed within a statistical unit, regardless of the source of the funds. Inside the national territory, extramural expenditures by one sector are identified in the intramural expenditure of another sector which performed the R&D (Statistics Canada 1984 p. 10).

Intramural expenditures include both current and capital expenditures. Current intramural expenditures cover labor costs, and other current costs, including non capital purchases of material, supplies and equipment but excluding capital depreciation. Capital expenditures refers to expenditures on fixed assets used in the R&D program, classified into land, buildings, and equipment (Statistics Canada 1985 p. 11).

Source: Statistics Canada (1984 & 1985)

Notes

[1] This was reported to be 40 by the World Bank in World Bank 1989b Annex 5 Table 5. The discrepancy is accounted for by a small company Qanalectron, which no longer exists.

[2] Roughly, 'big' is more than 10%, 'small' is less than 4-5%, and 'medium' is somewhere in between (see Annex III.4).

[3] According to EIC records, only five companies do not have a separate R&D unit as in group 2. These are: Ideal, Semaf, Tersanat Iskandareya, Metalce, Philips.

[4] Comparisons in nominal U.S. dollars are potentially misleading. Due to a drop in the prices of Egypt's engineering exports between 1981 and 1987 (see Table III.11) these exports increased much more (76 percent) in constant U.S. dollars than in current U.S. dollars (4 percent).

[5] According to Eng. A. Hamdy, there are four different levels in electronics hardware manufacturing:

1. material : zero in Egypt except copper or aluminium foil
2. components: started 2 months ago (fly back transformer, deflection yoke, and black and white picture tubes
3. set-making : TV, radio, VCR, fans, vacuum cleaner, etc.
4. systems : central antenna systems, rediffusion.

[6] The capital price index and wage index were computed by T. Moursi from CAPMAS unpublished data compiled by L. Abdellatif.

CHAPTER IV

TEXTILES INDUSTRIES

IV.1. Introduction

In this chapter, we focus on the performance of public sector textile firms, namely the thirty firms affiliated with the Textile Industries Corporation (TIC) of the Ministry of Industry. Most TIC companies are mainly engaged in spinning and weaving activities. Other activities include dyeing, finishing, knitting, garment-making, and even retailing operations (World Bank 1991 p. 47)

Our purpose is to examine indicators of technical change, and total and partial factor productivity (TFP and PFP). We also test for structural change after 1982 and 1986. We draw conclusions on the performance of the textile firms, and relate performance patterns to policy variables. In addition, our results will provide a basis for comparison with engineering firms.

We start the analysis with a brief overview of policy and historical background, to be followed by a presentation of the structure and a summary of the overall performance of the textiles industry, and specifically of the group of firms under study. We next present our estimation framework (econometric model), estimation procedure and data. This is followed by a presentation of the empirical results. Estimation is done for all Textiles Industry Corporation (TIC) firms taken as a group (pooled regression). A summary of conclusions on productivity and technical change concludes the chapter.

IV.2. General Background

At least until the end of the time period covered by this research, TIC enterprises continued to experience the effects of the policies of the sixties. These include employment policy, wage policy, pricing policies for both outputs and inputs, and trade policy. Most notable in this regard are employment policies. These have continued to influence the industry despite TIC's efforts starting in 1984 to limit the practice of hiring unneeded staff and to encourage early retirement. Wage increases were also lower for textiles than other public sector industries, which ultimately meant a deterioration in real wages. While these practices led to a decline in employment levels in the sector (more rapidly than in other industries, from nearly 300 thousand workers in the early eighties to 230 thousand workers in 1990), the industry remained 'over-manned'. By 1990, over-employment was estimated at 30 to 40 percent in most of the TIC enterprises, "compared with plants of similar capacity in many developing countries" (World Bank 1991 p. 48).

In addition to wage controls, pricing policies have involved controls on input and output prices. The subsidy on electricity is particularly significant. Since spinning is an energy intensive process, electricity accounts for about one-tenth of operating costs for spinning (World Bank 1991 p. 81). More importantly, the subsidy on cotton lint itself is substantial. Both the cotton buying prices (from farmers) and the selling prices (to spinners) are controlled by the government. Even when farm prices increased after policy changes in 1987, the increase in mill prices was slower, reflecting the reluctance of the government to transfer the farm price increase to industry. Until 1988, the f.o.b. export price of cotton was between one-and-one-half to two-and-one-half times the mill price. In 1988, the export price of Egyptian cotton increased. As a result, the f.o.b. export price increased to more than three and one half times (3.7) the mill price for extra long staple cotton (ELS) and between one and one half to three times for long staple cotton (LS). This means that ELS is more heavily subsidized than LS. This seems to encourage the wasteful use of ELS cottons (World Bank 1991 p. 81).

In addition, yarn output prices are controlled by the government (cotton yarn of count 80 or less). Even with recent price increases, they still stand at 50-80% of the f.o.b. yarn export prices. Accordingly, TIC prefers to export yarn rather than supply it domestically at the controlled domestic price. This constrains the supply of yarn to domestic knitting mills. Although private knitters and weavers have to pay premiums over the controlled price to obtain yarn, yarn and fabric inputs to the private sector are still subsidized (although the subsidy here is not as substantial as that on cotton inputs to the spinning mills) (World Bank 1991 p. 82).

The nature of the price controls in the textile industry has affected the efficiency of the sector. According to a World Bank study in 1983, negative value-added at world prices was found for 60% of firms "reporting production costs for rationed textiles. This means that the opportunity cost of their commodity inputs, primarily long staple cotton, exceeds the shadow value of output" (World Bank 1983 p. 303). Even by the end of the eighties, "prices of both outputs and inputs [in the textile sector] were found to be domestically below their international price" in 1988/89 (World Bank 1991 p. 83).

In addition to the above, trade policies represent the third major set of policies affecting the textile sector. At least until the time of writing this report, the structure of protection in Egypt has been described as "complex" and as consisting of "different policies that have not been conducive to export expansion" (World Bank 1991 p. 83). Trade limitations can be reduced to two major types: import restrictions and exchange rate distortions.

First, import restrictions included high tariffs and numerous exemptions from tariff duties for public mills (World Bank 1991 p. 83). While imports of cotton fabric and all garments were officially banned, cotton yarn imports were theoretically allowed at a tariff rate of 63%. In practice, however, private knitters could not easily obtain letters of credit for importing yarn (World Bank 1991 p. 83).

Import restrictions are deeply rooted in the policies of the sixties. In fact the increased protection for cotton yarn and low/medium grade fabrics dates back to the changes in industrial policy which took place in the fifties (together with increased protection for a wide range of consumer goods, and reduced tariffs on foodstuffs.) (Mabro and Radwan 1976 p. 62). In addition, the large subsidies on cotton inputs and energy have contributed to high effective protection accorded to the textile industry (World Bank 1991 p. 83).

The second major trade distortion has been the exchange rate problem. The exchange rate policy involved a multiple exchange rate system with overvalued Commercial and Central Bank rates. Different rates applied to different companies and activities (World Bank 1991 p. 79). Public enterprises mostly benefitted from exchange rate differentials and were protected from any exchange rate risks.

The nature of the multiple exchange rate system ensured protection for public sector firms. Until 1987, these firms imported cotton lint at the clearly overvalued Central Bank rate of L.E. 0.7=$1. At the same time, they exported their output at the Commercial Bank rate of L.E. 1.36=1$ (which was also the rate at which they imported capital goods and spare parts). When the Commercial Bank rate was changed to L.E. 1.89=$1 in 1987, the devaluation was implemented immediately for exports, but only gradually for imports of capital goods and spare parts. By early 1988, the new Commercial Bank rate was fully implemented for exports and imports, except imports of cotton lint which were still valued at the old Central Bank rate of L.E. 0.7=$1. In August 1989, the Central Bank rate was finally changed to L.E. 1.1=$1, and later to L.E. 2=$1 in July 1990 (World Bank 1991 p. 79). These rates, however, are still overvalued especially when compared to the 'free market rate' (see Chapter II).

Protection for TIC firms was extended to include protection from foreign exchange risk. Public sector firms were spared the foreign exchange risk involved in long-term borrowing. At least until 1986, borrowing was set at a fixed exchange rate and was "based on the investment program for the previous five years, which concentrated heavily on the modernization of the spinning mills" (World Bank 1991 p. 79). This compares with the private sector, which bought imported cotton at the Commercial Bank rate and borrowed foreign currency at 18% interest for long term investment. In contrast to the public sector, the private sector was thus "obliged to absorb the foreign exchange risk associated with the loan" (World Bank 1991 p. 80).

Benefits from foreign exchange rate differentials were also reaped by TIC firms through the system of foreign exchange budgeting and allocation. Until 1987, foreign exchange earned from exports of public enterprises (earned at the overvalued Central Bank rate) were automatically passed on to the government. The budgeting and allocation of foreign exchange was handled by the TIC as part of the budget allocation process for every enterprise (after the approval of the Ministries of Industry, Planning, and Finance). After 1987, TIC was allowed to keep foreign exchange earnings required for its import needs. The remaining foreign exchange was to be turned over to the government, or sold to other public enterprises at the Commercial Bank rate (World Bank 1991 p. 79). Thus, the difference between the Central and Commercial Bank rates was captured by TIC.

To sum up, the TIC firms have operated against a background of controlled employment, pricing and trade policies. The situation is summarized in the World Bank report (World Bank 1991) as:

> An overvalued currency that acts as an implicit tax on exports; the private garment industry's restricted access to domestically produced cotton; a trade regime that restricts the import of cotton yarns and fabric for the garment industry; distorted input and output prices for the spinning industry; and the noncompetitive structure of the spinning industry have had the combined effect of slowing down the development of an internationally competitive textile industry (World Bank 1991 p. 86).

IV.3.1. <u>Structure</u>

The Egyptian textile industry is dominated by thirty public enterprise companies controlled by the Textiles Industries Corporation (TIC), which is a holding company affiliated with the Ministry of Industry. During the time period covered by this research, the TIC was responsible for making "all the major decisions affecting the operations of each enterprise". This included the selection of imports, among other things. TIC also had the authority to "shift inventories and foreign exchange among mills". Moreover, TIC was the sole agent with the authority to buy domestically produced cotton and to import cotton lint, which is done through the Ministry of Economy and Trade. TIC also had a "virtual monopoly" over cotton yarn production. In addition, TIC accounted for about 60% of "installed capacity (80 percent of actual production) in the weaving industry". According to the World Bank report (1991), "The combination of TIC control of raw cotton procurement and yarn sales places the government/TIC in a position to control most downstream textile activities" (World Bank 1991 pp. 47 & 84).

More than half of the TIC companies were privately established prior to the revolution and nationalized as part of the wave starting in 1960. The rest were established after 1952, but mostly between 1960 and 1962 (probably as public sector companies from the start)[1]. The recent history of the sector is summarized in the World Bank report (1983) as:

> Prior to the proclamation of Arab Socialism in 1961 and the subsequent nationalization of private sector enterprises, the textile industry produced primarily for domestic import substitution, and was characterized by relatively small scale production units. In the period following nationalization, firms were consolidated into 22 public sector companies, most consisting of several integrated spinning and weaving mills. (World Bank 1983 p. 298).

TIC enterprises are "large and mostly vertically integrated" (World Bank 1991 p. 47). In 1989/90, they employed 41.74% of the total labor force of all Ministry of Industry companies, and produced 25% of their output. Within the textiles sector, TIC companies have a monopoly over spinning, and are responsible for almost 70% of dyeing, finishing and weaving operations (World Bank 1989a p. 22).

At least twenty of the thirty TIC companies are mainly engaged in spinning and weaving activities. They represent a "heavy concentration of basic spinning and weaving production facilities in a limited number of integrated public sector mills". These companies account for more than half of all industrial export earnings and almost 25% of industrial output, and 50% of the total labor force in the public sector industry (World Bank 1991 p. 47).

Many companies are also involved in dyeing, finishing and garment-making. Some companies include retailing operations; a few have facilities for knitting and garment-making. Only one company exclusively specialized in dyeing and finishing (World Bank 1991 p. 47).

Out of the thirty companies, firms one and two (Misr lel Ghazl wa al Naseeg bel Mahhala al Kobra and Misr lel Ghazl Wal Nasseg be Kafr al Dawwar) account for the largest share of TIC outputs and inputs. Alone they account for 29.3% of total TIC output, almost 23% of value-added, 25% of labor and 25.7% of capital in 1989/90. Each of the other 28 companies accounts for a small share in inputs and outputs, with a maximum share of around 6% for labor, capital and value-added, and 7.6% for output. The average shares in these categories ranged from 2% to 3%.

IV.3.2. Technology

The recent history of technical modernization of TIC plants dates back to the start of the sixties when investments were undertaken on a large scale for the purpose of "selective modernization of existing spinning equipment". Such investments brought about significant improvements "in yarn quality and productivity". Nevertheless, these improvements did not keep up with worldwide developments that took place in the field of spinning technology and engineering in the seventies (World Bank 1991 p. 71). By the mid seventies, some equipment replacement took place (World Bank 1989a p. 23). Still, major new investments in TIC spinning firms did not occur until the eighties. These involved many capital investment projects "aimed at increasing capacity, upgrading and modernizing plants and equipment and improving quality" (World Bank 1991 p. 49). Such efforts entailed the procurement of modern machines for spinning and balancing "from reputable textile machine manufacturers in Western Europe and Japan" (World Bank 1991 p. 71).

Despite these efforts, modern technology only represents about 30% of the production capacity of spinning mills. Modern capacity is mainly "open-end rotor spinning equipment (which) represents state-of-the-art technology in coarse yarn manufacturing". Ring spinning equipment also "reflects a reasonably updated technology" as "no major technological developments have taken place in ring spinning and preparatory equipment" (World Bank 1991 p. 71).

