

# **The Policy, Institution and Market Factors in the Development of Taiwan's Textile/Garment Industry**

Lee-in Chen & Kai-Fang Cheng<sup>1</sup>

## **I. Introduction**

Taiwan's economic development during 1960s to 1980s has been recognized as very successful and was hailed as "economic miracle" (Fei, Ranis, Kuo 1978, 1979; Kuo, Ranis and Fei, 1981; Ranis 1992). Taiwan's success story is marked by growth and structural shifts (kuznets, 1979). It is because during this period, Taiwan achieved a long period of averagely 9% annual GDP growth rate along with least income inequality which resulted in this miracle. Government-led macroeconomic reform and industrial policy can be regarded as major factors in achieving such outstanding performance. Textile, garment and electronics sectors were the three most important industries that made the miracle. Even though such outstanding economic performance had slowed down since 1990s, economic growth rates kept 6.30% to 7.85% before Asian financial crisis. After 1997, GDP growth rates fell to between -2.17% to 6.07%. With the rising of electronics and petrochemical industries in late 1980s and 1990s, the share of textile and garment industry in GDP and export is no longer as important.

Many theoretical studies stress that institutions are the fundamental cause of long-run growth (Acemoglu, Johnson and Robinson, 2005); Taxation influences development (Burgess and Stern, 1933); Regulations that influence the vertical integration may cause labor sabotage (Beard, Kaserman and Mayo, 2001). The function of the government is to ensure the integrated operation of all elements of industry policy (Armstrong and Sappington, 2006). Regardless of one country being big or small, when its government adopts a policy of exporting in order to establish one particular industry, complementary macroeconomic measures on international trade, foreign exchange, tax incentives, infrastructure all need to be reformed or newly designed. Industry specific measures also need to be added, revised or innovated periodically. This paper pays special attention on the year of particular policy for achieving such effects.

---

<sup>1</sup> Dr. Lee-in Chen is research fellow, Chung-hua Institution for Economic Research. Dr. Kai-Fang Cheng is Deputy Director, Center of Industrial Economics, Intelligence and Training, Taiwan Textile Research Institute. Correspondence author: [leein@cier.edu.tw](mailto:leein@cier.edu.tw). The data and basic information provided by TTRI is highly appreciated.

Furthermore, industrial policy making can not rule out the principles of industrial economics. For labor-intensive industries, market competition is better than oligopoly or monopoly; Production efficiency can be achieved via scale economy or economy of scope. Taiwan's textile development went through the scale economy of cotton-yarn weaving and then pursuing economy of scope (wool and various artificial fibers). Less developed countries (LDCs) need assess their conditions (including climate, raw materials supply, labor quantity and quality, technology education...etc) in order to achieve sustainable development for their own country.

This paper elaborates above concepts to interpret Taiwan's textile development. Section two excerpts the textile development history in six stages and with some statistical evidence. Section three elaborates the role of government policies, institutions and their effects. Among four sub-sections, policies/measures in fostering many small and medium sized enterprises to achieve competition effect and textile specific policy/regulation and institutes should draw special attention. Textile industry went through the stages of labor surplus to labor shortage. Section four slightly describes the current labor market and types of labor disputes in textile industry. Section five draws conclusions and implications for LDCs.

## **II. Development History of Taiwan's Textile Industry**

Taiwan had been colonized by Japanese government for fifty-one years before 1945. Very few cotton-yarn textile factories and weaving mills existed and most of them were destroyed during World War II. Therefore the development history of textile and garment industry began in 1945.

### **II-1 Recovery stage (1945 – 51)**

Due to the destruction of WWII, Taiwan was left with only two cotton-yarn factories and fourteen weaving mills, and about 800 filament weaving machines. The overall length of cotton cloth produced in 1945 was only some two millions yards. The equipment was out of date; supply could not meet demand and therefore import was huge. To meet basic demand, Taiwan government (then known as Republic of China) encouraged the establishment of new factories. Along with protective measures, such as control of textile imports, the government contracted weaving services, and provided capital and material sources. Due to a high rate of return on investment, the textile industry grew very quickly. Within five years (1948-52), the product volume achieved self-sustaining level (Table 1). It proved to be very helpful to the boom of the industry that several textile companies withdrew from Mainland

China as the ROC government relocated itself to Taiwan in 1949.