In spite of efficient maintenance and upkeep, the spindles installed before 1975 are the ones that "reflect a run-down-capacity". Actually the remaining 70 percent of production capacity is technology that is over 15 years old (World Bank 1991 p. 71). In fact most of the spinning equipment is more than 20 years old and was mostly imported from the Eastern Bloc (World Bank 1989a p. 23), and with much of it having diminished capabilities despite good maintenance. Such predominance of old equipment results in high raw material waste, a cotton waste rate that is generally higher than the norm in other countries (World Bank 1991 p. 74), frequent stoppages of work and an estimated Capacity Utilization Rate (CUR) of 60%[2]. Moreover, the combination of old and new machines "results in the production of threads and material of varying quality which is a serious problem for garment-makers" (World Bank 1989a p. 23). On the whole, technology in the TIC enterprise remains "outdated" (World Bank 1989a p. 22).

IV.3.3. R&D Situation

As in the case of engineering EIC companies, TIC companies are supposed to include R&D units. Unfortunately, no data is available on R&D allocations. In this context we could only accumulate qualitative material on problems, constraints and impact of R&D. The problems reduce to limited resources and improper management. Limited research funds are specifically pointed out by Head of TIC Dr. S. Dahmouche, making the situation of such units "totally unsatisfactory"[3]. Improper management entailed that research units were not involved in absorbing and adapting the imported technologies. The manpower employed in such units also require training (Hebeish, interview[4]).

Textile enterprises are also supposed to benefit from external research and development activities undertaken at the Academy (particularly the National Research Center), and universities, (particularly textile departments of faculties of engineering)[5]. Among the research units established with the National Research Center between 1956-61 were the Textile Dyeing and finishing and the Textile Spinning and Weaving research units (Mahmoud 1986 p. 26). The current structure of The National Research Center includes a Division for Textile Industries Research. The Division includes 21 professors, 4 assistant professors, 5 researchers, and 9 assistant teachers. The total of 39 professional personnel represents 2.9% of NRC research personnel (see Table IV.1). The Division also includes five labs (Mahmoud 1987 p. 84)[6].

Despite the above, the share of textile industries (particularly TIC enterprises) in NRC contracts has been modest. Before 1971, contracts with the textile sector in general represented 0.19% of the total value of NRC contracts in all fields. Of a total of 17 contracts with textiles, public sector firms had 13. Between 1975 and 1980, the share of textiles in the total value of contracts was 2.83% (5 contracts). Public sector firms had only one of these contracts while the remaining 4 were with the Academy. Between 1981 and 1986, the textiles industry had only 0.47% (4 contracts) of the value of all local contracts, the public sector having only one of these contracts (see Table IV.2).

While the R&D contract allocations have been modest, individual efforts have been successful. Mahmoud (Mahmoud 1986 p. 30) provides a story of success in the NRC contracted research for the Misr Beida Dyers Company. In 1979, the Company contracted research on wool scouring and wax recovery to the Textile Division of NRC. According to Mahmoud, the net additional profit from this research was 750,000 pounds annually (Mahmoud 1986 p. 31).

Another successful research activity was contracted between the Minister of Industry (representing Sherket al Kahira lel Mansougat al Harireya) and the Technical and Technological Consulting, Studies and Research Fund affiliated with the Ministry of Scientific Research/Academy. The research was conducted as part of the Fund's mandate of solving problems of production and productivity in the economy (Ministry of Scientific Research 1990, Arabic).

Finally, TIC companies are supposed to benefit from research conducted at The Textiles Research Center located in Alexandria. The Center was originally established with the purpose of undertaking "fundamental and applied research into dyeing and textiles finishing, physical and mechanical textiles testing, dye stuffs and fibres, and bleaching and preparation" (Sardar p. 142). The Alexandria Center was recently revived by Dahmouche[7] with support from the UNDP. Dahmouche explains:

> Because the gap exists between external research and the companies, we said let's do our own research, hence the establishment of the Textile Development Centre in Alexandria (UNDP). It involves the (practice) of a pilot plant; it is very well equipped and includes highly trained staff. I revived it. The Board of Directors contains top experts in the country from the public and private sector. The Center deals with problems from within the industry in both public and private sector. Our purpose is to link the Centre to the industry and vice versa. It involves the choice and approval of research topics, time frame, and publishable results (Damouche, interview).

In general, we can argue that there were a number of limitations hindering the technological development of the textiles enterprises despite individual successful efforts. Most importantly, a general plan for technological development, with specified priorities, goals and research roles was lacking. Efforts to develop indigenous technologies were practically nonexistent; as were any attempts to absorb imported modern technology. Internal research units were not involved in absorbing the new technologies, and links with external research units were not strong enough[8]. Academy Head Dr. A. Hebeish explains:

> Concerning the machine, we have actually imported modern technology, but we have not been able to absorb it, adapt it to our circumstances, nor develop it... This means that our choice of technology was not sound because we did not take into consideration the technical standard of our manpower and technicians. As for the knowledge, we did not involve the research agencies which are able to absorb technology (Al Akhbar 1992a).

IV.4. Performance

In general, the textile sector performed modestly during the period under study. In the yarn and cloth subsector output grew at a modest 0.4% per year over the period, and in 1987/8, the percentage share[9] of this subsector in total industrial output (21.9%) was less than it had been in 1982/3 (24.3%) (Table IV.3). Employment fell at an average annual rate of 3.8% over the same period and the share of this subsector in total industrial employment declined from 53.6% to 43.3% (Table IV.3). Between 1975 and 1986, the recorded share of Egyptian exports in world textile trade (SITC 65) was always less than it had been in 1970/71, and despite an increase in 1987, was again lower in 1988 (Tables IV.4 & IV.5). When looked at as a whole (yarn, fabric and clothing), recorded shares for the seventies and eighties were always less than the 1970/71 share (Table IV.4).

There was a modest increase in Egypt's textile exports and share in world textile trade between 1975 and 1980. Exports increased by 69.3% (Table IV.6) and Egypt's share in world textile trade increased by 21.4% (from 0.28 to 0.34) (Table IV.5). However, exports hardly increased between 1980 and 1985 (1.5% growth) (Table IV.6), and Egypt's share in world markets increased only slightly (from 0.34% to 0.37%) (Table IV.5; see also Table IV.7).

This happened at a time when world trade in textiles expanded considerably and the textiles and apparel manufacturing were being rapidly globalized at "exceptional" rates (World Bank 1991 p. 52). Still, the share of Egyptian textile exports in world markets remained modest. In fact Egypt's share in world trade in overall textiles remained at less than 0.20% throughout most of the eighties, before increasing sharply in 1987 to 0.24% (World Bank 1991 p. 53, and Table IV.5). In particular, between 1985 and 1987 the value of exports increased by 94%. (The increase between 1987 and 1989 was less than 10%). According to the World Bank (1991):

> The two fold increase in yarn and fabric exports in 1987 and 1988 appears to have been due to a combination of factors, including: i) the curtailment in the foreign exchange budget of all public enterprises; ii) the need to earn enough foreign exchange to cover import requirements; and iii) the desire to take advantage of higher earnings from exports compared to sales in the domestic market, at prices controlled below the f.o.b. export price (World Bank 1991 p. 80).

For TIC companies, exports increased fivefold between 1984 and 1989 (see Table IV.8). Over the same period imported inputs increased by 60% (Table IV.8). As a result, the percentage ratio of exports to imported inputs increased more than threefold between 1984 and 1989 (Table IV.8).

Nevertheless, this seemingly 'good' textile export performance compares unfavorably with other textile exporters in a world of expanding trade in textiles. While Egypt, Morocco and Turkey had comparable shares of textile exports in the OECD market in 1970/71, by 1988 the shares of Morocco and Turkey had increased by four and tenfold, respectively (World Bank 1991 p. 54). However, over the same period Egypt's share increased only slightly (from 0.13 to 0.18) (Table IV.9). Tunisia's share, which was less than 50% of Egypt's share in 1970/71, increased tenfold by 1988 to become more than three times the share of Egypt (Table IV.9).

In addition, the predominance of low value-added goods has been a characteristic of Egyptian textile exports. Low value-added products such as grey cotton yarn and grey cloth represented 60% and 20%, respectively, of total export earnings. Garments, on the other hand, accounted for less than 15% of total export earnings throughout the seventies and eighties. In fact the share of Egyptian exports in world garment trade was almost the same in 1987-89 as it had been in 1975 (Tables IV.4 & IV.5). This stands in sharp contrast to countries such as India, Bangladesh, South Korea and Hong Kong, where quality fabric and garments have come to account for 60% of their textile export earnings (World Bank 1989a p. 20). In the OECD market, the share of Egyptian garment exports in total Egyptian textile exports actually declined from 1980 to 1987. In Turkey, on the other hand, the same share more than doubled over the same period (see Table IV.10).

Measured in current L.E., the levels of output and value added of TIC firms increased steadily between 1975 and 1989. When measured in constant L.E., however, the increase was quite modest. The more than sevenfold increases in output and value-added in current L.E. between 1975 and 1989 become only 17.6% and 18.51% increases, respectively, when measured in constant L.E. (see Tables IV.11-14 and Fig. IV.1 & IV.2). The eightfold increase in the value of capital in current L.E.

is less than a twofold increase when measured in constant L.E. While labor increased in the second half of the seventies, it declined in the eighties (Tables IV.11-14 and Fig. IV.3).

Looking at rates of growth of TIC outputs and inputs reveals some interesting points. Measured in constant L.E., output and value-added grew at positive rates between 1975 and 1981, and at negative rates between 1982 and 1989 (and between 1986 and 1989). The real value of the capital stock increased only modestly between 1982 and 1989, and barely increased between 1986 and 1989. In fact real output, real value-added, and labor actually decreased between 1986 and 1989 (see Tables IV.12-14 and Fig. IV.2 & IV.3).

The average ratio of value-added to output for TIC firms was always around 0.4. On average, it was lower in 1975-81 than in 1982-89. Moreover, the average was lowest in the last four years (1986-89) (Table IV.15). The ratio of value-added to output follows an 'inverted-U' pattern, which peaks around 1983. This implies that the ratio of intermediate inputs to output was first falling and then rising. This might have been caused by different price movements for output and inputs due to price controls and exchange rate movements. Although imported inputs represented about 20% of total intermediate input in the eighties, relaxing control over the exchange rate could have made it easier to incorporate more imported inputs relative to output.

Finally, although the textiles industry in Egypt has been termed competitive, this competitive edge seems to have weakened with time. While Domestic Resource Costs (DRC's) (see Annex I.1) calculated prior to 1979 were all less than 1 (Table IV.16), the DRC figure generally increases (competitiveness decreases), with time[10]. For spinning industries alone, the situation further deteriorated in the eighties, reaching negative value-added in 1988/9 for the nine major public sector textile spinning companies (see Table IV.17).

In light of the above, it seems that the textile industries were far from achieving an impressive performance, particularly in the eighties. A potentially competitive industry, operating against a promising international environment, the textiles sector seems to have missed the opportunity to become a driving force behind Egypt's development in the eighties. In the following section, we examine this claim using quantitative data.

IV.5. Econometric Estimation

In this section we present quantitative work done on TIC companies. We first remind the reader of the theoretical framework by presenting a summary of the econometric model. We then present our data, to be followed by empirical results. We estimate total and partial factor productivity (TFP and PFP) and parameters of technical change. We also test for structural change after 1982 and 1986. Unfortunately, the shortage of quantitative data on R&D in textiles firms does not allow quantitative estimation of the role of R&D in production. Estimation is done for all thirty TIC firms taken as a group (pooled regression). A synthesis of results will conclude this section.

IV.5.1. <u>The Model (Theoretical Framework)</u>

In our analysis we rely on the same Cobb-Douglas production function as that estimated for engineering firms in Chapter III. We first estimate levels of total and partial factor productivity (TFP and PFP). Estimation of the levels of TFP relies on the Cobb-Douglas production function:

$$Q = A \; L^{b} \; K^{c} \; .$$

Thus,

$$\frac{dQ}{Q} = \frac{dA}{A} + b\,\frac{dL}{L} + c\,\frac{dK}{K}$$

or

$$\frac{dA}{A} = \frac{dQ}{Q} - b\,\frac{dL}{L} + c\,\frac{dK}{K}$$

where $A = \dfrac{Q}{L^{b} \; K^{c}}$ is the index of TFP,

and $L^{b} \; K^{c}$ is the index of total factor input.

We calculated TFP levels in two ways depending on the method of calculation of b and c. First, we estimated TFP with b and c taken as the estimated coefficients of ln labor and capital, respectively, in the pooled regression for the whole time period 1975-1989 (Method 1). Second, b was taken as the average ratio of employment compensation to value-added, and c equal to (1-b) (Method 2). For each of the two methods, TFP was calculated twice, once with value-added as the measure of output (VTFP) and once with gross output as the measure of output (QTFP).

In estimating the levels of partial factor productivity, we used ratios of output and value-added to labor and capital taken separately, and examined changes in these ratios over time.

Next, pooling time series and cross section data, ln output and ln value-added were separately regressed on ln labor and ln capital. Again the period under study was divided into two sub periods: 1975-1981, and 1982-1989. We summarize the equations as a reminder for the reader:

(1) Estimation of the production function

$$\ln Q = a + b \ln L + c \ln K$$

(2) Neutral technical change

(2a) $\ln Q = a + b \ln L + c \ln K + d\, t$

(2b) $\ln Q = a + b \ln L + c \ln K + d\, t + g\, t^2$

(where t is a time trend: t = 1, 2,.....16 for 1975, 76,...89)

(3) Capital augmenting technical change:

$$\ln Q = a + b \ln L + c \ln K + n\, t \ln K$$

(4) Labor augmenting technical change:

$$\ln Q = a + b \ln L + c \ln K + m\, t \ln L$$

(5) Neutral, capital and labor augmenting technical change:

$$\ln Q = a + b \ln L + c \ln K + d\, t + n\, t \ln K + m\, t \ln L$$

(6) test for structural change:

(6a) $\ln Q = a + b \ln L + c \ln K + d\, D1$

(6b) $\ln Q = a + b \ln L + c \ln K + d\, D2$

(7a) $\ln Q = a + b \ln L + c \ln K + d\, D1 + g\, D1 \ln L + h\, D1 \ln K$

(7b) $\ln Q = a + b \ln L + c \ln K + d\, D2 + g\, D2 \ln L + h\, D2 \ln K$

where Q = value-added,

L = labor,

K = capital taken as the gross value of fixed assets,

D1 = 1 for 1982-89 and 0 otherwise,

and D2 = 1 for 1986-89 and 0 otherwise.