Table 1: The Recovery (1945-51) of Cotton-yarn Weaving Industry in Taiwan

| Year | Cotton-yarn<br>(spindle) | Weave Machine<br>(set) | Product Value<br>(NT\$ million) |
|------|--------------------------|------------------------|---------------------------------|
| 1945 | 8268                     | 428                    | -                               |
| 1946 | 10664                    | 794                    | -                               |
| 1947 | 14564                    | 1087                   | -                               |
| 1948 | 18108                    | 1791                   | -                               |
| 1949 | 23787                    | 2557                   | 70.5                            |
| 1950 | 50020                    | 3326                   | 286.0                           |
| 1951 | 98536                    | 5205                   | 620.8                           |

Source: “The Development History of Taiwan Textile Industry”, Special Issue of Taiwan Textile Industry (in Chinese), Commercial Times Publisher, 1952.

The most crucial factor for Taiwan was US aid. During 1951 to 57, US government provided US\$ 230 millions worth of cotton which made up about 20% of total material aid. According to Lin (1994), there were about 200 private weaving mills in 1950. By 1953, the total had increased to 1,228 firms, one-tenth of the total number of private firms at that time, second only to food processing factories and kiln mills.

## II-2 Cotton product development stage (1952 – 61)

The major textile products at this stage were still made from cotton. Three years after withdrawal from mainland China to Taiwan and under with experts from US aid, the ROC government began working on the first four-year national development plan (1952 – 55). The development goal for the textile industry was to support the manufacturing import substitution policy. For the textile industry, the government set the policy slogan “importing yarn is better than importing cloth; importing cotton is better than importing yarn”. With encouragement from various tax incentives, many private firms imported weaving machines and materials. As a result, the textile industry entered a stage of speedy growth. The value of cotton-yarn production value doubled within four years. With further encouragement in the second four-year plan (1956 – 59), which focused on meeting domestic demand and improving quality, the cotton-yarn industry finally gained some export contracts in 1960. Exports grew very quickly (Table 2). Only three years later (1963). Export of cotton-yarn exceeded the domestic demand in 1966.

Another noticeable development during this stage was the first piece of locally produced artificial fibre, by China Man-made Fiber Corporation in 1957. This innovation was intended to develop self-sufficiency of raw materials for the long-term development of textile industry in Taiwan. This innovation proved Taiwan's capability of developing textile industry from end-products to upstream fiber manufacturing. This new artificial fiber was named after "Lai-Chu" (the queen of an ancient empire who had invented the silk production from worms three thousands years ago) to honor the historical achievement.

Table 2: Sales Statistics of Cotton Yarn and Cloth in Taiwan (1956~71)

| Year | Cotton Yarn             |                          |                        | Cotton Cloth           |                         |                       |
|------|-------------------------|--------------------------|------------------------|------------------------|-------------------------|-----------------------|
|      | Prod. Volume<br>(piece) | Domestic Sale<br>(piece) | Export Sale<br>(piece) | Prod. Volume<br>(role) | Domestic Sale<br>(role) | Export Sale<br>(role) |
| 1956 | 133924                  |                          |                        | 2154636                |                         |                       |
| 1957 | 153146                  |                          |                        | 2329038                |                         |                       |
| 1958 | 152782                  |                          |                        | 2070157                |                         |                       |
| 1959 | 162605                  | 82985<br>(51.0%)         |                        | 2173488                | 1906846<br>(87.7%)      |                       |
| 1960 | 188762                  | 89613<br>(47.5%)         | 6288<br>(3.3%)         | 2629374                | 1757041<br>(66.8%)      | 288891<br>(10.9%)     |
| 1961 | 230360                  | 88218<br>(38.3%)         | 35962<br>(15.6%)       | 3364799                | 2200707<br>(65.0%)      | 779948<br>(23.2%)     |
| 1962 | 282073                  | 82308<br>(29.2%)         | 65768<br>(23.3%)       | 4270038                | 1899127<br>(44.5%)      | 228869<br>(5.4%)      |
| 1963 | 255495                  | 67889<br>(26.6%)         | 76244<br>(29.8%)       | 4254934                | 1778418<br>(41.8%)      | 2475657<br>(58.1%)    |
| 1964 | 282344                  | 74307<br>(26.3%)         | 62211<br>(22.0%)       | 48152662               | 1441443<br>(29.9%)      | 3399660<br>(70.6%)    |
| 1965 | 299365                  | 74806<br>(25%)           | 73180<br>(24.4%)       | 4963391                | 1216121<br>(24.5%)      | 3484024<br>(70.2%)    |
| 1966 | 320252                  | 65446<br>(20.4%)         | 97442<br>(30.4%)       | 5587111                | 1385555<br>(24.8%)      | 4407628<br>(78.9%)    |
| 1967 | 407224                  | 71923<br>(17.7%)         | 128310<br>(31.5%)      | 7023286                | 952724<br>(13.5%)       | 6068314<br>(86.4%)    |
| 1968 | 506227                  | 82604<br>(16.3%)         | 132532<br>(26.2%)      | 7476307                | 1164897<br>(15.5%)      | 6862426<br>(91.5%)    |