IV.5.2. Hypotheses and Questions

In undertaking the present exercise, we attempt to answer the following questions:

1. What were the total and partial productivity trends?

2. Has there been any technical change in the textile industries (an export-promoting group of industries), and, if any, of what nature?

3. Based on the above, can we conclude that the changes in leadership and in macroeconomic policies have influenced the performance of these industries, and, if so, in what direction?

4. How different were the eighties from the seventies? Is the subperiod classification of 1975-1981 vs. 1982-1989 justifiable?

IV.5.3.Data

Annual data were collected (by firm) for output, value-added, labor input, and gross value of fixed assets (proxy for capital) for the period 1975-1989. As described in III.5.3, data for fiscal years after 1980 are taken to refer to the beginning of the year. Data cover 30 firms for 15 years providing a total of 450 observations. Data on output and value-added in current L.E. were deflated using the wholesale price index with 1985 as the base year (see III.5.3). Labor input was measured in number of persons. Gross fixed capital stock was also measured in constant 1985 L.E. The gross fixed capital stock series was generated using the gross stock assumption with the lifetime of capital taken equal to 8 years (see III.5.3).

IV.5.4. Empirical Results

We start this section by presenting results of estimating total and partial factor productivity levels. We then estimate technical change, test for constant returns to scale, and test for structural change for 1982-89 and 1986-89.

IV.5.4.1. Estimation of Factor Productivity

Patterns of total factor productivity change are not as clear cut as was the case for the engineering industries. Generally, the trend in VTFP resembles the case of EIC firms in following an inverted-U pattern which peaks around 1982. This pattern is more pronounced using Method 1 than using Method 2 (see Tables IV.19 & IV.22, and Fig. IV.5 & IV.6). Also, the results using Method 1 suggest a higher average productivity level in the eighties while the results using Method 2 suggest a higher level in the seventies, although the differences are not large. In contrast, QTFP shows no trend when Method 1 is used and a slight decline over the 1975-89 period when Method 2 is used. It is worth recalling that the ratio of value-added to gross output, discussed earlier (Table IV.15), shows the same inverted-U shape, implying that if QTFP shows no trend then VTFP will follow the inverted-U pattern.

It is the case that the level of TFP in 1989 is always less than the level in 1975, no matter how it is measured. Thus one can certainly argue that levels of TFP for TIC firms declined in the late eighties (Tables IV.19 and IV.22).

Our estimation of partial factor productivity levels revealed a number of interesting conclusions (Tables IV.24-26 and Fig. IV.7 & IV.8). Capital productivity declined throughout the 1975-89 period. The decline became more severe in the eighties, and the average level of capital productivity was lowest in the 1986-89 subperiod. Levels of labor productivity, on the other hand, generally increased over the 1975-89 period. It is worth noting that the subperiod 1975-81 witnessed a rise in labor productivity at the same time that the employment level was increasing, so that real output and value-added were increasing at a faster rate than labor input. The increase in labor productivity after 1981, however, is more likely to be the result of the consistent decline in the level of employment for TIC firms, which is attributed to the attempts at encouraging early retirement mentioned earlier.

IV.5.4.2. Technical Change

Estimation of the production function (equation 1) with ln value-added as the dependent variable resulted in values of the coefficient of ln labor which were generally in the range 0.6-0.8, and values of the coefficient of ln capital between 0.2 and 0.4 (see Tables IV.27-32).

The results of estimating technical change for TIC firms were similar to those presented for EIC firms in the previous chapter. Estimating coefficients of technical change separately (equations 2-4) for textiles over the 1975-1989 period led to values which were not statistically significant. When the three types of technical change were included together (equation 5), however, we found significant positive neutral and labor augmenting technical change, and significant negative capital augmenting technical change (Table IV.27). This is reminiscent of the results for EIC firms for the same equations over the same time period (see Table III.30).

As in the case of EIC firms, the regression results are trying to fit the inverted-U pattern of productivity (VTFP), since ln value-added is the dependent variable in the regressions. In Table IV.27, the intercept in equation (1) represents the average ln of VTFP, essentially trying to fit the inverted-U with a constant. When the time variable is added (equation 2a), it cannot represent the inverted-U pattern since it increases linearly. As a result, the coefficient of t is not significant. When both t and t^2 are included (equation 2b), both coefficients are significant with a positive coefficient for t and a negative coefficient for t^2 (Table IV.27). These coefficient values imply an inverted-U which peaks around 1983, fitting the time pattern of VTFP.

Results of estimating factor-augmenting technical change for the 1975-89 period (Table IV.27) can be interpreted along the same lines. Since both t and lnK increase throughout the time period, the variable tlnK cannot fit the inverted-U pattern of VTFP change. Thus the coefficient of tlnK is not significant when introduced separately (equation 3). The variable tlnL does not decline after 1981, even though labor input declines. Thus this variable also cannot fit the inverted-U and it does not have a significant coefficient when introduced separtely (equation 4). However, when all three technical change variables; t, tlnK and tlnL are included together (equation 5), a good fit to the inverted-U is possible. The capital-augmenting technical change variable, tlnK, has a negative coefficient to capture the downward movement in VTFP after 1984, the labour-augmenting technical change variable, tlnL, has a positive coefficient to capture the increase before 1984, and the neutral technical change variable, t, has a large positive coefficient to make the combination fit the inverted-U. Note that these results are very similar to those for the engineering industries (Ch.III.5.4.2).

Estimation results for the subperiods 1975-81 and 1982-89 can be interpreted in the same way. Coefficients for each type of technical change are positive and significant in the first subperiod, and negative and significant in the second subperiod when the technical change variables are introduced separately (Tables IV. 28 and 29). In the first subperiod, VTFP and t, tlnK and tlnL all increase, resulting in significant positive coefficients. When all three technical change variables are introduced together, some discrimination in their effects is observed. The coefficient of the neutral technical change variable is negative and marginally significant, the coefficient of the labour-augmenting technical change variable is positive and significant and the coefficient of the capital-augmenting technical change variable is negative and significant. These results are consistent with the measures of partial factor productivity which show the productivity of labor (V/L) increasing and the productivity of capital (V/K) decreasing over this subperiod (Table IV. 26). When the variable t^2 is introduced together with t, it has a positive significant coefficient, which reflects the more rapid increase in VTFP near the end of the subperiod.

Over the second subperiod, VTFP is rising in the first three years and then falling, with the drop accelerating in the last three years. This pattern is fit by significant negative coefficients on t, tlnK, and tlnL when they are introduced individually (Table IV.29). But when all three are introduced, only the positive coefficient of tlnL is significant, capturing the rise in labor productivity, V/L, except for the last year of the second subperiod (Table IV.26). When both t and t^2 are introduced (equation 2b), the coefficient of t^2 is negative and significant, helping to explain the decline in VTFP in the last year.

As in Chapter III, it must be noted that, while the results of the technical change regressions are consistent with the patterns of VTFP and partial factor productivities, they do not tell us whether the changes in productivity came from changes in technology or from other factors which could affect productivity. The fact that the pattern of changes in VTFP were similar in both the engineering and textile industries suggests the effects of common factors external to the individual industries.

Finally, the test for constant returns to scale based on equation 1 was accepted for the whole period, and for the individual subperiods (see Table IV.30). This provides support for method 2 used earlier for calculating TFP.

IV.5.4.3. Structural Change

Tests for structural change (Table IV.31, equations 6a & 7a) in the 1982-89 subperiod showed significant positive change after 1982, as indicated by the positive coefficient of the structural change dummy variable. The same result was also found when the interaction terms of the dummy variable with ln labor and ln capital were introduced separately, as coefficients of these variables were positive. When all three structural change variables were introduced together the coefficients were all significant, with the coefficients of the dummy variable positive, the interaction term with capital negative, and the interaction term with labor positive. This suggests a more rapid growth of labour productivity and a more rapid decline in capital productivity over the 1982-89 subperiod.

It is interesting to note, however, that when the same tests were performed for the 1986-89 subperiod (Table IV.32), the results were different. These tests indicated negative structural change in the 1986-89 subperiod, since the coefficients of the dummy variable and the interaction terms were negative and significant when introduced separately. The 1986-89 subperiod experienced rapidly declining VTFP as well as a lower average level than in 1975-85, leading to the negative coefficients. Recall that the same results were obtained for the engineering industries, suggesting that this phenomenon was the result of factors common to both textile and engineering industries.

IV.5.4.4. Summary

In light of the above results, one can draw a few conclusions about the performance of TIC firms. There was some positive trend in labor productivity and in total factor productivity (measured as VTFP) between 1975-81, and a decline between 1986-89, which mostly offset the peak which occurred around 1982-84. On the other hand, capital productivity declined throughout the period, while total factor productivity (measured as QTFP), was constant when measured by Method 1 and declined somewhat when measured by Method 2. For most indicators of total and capital productivity for TIC firms, average levels were lowest in the last four years 1986-89, a result that is consistent with negative structural change. Except for labor productivity, productivity levels in 1989 were lower than those in 1975. Like EIC firms, TIC firms experienced a decline in performance in the 1986-89 subperiod.

Regression results also indicated significant positive technical change of all types in 1975-81 and significant negative technical change in 1982-89. As mentioned in Chapter III, while regression results on neutral and factor-augmenting technical change are consistent with productivity trends, one should be careful not to interpret productivity changes as necessarily caused by technical change. Rather than reflecting changes in technology (which is implied by the term technical change), TFP changes could have been caused by other factors. It is not unlikely that productivity trends reflected changes in outputs relative to intermediate inputs which are the result of changes in the external environment discussed earlier in the chapter. Among these are exchange rate changes, controlled input prices, the rise and subsequent decline in labor after 1981, and the inability to 'lay off' capital in response to a slower market in the eighties.

Despite the above, negative capital-augmenting technical change in the eighties, in particular, does not seem implausible. The facts that most, if not all, machinery used in production was imported, and that the textile industry was capital intensive in a labor intensive environment, by definition, made the available level of technological capability fall short of the requirements for the maintenance, development, and efficient utilization of existing machinery. As in the case of EIC firms, the emergence of positive capital-augmenting technical change seems highly unlikely under these conditions. As with the EIC firms, an analysis of the extent to which technical factors contributed to TFP change, particularly after 1984, would be highly instructive. This will be the subject of future research.

IV.6. Conclusions

Generally speaking, we have grounds to conclude that the second half of the seventies saw some improvement in the performance of TIC Firms, while the eighties saw a deterioration, especially after 1986. Indicators of technical change and changes in total factor productivity based on value-added are represented by an inverted-U pattern; namely, a rise that peaked in the early eighties, followed by a decline which became particularly evident after 1986. This pattern also characterized the ratio of value-added to gross output. On the other hand capital productivity declined throughout the period, while total productivity based on gross output was constant or declining. By all measures the end of the eighties certainly witnessed a deterioration in the performance of TIC firms.

The initial improvements in TIC performance in the seventies shows that TIC firms were gaining the fruits of the investment in new technologies that took place in the sixties, or as we termed it in Chapter III, 'the output of domestic R&D'. As mentioned earlier, the seventies was a time of flourishing domestic demand, and general optimism in the economy brought about by the adoption of the 'Open Door Policy'.

In the eighties, however, the economy began to slow down, and despite significant investment in modern technology, the performance of TIC firms deteriorated. On the one hand, the consequences of the 'Open Door Policy' mentioned in Chapter II affected textiles firms in a way similar to EIC firms. On the other hand, the cotton pricing policy which kept domestic cotton prices from rising despite the increase in world cotton prices and in other prices meant a high rate of waste in cotton use. In addition, the continuing labor intensity of the production process, despite some decline in the labor force, was a deterrent, especially in a world of 'dramatically' increasing capital intensity in textile production (De Vries and Brakel 1983 p. iii). Although there was an expansion in the import of machines in the eighties, these machines embodied mostly capital intensive techniques that were imposed on a labor intensive system. Moreover, the continuing presence of outdated and worn out machinery alongside new machinery added to the low level of capacity utilization. Last but not least, the limited role played by research centers and other scientific bodies in absorbing - let alone developing - new technologies was an additional problem.

Again we seem to have a case of ailing public sector firms suffering from demand and supply problems that surfaced in the eighties. It is no surprise that a change in policy is currently taking place concerning the price of cotton, and that the privatization of these firms is being discussed.

The above exposition provides a basis for answering the questions raised in Section IV.5.2. First, on the question of technical change and productivity trends, we have found these, measured by value-added, to be represented by an inverted-U pattern peaking around 1983. Capital productivity declined throughout the period, while total productivity based on gross output was constant or declining. We argue that changes in leadership and macroeconomic policies had significant effects on performance. Policies and leadership of the sixties were reflected in the performance of the seventies; policies and leadership of the seventies were reflected in the performance of the eighties. The eighties were certainly different from the seventies. While the subperiod classification of 1975-81 vs. 1982-89 revealed significant differences, a better classification might be 1975-81; 1982-85; and 1986-89, in light of our findings of an inverted-U pattern, and the declining performance indicators in 1986-89.

In the next chapter we present a synthesis of our results on textiles and engineering companies. We also present our general conclusions, recommendations, and suggestions for future research.