|      |         |                  |                   |         |                    |                      |
|------|---------|------------------|-------------------|---------|--------------------|----------------------|
| 1969 | 520000  | 91550<br>(17.6%) | 167825<br>(32.3%) | 7750600 | 1262868<br>(16.2%) | 7367757<br>(95.1%)   |
| 1970 | 560000  | 97862<br>(17.5%) | 253759<br>(45.3%) | 9264271 | 1994875<br>(21.2%) | 11752622<br>(126.8%) |
| 1971 | 6008840 | 65209<br>(10.9%) | 370597<br>(61.8%) | 7875189 | 1586633<br>(20.1%) | 10869230<br>(138.0%) |

Source: Chung-ha Lin, A Study of Cotton Textile Industry in Free China (1973)

Note 1: Numbers in parenthesis designating ratio of domestic and export sales. The export share of 1970 and 1971 exceed 100% owing to inventory from previous years.

Note 2: 1 piece cotton-yarn = 400 pounds; 1 role = 40 yard = 36.576 meter

### II-3 Export expansion and emerging product scope (1962 – 71)

The cotton yarn and cloth weaving industries continued growing. Weaving spindle production grew from 430 thousand items in 1962 to 1.25 millions in 1971. The export capability continued to strengthen, which steadily increased the export share of production and transform the cotton textile industry into export oriented sector by early 1970s.

US aid ceased in 1968. This significantly influenced the intra-industry structure of the textile industry. The supply of cotton and capital were suddenly suspended. To cope with this external impact, Taiwan textile manufacturers started to invest in artificial fiber plants so as to diversify resources of raw material. The product assortment diversified to Lai-Chu, nylon and polyester filaments. Various artificial fiber products grew rapidly, laying the foundation of artificial fiber processing industry in Taiwan. The diversification began from China Man-made Fiber Corporation which in 1964 set up a polyester fiber factory with the capacity of producing 250 thousands of polyester filament daily. In the same year, CMFC proposed the second plant for producing polyester staple. Formosa Plastic entered the market and started to produce acrylic staple in 1967. Then many other artificial fiber companies were established. Up to 1970 there were 16 companies producing artificial fibers<sup>2</sup>. Most of the companies were set up with a vision of developing technologies from fiber production backward linked to upper stream technologies such as dyeing, printing, finishing...etc. Such technology integration strategy had laid the foundation of further development of Taiwan's synthetic fiber industry in the 1980s.

On the other hand, because the US government inaugurated import quotas on

---

<sup>2</sup> At this stage artificial fiber mainly represents "Lai-Chu filament". The production of synthetic fiber emerged in later stage.

cotton products, the national four-year development plan started to pursue adding value in industries linked to textiles, and the garment industry began to grow from this stage.

The achievement of textile technology upgrading can be examined by export statistics of artificial fiber and textile products. During this stage the product value of textile products' grew at an average annual rate of 22.7%. The added value share of textile products in all manufacturing industry grew from 16.3% in 1959 to 20.3% in 1972. In the same period, the employment share of the textile industry grew from 22.4% (110 thousands persons) to 28.9% (350 thousands) which made the highest record in the history.

Under above mentioned active private investment and policy-led environment reform (to be analyzed in the next section), Taiwan's textile industry with export expansion performance made significant progress quantitatively and qualitatively. This period was also critical as textile material and components supply chain was formed and the manufacturing division of labor was fostered within the domestic enterprises. Textiles became the most important export industry and source of foreign exchange.

#### **II-4 Growth stage (1972 – 81)**

The industry continued growth led to a great increase in weaving shuttles and open-ended weaving machines, with 3.54 million and 650 thousand spindles respectively in 1981. The market for traditional cotton yarn and cloth became saturated. Artificial fiber became the basis of the second wave of Taiwan's textile industry.

Thanks to flourishing exports, Taiwan's artificial fiber plants expanded to the level of economy scale which reduced the average product cost dramatically. The core technology competence was focusing on the development of synthetic fiber. Among various man-made fibers, nylon and polyester grew most rapidly.

During this stage, the world encountered two energy crises. In 1973, as the price of petrochemical raw materials sky-rocketed, the price of artificial fibers rose accordingly. Since the increase in prices was much greater than the increase in production costs, the profit on artificial fiber at one point reached 40% which led to the over-investment of fiber factories. Within only four years, 12 new plants were built. Up to the end of 1974, it was estimated that Taiwan's artificial fiber production capacity was 1700 kilogram a day, making it number four in the world in production

of artificial fibers. It was over capacity. When the second oil crisis occurred in 1979, the oil price rose more than 60%, which induced the price of artificial fiber to soar again. As the demand of down-stream production did not increase as much, Taiwan's artificial fiber business faced a crisis that eventually led to closures, restructuring and mergers of competing firms.