Table IV.1

The Distribution of NRC Researchers and Research Assistants over the General Fields and Divisions, May 1987

	Prof.	Asst. Prof.	Resear -cher	Asst. Tea- cher	Asst. Resear -cher	Total	Percent of NRC Total
Division of Industrial & Engineering Research:							
Textile Industries	21	4	5	9	0	39	2.9%
Engineering Industries	16	12	16	13	6	63	4.7%
Institute for Electronic Research	5	4	17	7	9	42	3.1%
Division Total							39.5%

<u>Source</u>: Mahmoud 1987 p. 56

Table IV.2

Extramural R&D: NRC Financing, NRC Local Contracts: Field/Areas of Contract

	Number of Contracts	Number of Contracts by Contracting Agency			Total Value
	Total	Public Sector	Academy	Other	(LE)
1. Before 1971					
Textiles	17	13	0	3	17,350
Total Industry & Mining	68	59	0	9	305,348
2. 1975-80					
Textiles	5	1	4	0	22,600
Electrical Engineering	1	0	1	0	5,000
Total Industry & Mining	52	29	20	3	797,390
3. 1981-86					
Textiles	4	1	3	0	261,904
Electronics	2	1	0	1	5,000
Total Industry & Mining	70	40	25	5	55,332,529

Source: Mahmoud 1987, p. 106-108.

Table IV.3

The Textile Industries Relative to Industry

Textile Industries Share of	Share (%) 1982/3	1987/8	Growth Rate % per year (82/3-87/8)
Industrial Output	24.3	21.9	0.4
Industrial Employment	53.6	43.3	-3.8
Industrial Export Earnings	37.3	60.5	n/a
Yarn & Cloth	32.7	52.6	6.8
Clothing	4.6	7.9	10.9

Source: World Bank 1991 p. 49.

Table IV.4

The Share of Egyptian Exports in the World Market for Textile Products, Selected Years (percent)

	1970/1	1980/1	1986/7	1988/89
Yarn and Fabric	0.44	0.34	0.53	0.35
Grey Cotton Yarn	5.00	4.24	5.92	4.33
Cotton Yarn - Bleached and Dyed	1.58	0.62	0.52	0.51
Clothing	0.03	0.07	0.07	0.09
Total (Yarn, Fabric, Clothing)	0.26	0.19	0.24	0.18

Source: World Bank 1991 p. 53.

Table IV.5

The Share of Egyptian Exports in the World Market
for Textile Products; (Detailed)
(percent)

	1970-1	1975-6	1980-1	1982-4	1985-6	1987-8
All Textiles	0.29	0.20	0.20	0.20	0.18	0.24
Textiles (SITC 65)	0.44	0.28	0.34	0.38	0.37	0.53
Grey Cotton Yarn in Bulk (SITC 6513)	5.00	2.16	4.24	4.62	4.51	5.83
Cotton Yarn - Bleached and Dyed (SITC 6514)	1.58	1.74	0.62	0.20	0.22	0.21
Non-Cotton Raw Textiles (SITC 26 less 262 and 263)	0.72	0.65	0.38	0.63	0.42	0.38
Clothing (SITC 84)	0.03	0.08	0.07	0.04	0.04	0.07
Other Clothing (SITC 61 and 85)	0.01	0.02	0.03	0.01	0.01	0.01

Source: World Bank 1989a Annex 2 Table 6.

Table IV.6

The Value of Egyptian Textile Exports
(thousands of U.S. $)

	1975	1980	1985	1986	1987	1988	1989
Cotton Yarn	88,656	180,782	196,846	212,110	405,408	302,874	395,523
Cotton Fabrics	26,454	52,994	52,221	62,476	96,134	71,648	76,525
Knit-ting	19,701	14,975	9,371	4,495	8,099	44,879	60,158
Terry Fabrics	3,760	2,921	1,716	1,315	3,540	3,101	6,371
Ready-Made Garments	14,057	8,008	5,488	4,288	6,357	13,886	24,297
Ready-Made Fabrics	3,679	4,948	2,844	2,719	1,926	3,023	8,664
Total Textiles	156,307	264,627	268,484	287,402	521,464	439,411	571,538

Source: World Bank 1991 Annex 7 Table 3 p. 143.

Table IV.7

Growth Rates of Egyptian Textile Exports

I. Growth of Exports (Percent per Year)

1975-80	1980-85	1985-89	1985-87	1987-89
13.86	0.29	28.22	47.11	4.80

II. Growth in Share of World Market (percent per year)

1975/6-1980/1	1980/1-1985/6	1985/6-1987/88
4.28	1.76	21.62

Source: Based on Tables IV.5 & IV.6 above.

Table IV.8

Total Exports and Imported Inputs of TIC Firms

(thousands of constant 1985 L.E.)

	Exports	Imports	Export/Import (%)
1984	263,229	155,679	169.08
1985	336,455	153,997	218.48
1986	682,126	157,428	433.29
1987	910,739	208,280	437.27
1988	911,566	226,310	402.79
1989	1,322,465	248,607	531.95

Source: Data in thousands of current L.E. from Ministry of Industry Performance Evaluation Reports, various issues, was deflated by the export and import price indices provided in Table III.11 above.

Table IV.9

A Comparison of Country Shares of Textile Exports In the OECD Market

(percentage shares)

	1970/71	1980/1	1987	1988
Egypt	0.13	0.19	0.25	0.18
Turkey	0.19	0.55	1.92	1.95
Morocco	0.14	0.31	0.56	0.64
Tunisia	0.05	0.53	0.54	0.55

Note: Shares refer to total textiles, including yarn, fabric, and clothing.
Source: World Bank 1991 p. 55 table 5.6.

Table IV.10

A Comparison of Textile Exports to OECD Countries

(millions of US $)

	1980	1986	1987	Average Annual Growth Rate (percent) 1980-87
Egypt:				
Yarn and cloth	144	154	316	11.9
Garments	18	24	54	17.0
Total	162	178	370	12.5
Turkey:				
Yarn and cloth	295	611	880	17.9
Garments	113	1242	2014	50.9
Total	408	1853	2894	32.2
Tunisia:				
Yarn and cloth	64	60	84	4.0
Garments	376	538	694	9.2
Total	440	598	778	8.5
Morocco:				
Yarn and cloth	109	112	135	3.1
Garments	136	425	666	25.5
Total	245	537	801	18.4

Source: World Bank 1991 Table 5.7 p. 56.

Table IV.11

Total Output, Value-Added, Capital and Labor for TIC Firms

(Output, Value-added and Capital in thousands of current L.E., Labor in thousands of persons)

Year	Output	Value-Added	Capital	Labor
1975	504,184	186,864	298,483	273.93
1976	563,602	212,775	345,717	281.94
1977	641,146	275,536	421,028	292.50
1978	798,265	323,550	485,504	295.67
1979	838,727	349,356	546,138	295.47
1980	1,162,082	507,334	773,255	300.10
1981	1,262,201	596,894	918,384	301.08
1982	1,317,030	661,323	1,021,158	290.98
1983	1,442,525	778,094	1,277,720	285.66
1984	1,672,378	846,312	1,363,000	273.83
1985	2,057,175	915,230	1,540,937	259.43
1986	2,194,149	977,961	1,751,184	243.82
1987	2,559,939	1,203,468	1,887,000	233.87
1988	3,202,629	1,342,373	2,151,000	230.24
1989	3,909,121	1,459,974	2,401,000	228.94

Source: Ministry of Industry Performance Evaluation Reports, various issues.

Table IV.12

Total Output, Value-Added, Capital, and Labor for TIC Firms

(Output, Value-added and Capital in thousands of constant 1985 L.E, Labor in thousands of persons)

Year	Output	Value-Added	Capital	Labor
1975	1,553,247	575,675	757,855	273.93
1976	1,610,752	608,102	848,572	281.94
1977	1,677,076	720,732	988,215	292.50
1978	1,819,200	737,352	1,036,487	295.67
1979	1,741,181	725,256	1,114,612	295.47
1980	1,982,398	865,462	1,404,780	300.10
1981	1,993,998	942,961	1,511,343	301.08
1982	1,902,398	955,255	1,543,625	290.98
1983	1,797,987	969,829	1,742,009	285.66
1984	1,892,901	957,908	1,789,448	273.83
1985	2,057,175	915,230	1,878,481	259.43
1986	1,870,545	833,726	2,078,598	243.82
1987	1,920,434	902,827	2,144,905	233.87
1988	1,906,327	799,032	2,087,556	230.24
1989	1,826,692	682,231	2,113,826	228.94

Source: Based on data in current L.E. thousands presented in Table IV.11. Data on Output and Value-Added were deflated by the wholesale price index; data on Capital were constructed using deflated gross investment and the gross stock assumption with T=8. Price indices are presented in Table III.2 above.

Table IV.13

Indices of Total TIC Outputs and Inputs

(Based on data in thousands of constant 1985 L.E.)

Year	Output	Value-Added	Capital	Labor
1975	100.00	100.00	100.00	100.00
1976	103.70	105.63	111.97	102.92
1977	107.97	125.20	130.40	106.78
1978	117.12	128.08	136.77	107.93
1979	112.10	125.98	147.07	107.86
1980	127.63	150.34	185.36	109.55
1981	128.38	163.80	199.42	109.91
1982	122.48	165.94	203.68	106.22
1983	115.76	168.47	229.86	104.28
1984	121.87	166.40	236.12	99.96
1985	132.44	158.98	247.87	94.71
1986	120.43	144.83	274.27	89.01
1987	123.64	156.83	283.02	85.38
1988	122.73	138.80	275.46	84.05
1989	117.60	118.51	175.67	83.57

Source: Calculated based on data in Table IV.12 above.

Table IV.14

Average Annual Growth Rates of TIC Outputs and Inputs

(Values based on data in thousands of constant 1985 L.E.,
Labor in thousands of persons)

Period	Output	Value-Added	Capital	Labor
1975-89	1.26	1.32	12.78	-1.17
1975-81	4.73	10.63	16.57	1.65
1982-89	-0.57	-4.08	5.28	-3.05
1982-85	2.71	-1.40	7.23	-3.61
1986-89	-0.78	-6.06	0.56	-2.03

Source: Calculated based on data in Table IV.13 above.

Table IV.15

The Ratio of Total Value-Added to Total Output for All TIC Firms (Degree of Processing)

(Based on values in thousands of constant 1985 L.E.)

Year	Value-Added/ Output	Period	Average Value-Added/Output
		1975-89	0.441
1975	0.371	1975-81	0.416
1976	0.378		
1977	0.430		
1978	0.405		
1979	0.417		
1980	0.437		
1981	0.473		
		1982-89	0.463
1982	0.502	1982-85	0.498
1983	0.539		
1984	0.506		
1985	0.445		
		1986-89	0.427
1986	0.446		
1987	0.470		
1988	0.419		
1989	0.373		

Source: Based on data in Table IV.12 above.

Table IV.16

Domestic Resource Costs (DRC) for Textiles,
Egypt 1956-1979

	Primarily yarn[2] with some fabric	Fabrics2	Yarn[2]	Cotton[1] Textiles	Other[1] Textiles
1956	0.388				
1960	0.469				
1965-6		0.645			
1969-70			0.707		
1979				0.629	0.994

$$DRC_j = \frac{\sum_{s}^{m} f_{sj} P_s}{P_j - \sum_{i}^{n} a_{ij} P_i} = \frac{\text{Economic Value of Primary Inputs}}{\text{Value-Added at International Prices}}$$

(See Annex I.1 for a detailed definition of DRC)

[1]Average Rate of Interest (ARI) 6%. Source: World Bank, Arab Republic of Egypt; Issues of Trade Strategy and Investment Planning. World Bank Report no. 4136-EGT. January 14, 1983, p. 280.
[2]Average Rate of Interest (ARI) 5%. Source: Hansen and Nashashibi, Foreign Trade Regimes and Economic Development: Egypt. New York: Columbia University Press, 1975, p. 219.

Table IV.17

Comparison of DRC ratios for the Textile Spinning Industry

Company	Case 1 1981/2	Case 2 1987/8	Case 3 1988/9	Case 4 1988/9	Case 5 1988/9
1	0.74	1.06	NIVA	0.53	0.24
2	0.86	1.47	NIVA	0.64	0.27
3	1.34	1.72	NIVA	0.80	0.28
4	1.94	1.76	NIVA	0.82	0.29
5	2.11	2.07	NIVA	1.07	0.30
6	2.81	2.78	NIVA	1.10	0.33
7	3.63	4.54	NIVA	1.10	0.33
8	NIVA	9.67	NIVA	1.18	0.38
9	NIVA	NIVA	NIVA	2.36	0.45

Notes: The opportunity cost of capital is assumed to be ten percent in all cases. NIVA denotes negative value-added.

$$DRC_j = \frac{\sum_{s}^{m} f_{sj} P_s}{P_j - \sum_{i}^{n} a_{ij} P_i} = \frac{\text{Economic Value of Primary Inputs}}{\text{Value-Added at International Prices}}$$

(See Annex I.1 for a detailed definition of DRC.)

Case 1: Khedr, H. and Kheir el Din, H. 'Economic Indicators of Efficiency of the Egyptian Cotton Spinning Industry', Agricultural Development Systems Project, A.R.E, Ministry of Agriculture and the University of California Economic Working Paper No. 104, December 1982.
Cases 2 and 3: Actual revenue stream and actual f.o.b. cotton prices for grade good plus one-fourth of the lowest internationally quoted price.
Case 4: Actual revenue stream for yarn output (1988/89); average cotton input price (grade good plus 1/4) for the five year period (1982/83-1986/7), i.e. before Egyptian cotton prices rose sharply.
Case 5: Actual revenue stream (1988/89); cotton input prices based on matching the appropriate cotton staple (and price) to the yarn counts actually produced in 1988/89.

<u>Source</u>: World Bank 1991, Table 6.1 p. 60.

Table IV.18

Total Factor Productivity Levels for TIC Firms 1975-89

(Method 1)*

	Qtfp	Vtfp
1975	544.76	201.90
1976	534.96	201.96
1977	518.24	222.72
1978	549.87	222.87
1979	514.64	214.36
1980	539.32	235.45
1981	529.02	250.17
1982	512.80	257.50
1983	472.32	254.77
1984	507.03	256.58
1985	562.39	250.21
1986	516.08	230.03
1987	539.28	253.52
1988	545.50	228.64
1989	522.62	195.19

* Regression coefficients are used for b and c, b = 0.66, c = 0.314, from Table IV.27.

Table IV.19

Average TFP Levels for TIC Firms in Different Subperiods

(Method 1)

Sub-Period	Qtfp	Vtfp
1975-81	532.97	221.35
1982-89	522.25	240.80
1982-85	513.64	254.76
1986-89	506.88	215.98

Source: Based on Table IV.18.

Table IV.20

Index of Total Factor Productivity for TIC Firms 1975-89

(Method 1)

	Qtfp	Vtfp
1975	100.00	100.00
1976	98.20	100.03
1977	95.13	110.31
1978	100.94	110.39
1979	94.47	106.17
1980	99.00	116.62
1981	97.11	123.91
1982	94.13	127.53
1983	86.70	126.18
1984	93.07	127.08
1985	103.24	123.92
1986	94.74	113.93
1987	98.99	125.57
1988	100.14	113.24
1989	95.93	96.67

Source: Based on Table IV.18.

Table IV.21

Total Factor Productivity Levels for TIC Firms 1975-89

(Method 2)*

	Qtfp	Vtfp
1975	136.59	50.62
1976	132.28	49.94
1977	125.73	54.03
1978	132.60	53.75
1979	122.69	51.11
1980	124.27	54.25
1981	120.56	57.01
1982	115.96	58.23
1983	104.56	56.40
1984	111.16	56.25
1985	121.51	54.06
1986	108.87	48.53
1987	112.60	52.93
1988	114.15	47.84
1989	109.06	40.73

* b is the average ratio of employment compensation to value-added and c equals 1-b; b = 0.5299, c = 0.4701.

Table IV.22

Average TFP Levels for TIC Firms in Different Sub-Periods

(Method 2)

Sub-Period	Qtfp	Vtfp
1975-81	127.82	52.96
1982-89	112.23	51.87
1982-85	113.30	56.24
1986-89	111.17	47.51

<u>Source</u>: Based on Table IV.21.

Table IV.23

Index of Total Factor Productivity for TIC Firms 1975-89

(Method 2)

	Qtfp	Vtfp
1975	100.00	100.00
1976	96.84	98.65
1977	92.05	106.74
1978	97.08	106.17
1979	89.83	100.96
1980	90.98	107.17
1981	88.27	112.62
1982	84.90	115.03
1983	76.55	111.41
1984	81.39	111.12
1985	88.96	106.79
1986	79.71	95.86
1987	82.44	104.57
1988	83.57	94.51
1989	79.85	80.46

Source: Based on Table IV.21.

Table IV.24

Levels of Partial Factor Productivity for TIC Firms 1975-89

	O/K	V/K	O/L	V/L
1975	2.05	0.76	5,670.19	2,101.52
1976	1.90	0.72	5,713.12	2,156.86
1977	1.70	0.73	5,733.63	2,464.06
1978	1.76	0.71	6,152.87	2,493.86
1979	1.56	0.65	5,892.84	2,454.55
1980	1.41	0.62	6,605.82	2,883.92
1981	1.32	0.62	6,622.80	3,131.92
1982	1.23	0.62	6,537.94	3,282.91
1983	1.03	0.56	6,294.08	3,395.01
1984	1.06	0.54	6,912.64	3,498.16
1985	1.10	0.49	7,929.50	3,527.81
1986	0.90	0.40	7,671.80	3,419.42
1987	0.90	0.42	8,211.51	3,860.36
1988	0.91	0.38	8,279.77	3,470.44
1989	0.86	0.32	7,979.05	2,980.01

Table IV.25

Average Levels of Partial Factor Productivity for TIC Firms In Different Sub-Periods

Sub-Period	O/K	V/K	O/L	V/L
1975-81	1.67	0.69	6,055.90	2,526.67
1982-89	1.00	0.47	7,477.04	3,429.27
1982-85	1.10	0.55	6,918.54	3,425.97
1986-89	0.89	0.38	8,035.53	3,432.56

Source: Based on Table IV.24.

Table IV. 26

Index of Partial Factor Productivity for TIC Firms

	O/K	V/K	O/L	V/L
1975	100.00	100.00	100.00	100.00
1976	92.62	94.34	100.76	102.63
1977	82.80	96.01	101.12	117.25
1978	85.64	93.65	108.51	118.67
1979	76.22	85.66	103.93	116.80
1980	68.85	81.11	116.50	137.23
1981	64.37	82.14	116.80	149.03
1982	60.13	81.47	115.30	156.22
1983	50.36	73.29	111.00	161.55
1984	51.61	70.47	121.91	166.46
1985	53.43	64.14	139.85	167.87
1986	43.91	52.80	135.30	162.71
1987	43.69	55.41	144.82	183.69
1988	44.56	50.39	146.02	165.14
1989	42.16	42.49	140.72	141.80

Source: Based on Table IV.24.

Table IV.27

Technical Change for TIC Firms 1975-89

constant	lnK	lnL	t	t^2	tlnK	tlnL	R^2
Equation (1)							
5.31	0.31	0.66					0.7875
(24.62)	(13.34)	(24.62)					
Equation (2a)							
5.27	0.32	0.65	-0.001				0.7664
(18.73)	(9.16)	(15.72)	(-0.27)				
Equation (2b)							
5.37	0.29	0.66	0.08	-0.0047			0.8172
(22.37)	(9.57)	(19.05)	(8.22)	(-9.16)			
Equation (3)							
5.15	0.34	0.64			-0.0003		0.7614
(16.70)	(8.85)	(15.37)			(-0.73)		
Equation (4)							
5.36	0.31	0.66				0.0007	0.7427
(17.64)	(9.05)	(17.64)				(0.31)	
Equation (5)							
3.55	0.53	0.43	0.23		-0.03	0.03	0.7846
(8.46)	(10.76)	(7.39)	(5.62)		(-6.01)	(4.94)	

Notes: The regressions are based on pooled cross-section, time series data for 30 firms and 15 time periods (1975-1989). The dependent variable is ln value-added. The CORCOEF option is used for all equations except (2b) (see note to Table III.31). Numbers in parentheses are t-statistics.

Table IV.28

Technical Change for TIC Firms 1975-81

constant	lnK	lnL	t	t^2	tlnK	tlnL	R^2
Equation (1)							
4.58	0.41	0.57					0.9118
(16.51)	(11.90)	(13.78)					
Equation (2a)							
5.37	0.29	0.66	0.038				0.8875
(16.96)	(7.23)	(14.36)	(5.12)				
Equation (2b)							
5.47	0.29	0.68	-0.02	0.008			0.8934
(17.91)	(7.39)	(14.84)	(-1.15)	(3.25)			
Equation (3)							
5.55	0.28	0.665			0.0039		0.8806
(16.90)	(6.58)	(14.51)			(5.38)		
Equation (4)							
5.28	0.32	0.57				0.016	0.8625
(15.47)	(7.85)	(13.25)				(4.45)	
Equation (5)							
6.23	0.18	0.82	-0.15		0.026	-0.035	0.8959
(14.00)	(3.24)	(12.43)	(-1.74)		(2.56)	(-2.64)	

Notes: The regressions are based on pooled cross-section, time series data for 30 firms and 7 time periods (1975-1981). The dependent variable is ln value-added. The CORCOEF option is used for all equations (see note to Table III.31). Numbers in parentheses are t-statistics.

Table IV.29

Technical Change for TIC Firms 1982-89

constant	lnK	lnL	t	t^2	tlnK	tlnL	R^2
Equation (1)							
6.66	0.17	0.84					0.8945
(28.70)	(6.67)	(28.15)					
Equation (2a)							
5.77	0.29	0.70	-0.038				0.9349
(24.07)	(10.53)	(23.78)	(-7.58)				
Equation (2b)							
6.01	0.245	0.75	0.042	-0.0087			0.9471
(25.78)	(8.95)	(24.92)	(2.84)	(-5.92)			
Equation (3)							
5.66	0.295	0.71			-0.0034		0.9304
(22.68)	(10.43)	(23.71)			(-7.24)		
Equation (4)							
5.84	0.26	0.78				-0.014	0.9175
(23.30)	(9.79)	(30.92)				(-5.75)	
Equation (5)							
5.64	0.31	0.65	0.055		-0.012	0.020	0.9556
(14.83)	(7.41)	(16.63)	(0.72)		(-1.46)	(2.32)	

Notes: The regressions are based on pooled cross-section, time series data for 30 firms and 8 time periods (1982-1989). The dependent variable is ln value-added. The CORCOEF option is used for all equations (see note to Table III.31). Numbers in parentheses are t-statistics.

Table IV.30

Test for Constant Returns to Scale, TIC Firms

Period	Option	T	D.F.	F	D.F.	Result
1975-89	CORCOEF	-1.0586	447	1.1205	1,447	Accept
1975-81	CORCOEF	-1.4005	207	1.9614	1,207	Accept
1982-89	CORCOEF	0.2008	237	0.0403	1,237	Accept

Note: Tests are based on equation (1).

Table IV.31

Test for Structural Change for all TIC Firms, 1982-89

constant	lnK	lnL	D1	D1lnK	D1lnL	R^2
Equation (6a)						
5.47	0.29	0.68	0.047			0.7853
(24.91)	(11.75)	(21.18)	(1.97)			
5.46	0.30	0.68		0.004		0.7771
(24.11)	(11.50)	(20.86)		(1.71)		
5.43	0.30	0.66			0.019	0.7625
(23.95)	(12.13)	(21.52)			(1.81)	
Equation (7a)						
4.92	0.36	0.62	1.09	-0.12	0.11	0.7951
(18.64)	(11.64)	(15.39)	(3.50)	(-3.39)	(2.38)	

Notes: D1 = 1 for 1982-1989, 0 otherwise. The dependent variable is ln value-added. The numbers in parentheses are t-statistics. All equations are estimated with the CORCOEF option.

Table IV.32

Test for Structural Change for all TIC firms, 1986-89

constant	lnK	lnL	D2	D2lnK	D2lnL	R^2
Equation (6b)						
4.86	0.37	0.60	-0.13			0.8207
(22.48)	(15.35)	(19.95)	(-5.37)			
4.85	0.37	0.60		-0.012		0.8227
(22.28)	(15.33)	(20.26)		(-5.38)		
4.92	0.36	0.62			-0.053	0.8148
(22.26)	(14.74)	(21.46)			(-4.58)	
Equation (7b)						
4.79	0.38	0.58	0.46	-0.07	0.11	0.8127
(20.81)	(14.94)	(18.32)	(1.19)	(-1.7)	(1.99)	

Notes: D2=1 for 1986-1989, 0 otherwise. The dependent variable is ln value-added. The numbers in parentheses are t-statistics. All equations are estimated with the CORCOEF option.

Fig IV.1

TIC Output and Value Added (Current L.E.'000)

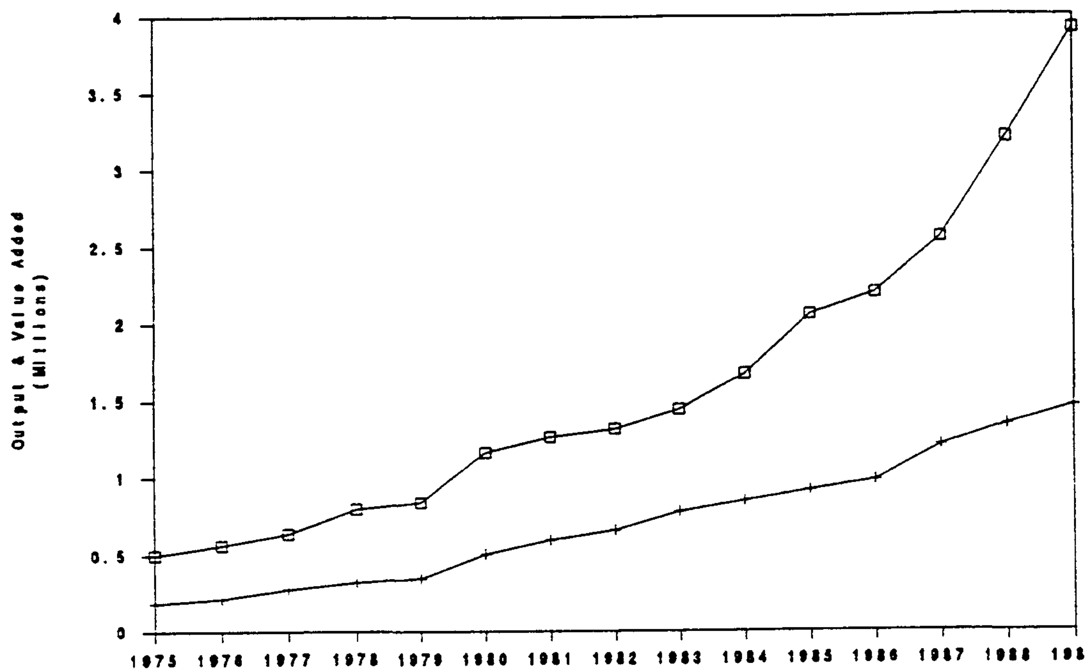


Fig IV.2

TIC Output and Value Added (Constant L.E.'000)

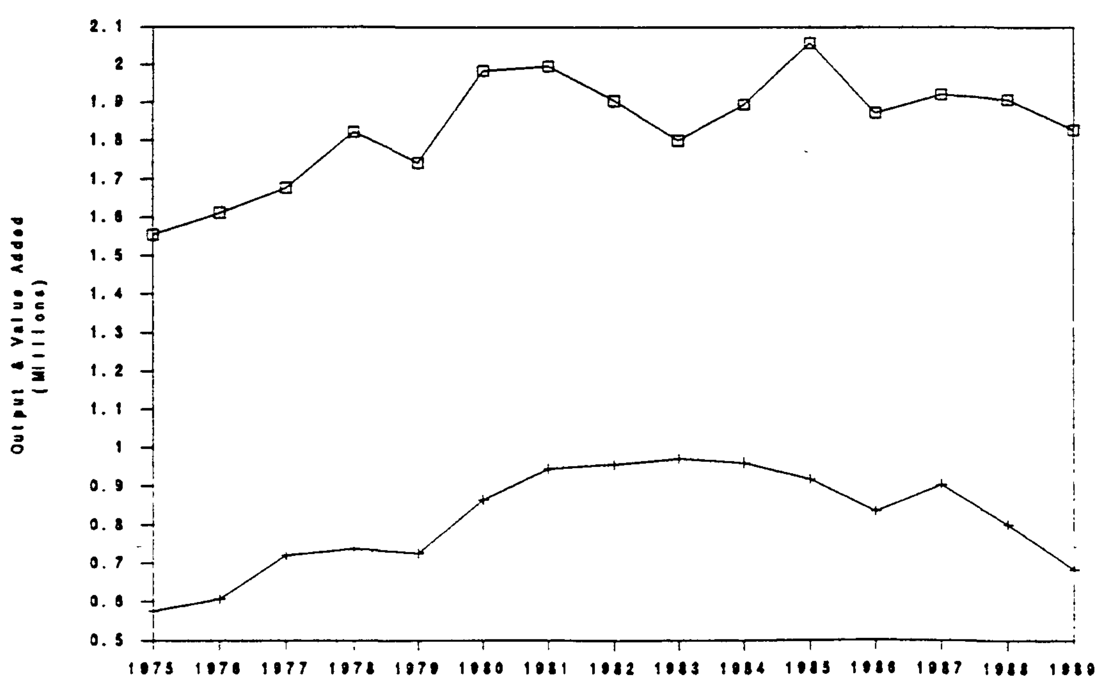


Fig IV.3

TIC Labor (Thousands of Persons)

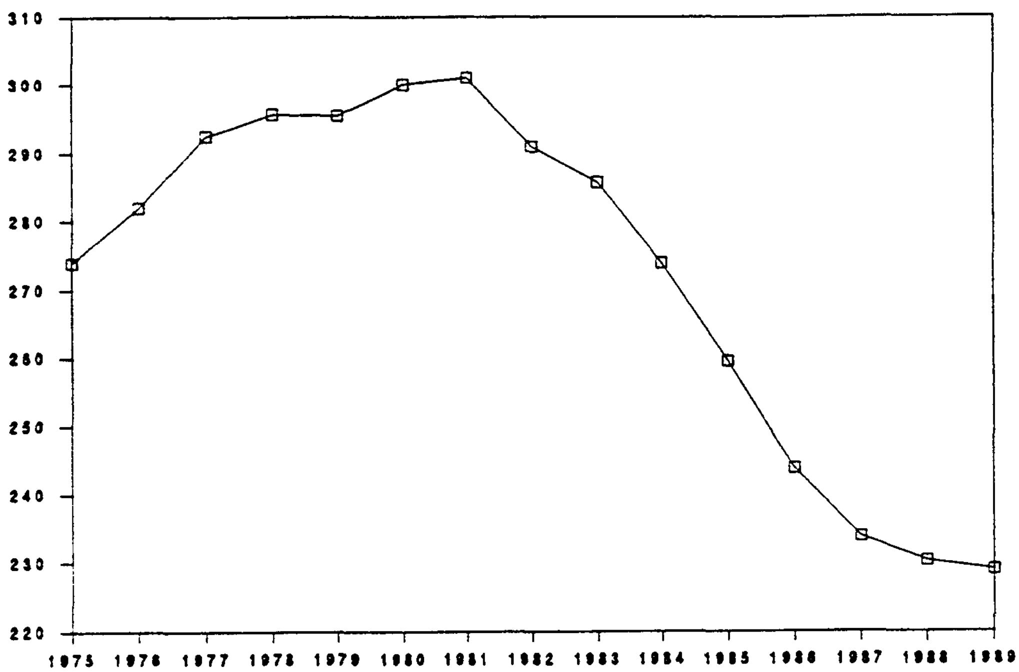


Fig IV.4

TIC Capital Stock (Constant L.E. '000)

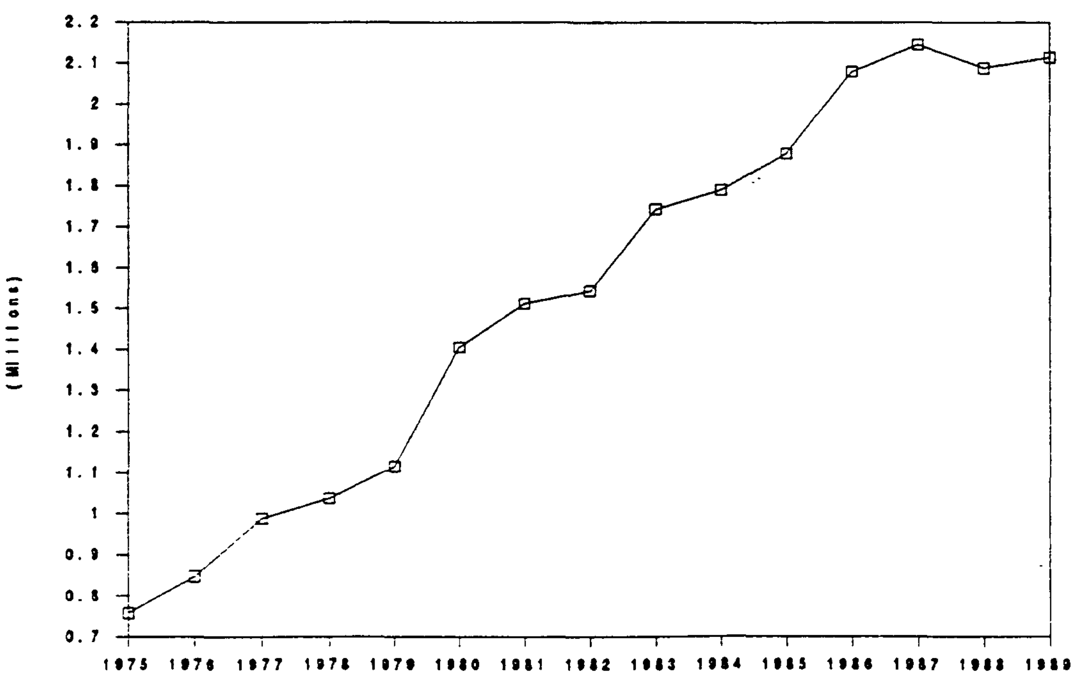


Fig IV.5

TIC: Total Factor Productivity (Method 1)

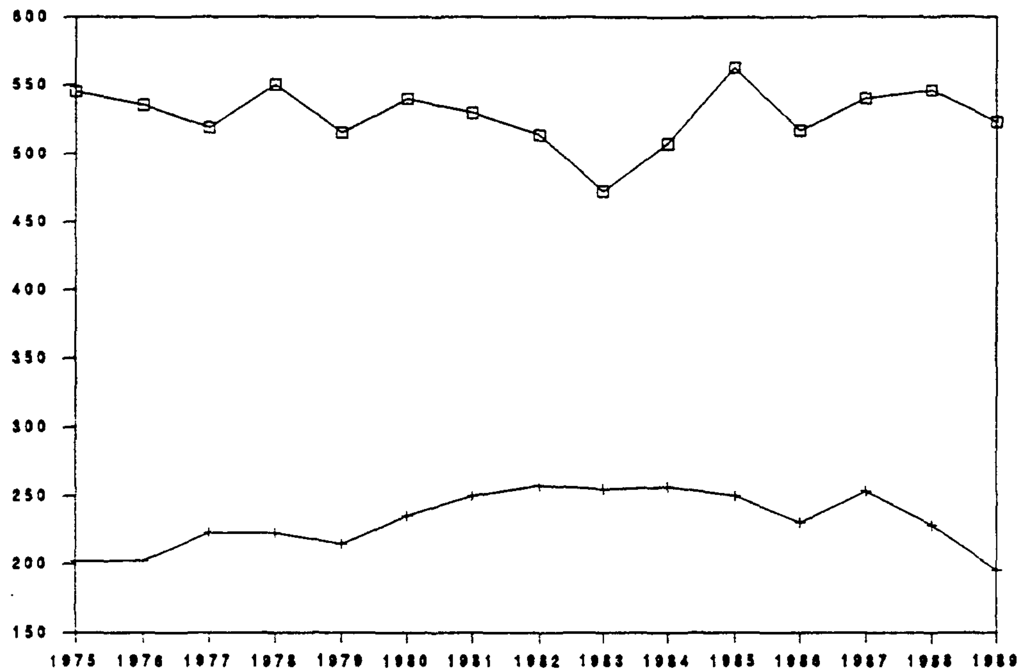


Fig IV.6

TIC: Total Factor Productivity (Method 2)

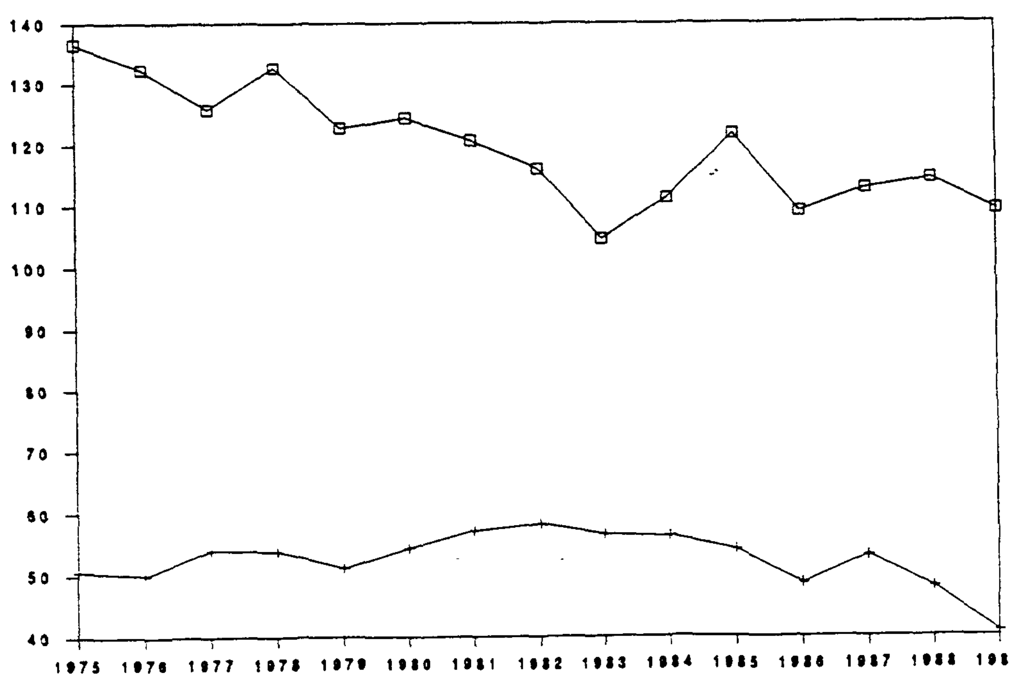


Fig IV.7

Labor Productivity for TIC Firms

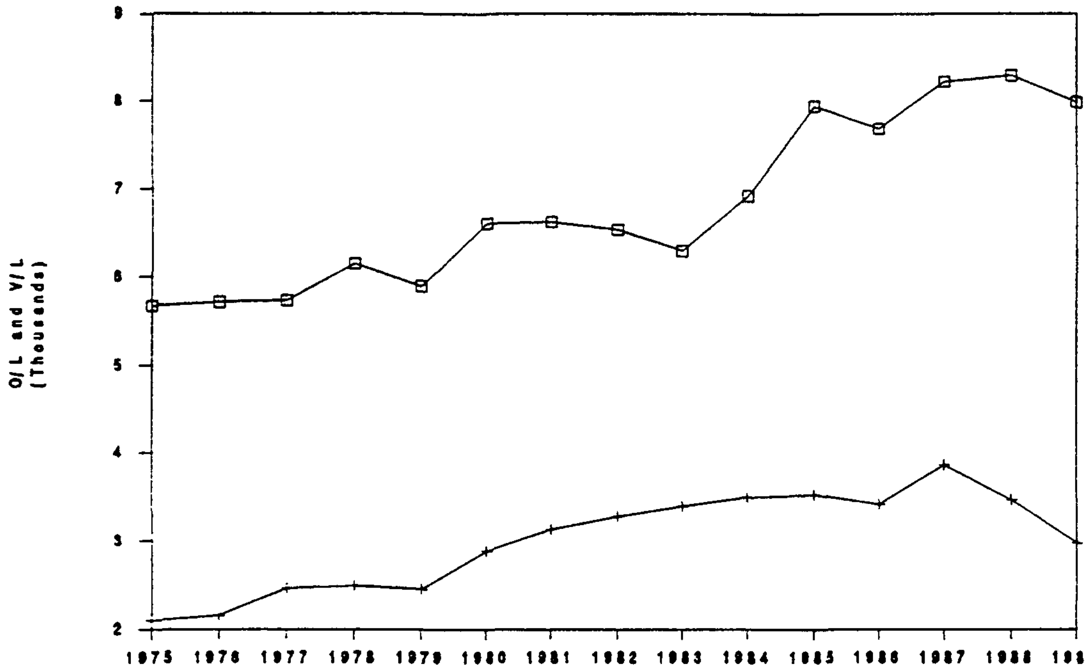
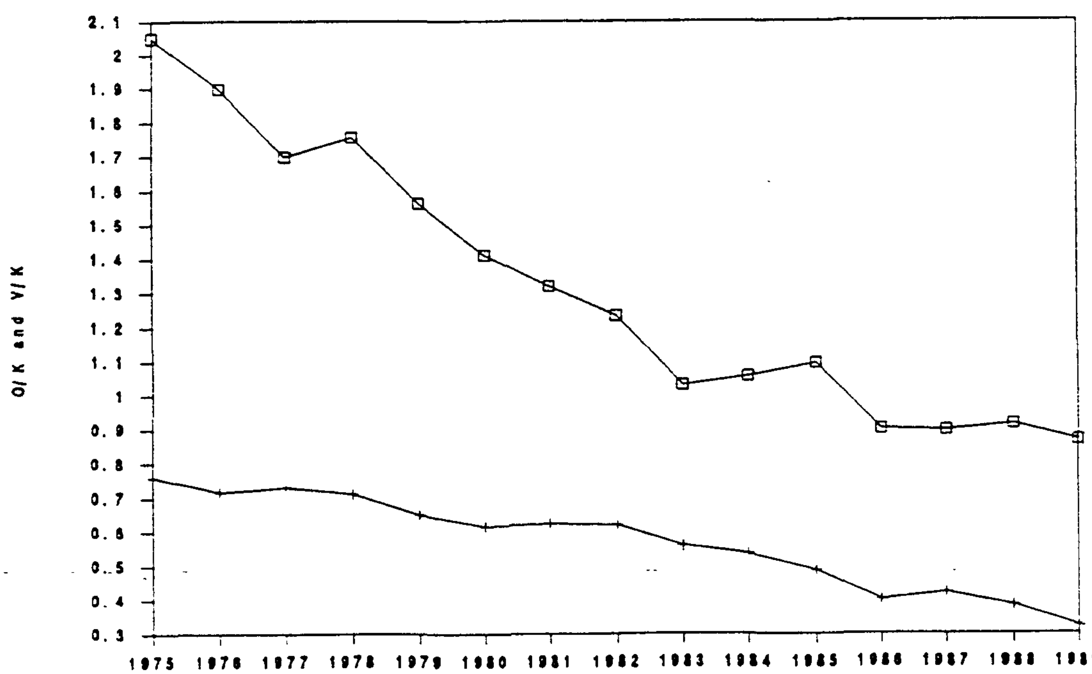


Fig IV.8

Capital Productivity for TIC Firms



Annexes

Annex IV.1: Textile Companies Affiliated with the Textile Industries Corporation (TIC): Dates of Establishment, Main Activities or Principal Products

1. Misr Lel Ghazl Wa Al Naseeg Bel Mahhala Al Kobra
Established in 1927
Main activities:
-spinning, weaving and finishing of cotton, wool, & blended fabrics
-production of woolen and blended blankets
-production of hydrophile cotton wool
-production of ready made garments.

2. Misr Lel Ghazl Wa Al Naseeg Al Rafee' Be Kafr Al Dawwar
Established in 1938
Main activities:
-spinning and weaving of cotton and blended fabrics
-production of ready made garments
-production of sewing thread.

3. Misr/Helwan Lel Ghazl Wa Al Naseeg
Established in 1927
Main activities:
-spinning, weaving and finishing of cotton and blended fabrics
-production of ready made garments.

4. Al Mahallat Al Sena'eya (Esco)
Established in 1940
Main activities:
-spinning, weaving and finishing of cotton, wool and blended fabrics.

5. Al Nasr Lel Ghazl Wa Al Naseeg Wal Sebagha Bel Mahalla
Established in 1960
Main activities:
-spinning, weaving, and finishing of cotton and blended fabrics
-production of terry fabrics and bed covers
-production of ready made garments.

6. Al Arabeya Wal Mottahida Lel Ghazl Wa Al Naseeg (UNIRAB)
Established in 1945
Main activities:
-spinning, weaving and finishing of cotton and blended fabrics
-production of sewing thread
-production of knitwear.

7. Misr/Shebeen El Kom Lel Ghazl Wal Naseeg (Shebintex)
Established in 1962
Main activities:
-production of cotton and blended yarn
-production of polyacrylic yarn.

8. Al Nasr Lel Aswaf Wal Mansougat (Stia)
Established in 1946
Main activities:
-spinning, weaving, and finishing of cotton and blends
-spinning, weaving, and finishing of wool and blends
-production of woolen and blended blankets
-production of knitted cotton underwear.

9. Al Ahleya Lel Ghazl Wal Naseeg
Established in 1912
Main activities:
-spinning, weaving and finishing of cotton fabrics
-production of ready made garments.

10. Misr/Sabbaghi Al Bayda
Established in 1938
Main activities:
-wool washing and tops making
-wool and blended fibre spinning
-bleaching and dyeing of cotton and blended yarbs and fabrics
-production of hydrophile cotton-wool.

11. Al Masreya Leghazl Wa Nasg Al Souf (Wooltex)
Established in 1938
Main activities:
-wool and blended spinning, weaving and finishing
-production of woolen and blended blankets
-production of woolen and blended socks
-production of tubular woolen felts
-production of men's suits.

12. Al Nasr Lel Ghazl Wal Nasseg Wal Trico (Shourbagi)
Established in 1947
Main activities:
-spinning, weaving and finishing of cotton and blended fabrics
-production of knitted underwear
-production of hosiery and stockings
-production of ready made garments.

13. Misr Lel Harir Al Sena'y 'MISRAYON'
Established in 1946
Main activities:
-production of synthetic filaments (Viscose, Nylon, Polyester)
-production of synthetic fibres ((Viscose, Nylon, Polyester)
-production of Cellophane
-production of blended yarns.

14. Al Wagh Al Qibly Lel Ghazl Wal Naseeg
Established in 1960
Main activities:
-spinning of cotton and blended yarns
-spinning of wool and blended yarns
-production of ready made garments.

15. Misr Al Wosta Lel Ghazl Wal Naseeg 'MINATEXCO'
Established in 1962
Main activities:
-spinning and weaving of cotton fabrics.

16. Al Sharqeya Lel Kettan Wal Qotn
Established in 1946
Main activities:
-spinning, weaving and finishing of linen, cotton and blended fabrics
-production of terry towels
-production of furnishing fabrics
-production of ready made garments
-production of bed-covers, curtains.

17. Domyat Lel Ghazl Wal Naseeg
Established in 1959
Main activities:
-production of cotton yarns and fabrics (Arabic: spinning of cotton)
-production of embroidered bed covers
-production of ready made garments.

18. Al Nasr Lel Ghazl Wal Naseeg be Port Said
(Port Said spinning and Weaving Co. PORTEX; Port Said Lel Ghazl Wal Naseeg)
Established in 1960
Main activities:
-weaving and finishing cotton fabrics.

19. Al Arabeya Lel Seggad Wal Mafroushat
Established in 1969
Main activities:
-manufacture of wool and blended carpets and moquette
-manufacture of woolen and blended blankets.

20. Al Seyouf Lel Ghazl Wal Naseeg (SIOUFTEX)
Established in 1938
Main activities:
-production of cotton and blended yarns and fabrics.

21. Iskandareya Lel Ghazl Wal Naseeg (SPINALEX)
Established in 1947
Main activities:
-spinning cotton yarns
-finishing cotton fabrics.

22. Al Dakahlia Lel Ghazl Wal Naseeg (DAKAHLETEX)
Established in 1962
Main activities:
-production of cotton and blended yarns
-production of knitwear
-production of ready made garments.

23. Al Delta Lel Ghazl Wal Nasseg (DELTATEX)
Established in 1960
Main activities:
-production of cotton and blended yarns and fabrics
-production of terry towels
-production of sewing thread
-production of ready made garments.

24. Al Nasr Lel Malabes Wal Mansougat (KABO)
Established in 1940
Main activities:
-production of knitted products.

25. Al Kahira Lel Malbousat Wal Trico (Tricona)
Established in 1961
Main activities:
-production of knitted products.

26. Al Kahira Lel Sebagha Wal Tagheez
Established in 1960
Main activities:
-finishing cotton and blended yarns and fabrics.

27. Al Kahira Lel Mansougat Al Harireya (QAKIRATEX)
Established in 1918
Main activities:
-production of cotton, silk, and blended fabrics (Arabic: spinning of cotton and blends).

28. Al Mansougat Al Haditha (POLVARA)
Established in 1961
Main activities:
-produciton of silk and syntheic fibres.

29. Al Ama Lemontagat Al Gout (JUTIMA)
Established in 1956
Main activities:
-spinning and weaving of jute
-manufacture of jute sacks.

30. Moedat Al Ghazl Wal Naseeg (KARD HELWAN)
Established in 1958
Main activities:
-manufacture of accessories for spinning, weaving and ready made garment factories, e.g., picking sticks, paper cones and bobbins, furniture for garment factories, shuttles, pirns, etc.

Source: Textiles Industries Corporation, Brochure.

Annex IV.2: Classification of Textile Companies According to Specialization

SPINNING & WEAVING (& SOME READY MADE GARMENTS) [22 COMPANIES]
1. Misr Lel Ghazl Wa Al Naseeg Bel Mahhala Al Kobra
2. Misr Lel Ghazl Wa Al Naseeg Be Kafr Al Dawwar
3. Misr/Helwan Lel Ghazl Wa Al Naseeg
4. Al Mahallat Al Sena'eya (Esco)
5. Al Nasr Lel Ghazl Wa Al Naseeg Wal Sebagha Bel Mahalla
6. Al Arabeya Wal Mottahida Lel Ghazl Wa Al Naseeg
7. Misr/Shebeen El Kom Lel Ghazl Wal Naseeg
8. Al Nasr Lel Aswaf Wal Mansougat (Stea)
9. Al Ahleya Lel Ghazl Wal Naseeg
11. Al Masreya Leghazl Wa Nasg Al Souf (Wooltex)
12. Al Nasr Lel Ghazl Wal Nasseg Wal Trico (Shourbagi)
14. Al Wagh Al Qibly Lel Ghazl Wal Naseeg
15. Misr Al Wosta Lel Ghazl Wal Naseeg
16. Al Sharqeya Lel Kettan Wal Qotn
17. Domyat Lel Ghazl Wal Naseeg
18. Al Nasr Lel Ghazl Wal Naseeg be Port Said
20. Al Seyouf Lel Ghazl Wal Naseeg
21. Iskandareya Lel Ghazl Wal Naseeg
22. Al Dakahlia Lel Ghazl Wal Naseeg
23. Al Delta Lel Ghazl Wal Nasseg
27. Al Kahira Lel Mansougat Al Harireya
28. Al Mansougat Al Haditha

KNITWEAR: [2 COMPANIES]
24. Al Nasr Lel Malabes Wal Mansougat (KABO)
25. Al Kahira Lel Malbousat Wal Trico (Tricona)

DYEING & FINISHING [2 COMPANIES]
10. Misr/Sabbaghi Al Bayda
26. Al Kahira Lel Sebagha Wal Tagheez

SYNTHETIC FIBRES [2 COMPANIES]
13. Misr Lel Harir Al Sena'y
29. Al Ama Lemontagat Al Gout

UPHOLSTRY [1 COMPANY]
19. Al Arabeya Lel Seggad Wal Mafroushat (DAMANHOUR CARPETS)

ACCESSORIES FOR TEXTILES [1 COMPANY]
30. Moedat Al Ghazl Wal Naseeg

Source: My Classification.

Notes

[1] Of the thirty companies, 16 were established prior to the 1952 revolution and were almost certainly private sector companies. Three were established between the 1952 revolution and the nationalization waves starting in 1960 (one in 1959, one in 1958, and one in 1956). These were probably established as public sector firms. The remaining 11 were established after 1960 (six of these were established in 1960, two in 1961, and three in 1962). These were almost definitely public sector firms from the start.

[2] CUR is "actual production as a percentage of optimum achievable production". For the whole of ring spinning, "capacity is estimated in the range of 87 percent on a daily basis and 79% on an annual basis. The CURs obtained during mill visits show a range of CURs from 60-70% to 90-100% in one or two mills". According to the World Bank (1991 Table 7.2 p. 73), capacity utilization in rotor spinning is 62.4%. The CUR for the spinning industry overall is low, at about 80 percent (World Bank 1991 p. xii).

[3] According to Dahmouche, the situation (with public sector intramural research) is "totally unsatisfactory". "They do not have enough funds; once you've seen one, you've seen them all", he said.

[4] Hebeish was awarded the prize of the Network of the Scientific Organizations for the Third World. This prize is given for the best scientist whose research and studies have contributed to the development of industry and technology in countries of the developing world. The research was about 'tahweer' i.e. the transformation of cotton into a substance that does not break, that does not need ironing, that is anti-flammable, anti small creatures like etta and bacteria, and that is easier to dye. Unfortunately, Egyptian factories have not made use of this research (Al Akhbar 1992a).

[5] According to Dahmouche: "the slogan of linking university to industry is not real; [it is] artificial, fake. The situation with the Department of Spinning and Weaving in Alexandria University is very 'sad'."

[6] Labs with the Textile Industries Research Division of the NRC are classified as follows:

- lab for dyeing and printing (Mawad Wasita)
- lab for spinning and weaving
- lab for al Tahdirat wal taghizat (preparation) for cellulose fibres
- lab for alyaf al protineya wal senaeya (protein and synthetic fibres)
- mabna al wehda al tagribia lel ghazl wal naseeg (experimental unit for spinning and weaving)

(Mahmoud 1987 p. 84).

[7] Since the Centre has only been recently revived, we cannot judge its performance.

[8] According to Dahmouche, NRC, the Academy, and Universities are "supposed to do diagnostic research, applied research, reverse engineering....NRC did pilot plants that turned out [to be] very expensive and required highly qualified staff."

[9] These figures cover industrial production of public and private companies monitored by MOI, which are estimated to account for 80% of industrial output. They do not include output of foreign investment companies.

[10] Data is for the public sector. The World Bank report notes that data from private sector companies support the same general conclusion on the competitiveness of the textiles industry (World Bank 1989b p. 10).

CHAPTER V

CONCLUSION

V.1. Introduction

In this chapter we provide the conclusions of our research. In doing so, we attempt to provide answers to the questions raised at the beginning of the thesis. We first present a summary of the main findings and policy implications. We then view the performance of the two industries in light of the experience of other countries. We finally present our suggestions for future research to extend the analysis.

V.2. Conclusions and Policy Implications

The present research has been an attempt at measuring indicators of productivity, technical change and the role of R&D in public sector engineering and textile firms. Qualitative analysis based on previous studies and questionnaires with key persons was complemented by quantitative work based on data collected from primary sources. For each group of industries, estimation was divided into three main blocks: estimation of total and partial factor productivity, estimation of technical change, and testing for structural change. In the case of EIC firms, we also were able to examine the effect of R&D on production.

Based on these results, we have grounds to conclude that the second half of the seventies witnessed some improvement in the performance of both EIC and TIC firms, while the eighties witnessed a deterioration that became particularly evident after 1986. At least until 1979, indicators of technical change, TFP and PFP were positive and increasing. The advent of the eighties witnessed a change in direction. The sub-period 1982-89 witnessed negative significant technical change of all types for both industries. At least in the last four years (1986-89), average total and partial factor productivity levels were mostly low and/or declining. This period (1986-89) was shown to be a time of negative structural change for both industries.

All performance indicators for EIC firms, and most indicators for TIC firms, showed productivity to be represented by an inverted-U pattern that peaked around 1982-84. This finding explains the results of the regressions testing for technical change. Accordingly, conclusions on technical change are to be carefully interpreted, especially since productivity change could have been caused by other factors affecting the input-output relationships for these firms. The point remains, however, that productivity in general improved in the seventies, and deteriorated later in the eighties.

In trying to account for this, a combination of factors are considered. On the one hand, a vast expansion in domestic demand witnessed in the seventies meant high rates of capacity utilization. On the other hand, the supply side was characterized by a generation of well educated and trained personnel. These represented the fruit of the investment in science and technology in the sixties, or the 'output of domestic R&D input'. While machinery was imported from the West (representing the output of foreign R&D input), it was still new and in good shape. On the policy level, this period witnessed the start of foreign exchange liberalization and a generally positive attitude in the whole economy. There were even attempts at providing firms with more autonomy at that time.

Unfortunately, this optimism did not last very long. The consequences of the limited awareness of the importance of science and technology typical of the seventies were beginning to be felt in the eighties. The lack of the know how required for the maintenance of depreciating machinery was a major deterrent. The emergence of idle capacity was aggravated by a shrinkage in domestic demand. The cut in Arab Aid was a serious blow dealt to the economy at large. The decline in workers' remittances later in the eighties was an additional restriction on domestic demand. This was magnified by soaring price indices and high inflation rates. The situation was made more difficult by the foreign exchange crisis, continued trade and price controls, and of course the persistence of old employment policies making excess labor a heavy burden on firms.

In fact the consequences of the open door policy started showing with the start of the eighties. Whatever policies favored the private sector meant its emergence at the expense of a gradually ailing public sector that suffered from the evils of constrained liberalization. Such dualism was certainly not in favor of the public sector. The situation was magnified by unfavorable external circumstances: cuts in aid, a decline in remittances, a decline in Suez Canal and tourism earnings, and the gradual adoption of the World Bank and IMF macroeconomic policy prescription. It is no surprise that the sub period 1986-89 generally witnessed the lowest levels for most indicators of total and partial factor productivity. While individual firms may have done relatively better than others, and despite sporadic stories of success on the technological level, one can safely assert that by 1990, both EIC and TIC firms were performing at a much lower level than in the seventies.

It is our belief that the performance of both groups of firms under study was affected by 'technological inertia'. Efforts at establishing scientific foundations characteristic of the sixties were bearing fruit in the seventies. Limited interest in R&D in the seventies eventually brought about the slack performance of the eighties. Technological inertia, or simply the long term impact of R&D investments, should be in the minds of those responsible for the technological advance of Egypt.

Although my attempt at quantifying the role of R&D was only preliminary, my conclusion is based on the wealth of qualitative data collected in the course of the present research. I have found the role of R&D to be limited. There were sporadic efforts, with perhaps some individual stories of success. The interaction between the production sector on the one hand, and R&D bodies (or units) on the other, is virtually nonexistent.

One important point in this respect, however, is that the distinction between local and imported R&D should not be a point of concern. They are not substitutes, rather they should be viewed as complementary. What really matters is technology management. Mahmoud provides the example of Great Britain, a country with the highest number of patents, yet not the most technologically developed. It stands in contrast to Taiwan or Singapore who can import the technology and properly manage it, and even improve on it to increase productivity (Mahmoud interview). Even Japan has a fantastic ability to utilize the R&D of others to produce and develop a product

(Mahmoud interview). The Japanese think of technology and application as "one and the same; the difference between nations is in mastering the application, and more importantly, the marketing" (Mansour 1991a).

This implies that domestic investment in R&D is necessary but not sufficient for achieving technological development. It is necessary because it is a prerequisite for technological adaptation. It is not sufficient because it requires proper technology management. Before I present my recommendations in this respect, it is useful to consider the experience of other countries at similar stages of development.

V.3. The Experience of Other Countries

The comparison with East Asian countries is especially interesting as their industrial development has been a story of success. While Korea and Singapore relied on a strong government role to encourage the private industrial sector, Hong Kong and Taiwan leaned towards "entrepreneurial capitalism" (Berger & Hsiao 1988 p.231). Despite these differences between the cases of individual countries, the general theme of success has been the dynamic and efficient utilization of resources, the use of appropriate and innovative technologies, and the adoption of export-oriented industrial policies.

While East Asian countries were open to foreign ideas and technology, they still encouraged research into improving and appropriating technologies of production. In Singapore, the government offered research and training grants to induce private industries to invest in desired industries (Berger & Hsiao 1988 p. 229). In Hong Kong, the government is establishing new agencies to develop industrial technologies (Berger & Hsiao 1988 p. 231), including a recent one to promote technological innovation in industry. In South Korea, the government is pressuring large firms to establish their own research centers (Patel 1993 p. 174).

In particular, South Korea presents a case of strong awareness of the role of science and technology in production. Since the establishment of the Ministry of Scientific Research and Technology in 1967, investment in R&D increased by more than 20 percent annually. It reached a level of 2 percent of national income in the mid eighties (Kishk 1986 p. 18). In the manufacturing sector alone, R&D spending increased more than twenty eight times from 1976 to 1984 from 22.25 million current U.S. dollars in 1976 to 651 million in 1984 (see Table V.1). Even when measured in constant prices, R&D spending increased by a factor of 9.4 in 8 years, which was faster than the growth of sales. In fact the ratio of R&D to sales in manufacturing increased from 0.39 percent in 1976 to 1.01 percent in 1984. Within manufacturing, the highest percentage of R&D spending to sales (2 percent) was in the capital goods sector including electronics (Patel 1993 p. 174). In electronics alone, the ratio was 3.51 percent in 1984. In fact, electronics is considered to have been "the most technologically dynamic sector" in the country (Patel 1993 p. 182). Patel (1993 p. 181) further writes:

> What characterizes Korea's electronics industry is its intensity in R&D activities to complement foreign licensing... Indigenous R&D activities not only accelerated the pace of assimilation of imported foreign technology and enhanced its innovativeness but also strengthened the bargaining power of licensing negotiations.

Of course, Japan has provided an excellent example of the connection between R&D and technological development in industry. Between 1970-1979, private expenditure on industrial R&D increased by more than 200 percent (see Table V.2). The most striking increase (more than 370 percent) has been in motor vehicles (Anderson 1984 p. 105). The figures for transport equipment, machinery and fabricated metals are also impressive. The improvement in total factor productivity (TFP) presented in Tables V.3 & V.4 is no surprise. Considering that these tables include Japanese TFP improvements only until 1973, the change for the rest of the seventies must have been even greater. Mansour (1991a) writes:

> The golden rule of the Japanese, and that which is the source of all success is: it is not only the idea nor its application, but the application in an innovative and creative manner, and its marketing on the largest scale.

V.4. Recommendations

The importance of productivity improvement, technological development, and investment in R&D is today a top priority on the agenda for Egypt's development. In a world of emerging regional groupings, newly industrialized economies and new competitors, an awareness of the importance of science and technology is no longer a luxury which Egypt can choose to miss. Perhaps a more creative approach to technological management is what the country needs at this stage. In particular, technological development is an essential priority for engineering and textile industries since they provide good potential for the country's development, a potential which was successfully utilized in the Newly Industrialized Countries of Asia.

Specifically, there is a need for a stronger role to be played by research institutions and R&D units in individual firms under the auspices of a coordinating body. For one thing, the wage structure needs to be redefined. Since some of these firms are being privatized as we speak, we hope that a new wage policy will be made taking R&D personnel into consideration. Researchers should also have more exposure to modern technology, wherever it may be. As Hamed (1989) eloquently put it:

> Scientists and engineers (i.e. undertakers of R&D and technological application) are the new working class (new proletariat) in the coming age. They will replace the traditional working class with respect to their place in the production process, since they are the essential foundation for value-added which they achieve through the organized utilization of their minds (and not their arms)... In about 15-30 years it is expected that applied research and development processes will be merged with production processes, and the work force will be mainly formed out of scientists and engineers. Only large industrial conglomerates will then be able to accommodate the .. needs of production and operation. The driving force of the conglomerates will be the new proletariat. It should be taken into consideration with respect to the privatization, the priority of preparation, development and improvement to accommodate the industrial needs of the coming age... There is a need for scientific and educational preparation from now for a stage when 'knowledge will be production and production will be knowledge', and the working force will be formed out of scientists.

While privatization may not provide the solutions to ailing industries, it should at least allow for a more flexible employment policy. Of course this is no easy task in a country living in a highly turbulent political atmosphere. Perhaps a relatively easier task would be to update existing machinery and ensure better utilization of the existing capital stock.

All this said, it is our contention that most of the problems encountered by public sector firms and dealt with in this research boil down to a lack of the awareness of the importance of technological development and the role of R&D in this process. We thus sum up our recommendations in one point: there is a need for a coherent and well planned science and technology policy, with well defined roles for research centers, universities, and research units within the production sector, and with a positive role played by the production sector itself. There is no room for sporadic activities. The chain has to be complete: from research in its broad sense, including technology adaptation, to application. As John Kenneth Galbraith put it, "I see an industrial policy and investment in innovation, as one of the emergent policies in all countries" (Galbraith 1993 p. 48).

V.5 Future Research

As pointed out in Chapter I, the timing of the present research is of special interest as the Egyptian government is currently taking steps at privatization. It will be interesting to extend the present research to compare the performance of such firms after a decade or so of privatization. Moreover, since this research has been conducted on public sector firms, it would be interesting to do the same for private sector firms and compare their experience.

More importantly, the data available on R&D expenditures in Egypt is virtually non existent. The present research has been an attempt at articulating this data on the firm level. Despite the crudeness, and sometimes incompatibility of the data, it was a first step towards achieving such a goal. There is certainly a need for more work in this regard. Estimation of the effect of R&D in the economy, perhaps by sector, or within a CGE model, provides a whole new area of research that has never been done for Egypt.

Table V.1

South Korea: R&D Information/Indicators

	1970	1976	1980	1984
R&D exp (million won)	10,548	60,900	211,726	833,893
Government	7,414	39,461	109,281	178,171
Private	3,023	21,438	102,445	655,722
Government:Private	2.33	1.86	1.08	0.27
GNP (billion won)	2,735	13,273	34,321	65,379
R&D/GNP (%)	0.39	0.46	0.62	1.28
R&D per capita (1000 won)	327	1,699	5,553	20,583
R&D per capita U.S.$	1,032	3,510	8,426	24,888
number of researchers	5,628	11,661	18,434	37,103
number of researchers per 1000 population	0.17	0.33	0.48	0.92
patents	218	568	647	1,123
utilities	1,145	1,115	1,753	2,360
private R&D centers	1	12	54	152
Eng consultant firms	1	127	194	193

Source: Patel 1993 p. 174.

Table V.2

Increase in Private Expenditures on Industrial R&D
Japan, 1970-1979: Selected Industries

Industry	Percentage Increase Between 1970-79
Textiles	135.71
Fabricated Metals	292.86
Machinery	158.33
Electrical Machinery	221.65
Communication & Electronic Appliances	194.62
Motor Vehicles	372.15
Other Transport Equipment	350.00
Precision Machinery	305.30
Other Machinery	269.23
All Manufacturing	221.55
All Industry	223.82

Source: Calculated based on p. 105 in Anderson 1984.

Table V.3

Total Factor Productivity Change:
Selected Engineering Industries,
Egypt, Japan, Korea, & Turkey

(Annual Percentage Change)

	Egypt 1973-79	Japan 1955-73	South Korea 1960-77	Turkey* 1963-76
Iron & Steel	0.65	0.96	1.87	
Basic Metals				0.87
Transport Equipment	4.52	2.53	5.10	3.33
Fabricated Metals & Machinery	0.46	3.14	5.73	
Fabricated Metals		0.84	6.01	1.51
Machinery				1.33
Electrical Machinery	3.81	4.42	7.25	1.83
China & Glass	-0.46	1.73	4.53	
Stone, Clay & Glass				0.26

Note: *This column includes non-Egyptian classifications.
Source: World Bank 1983 p. 235 table 8.4.

Table V.4

Total Factor Productivity Change in Textiles:
An International Comparison

(Annual Percentage Change)

	Egypt (73-79)	Japan (55-73)	Korea (60-77)	Turkey (63-76)	USA (66-73)	Yugoslavia* (65-78)
Textile Mill Products		1.70	4.51	1.44	2.25	-0.17
Cotton Products	-2.0					
Apparel		1.94	1.62	2.74	1.83	
Other Textiles	1.40					

Note: *This column contains non-Egyptian classifications.
Source: World Bank 1983 p. 235.

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LIST OF COMPANIES VISITED

1. Telemasr
2. ERISCOM
3. Steelco and Metalco
4. Nasr Sayyarat
5. Semaf
6. Nasr TV
7. Kablat
8. Koldair
9. Maragel
10. Mikar
11. Sabi
12. EIC, TIC and the Fashion and Design Centre.
13. Ideal