Textile export quota control and bidding within textile firms was another important issue during this period. In 1961 US enforced the "Short-term Agreement on Cotton Textile Products" on Taiwan, which inaugurated a new era of international import quotas. Thereafter, US government initiated twice the "Long-term Agreement on Cotton Textile Products" with Taiwan in 1962 and 1967. Such quota constraint even applied to wool products in 1971. The European Community followed with a similar import quota in 1970. Until 1974 when the Multi-Fiber Arrangement (MFA) became effective, US, Canada and EC followed those articles and signed bilateral agreements with Taiwan government. By then, the quota had been extended to the export of cotton, artificial fiber, wool, yarn, cloth and garment. The quota constraint applied to various processing levels<sup>3</sup>.

Even though the quota control had become such a sensitive issue, Taiwan government still encourages the export of textile and garment. Garment and accessory exports in particular gradually became Taiwan's core exporting products in this stage, due to market demand, technology and financing. The export value of the textile and garment industry increased from US\$ 1.24 billions (or NT\$ 47.1 billions) in 1973 to US\$ 4.12 billion (or NT\$ 148.3 billion) in 1980. The grow rate reached 215% within seven years.

## **II-5 Maturity and Upgrading of Technology (1982 – 91)**

The 1980s in general were a stable growth period for the world economy. Leading economies strove to recover from the two oil crisis. Taiwan's textile

---

<sup>3</sup> The Taiwan Textile Federation (TTF) was founded on November 25, 1975 in response to a move by the European Economic Community (EEC) to impose import quotas on textile manufacturing countries. These quotas were to be negotiated individually through diplomatic channels. However, Taiwan did not have formal diplomatic relations with the EEC, so the TTF was formed with the guidance and financial support from the government and textile manufacturers to represent Taiwan's textile industry to negotiate with the EEC. Over the years, the TTF has gradually adapted to meet the needs of the textile industry, expanding its functions to market promotion, product design, fashion information analysis, online information, technology training, collection and analysis of market information, certification of functional textiles.

entrepreneurs sought to solidify their technology and market shares. Central government proposed a ten year national development plan (1980-89), and developing textile machinery was identified as one of the major industrial policy. High speed equipments were introduced; no-shuttle weaving machines replaced the traditional ones. Product quality and technology of textile industry were highly upgraded and achieved international competitiveness.

The peak year of Taiwan's textile and garment industry was 1987. The total of textile production (including artificial fibers, weaving and garment) reached NT\$ 559.34 billions and the share of garment was also the highest record, reaching 37%. Afterwards, due to mainland China's high demand for Taiwan's yarn, fiber, and cloth, the export of those two textile materials increased very rapidly, while the share of garments in textile exports dropped steadily. By 2004, the share of artificial fiber increased to 31% and garment dropped to 11%.

In the latter part of this stage, the protectionism of international trade and the rise of newly developed textile countries led to an increase in the international competition. On the other hand, Taiwan faced the pressure of labor shortage, rising wages, and NT dollar appreciation. Some labor-intensive textile firms started to move their factories to southeast Asian countries (at this time investment to mainland China was illegal).

For those remaining in Taiwan, technological breakthrough had become major goal. Although polyester fiber was still the key product, leading firms started to develop polyester filament and nylon staple for possible industrial use. The new R&D focused on hyper-thin fibers. Under the basis of its integrated structure, Taiwan's textile industry had been successfully transformed from labor-intensive type to capital and technology-intensive. The core competence had shifted to artificial fibers and their related weaving products. Taiwan became internationally known as a leading synthetic fiber country.

## **II-6 Transformation, outward investment, and innovation stage (1992 - )**

Due to changes in the external and domestic economic environment, such as labor shortage, NT\$ appreciation, trade liberalization, the rise of new textile producers, division of labor across the Taiwan Strait, the textile industry began losing its comparative advantage on international production in 1990s. Especially the labor-intensive parts of production, which was mainly conducted by small and medium sized enterprises, moved to China so quickly that the original production and supply chain were broken. As shown in Table 3, outward FDI (mainly 1980s, 1990s

up to 2004) of textile firms and garment & footwear firms were only 142 and 155 cases while those indirectly invested to mainland China achieved 1,055 and 554 cases respectively. The contribution of garment industry in Taiwan's manufacture as well as whole economy in recent years has dropped to respectively 1.07% and 0.35% in 2005.

The irreversible trend of competition from low production cost has been the biggest challenges since the mid-1990s. The textile and garment industry is currently encountering following problems:

- (1) Technology breakthrough in various new functional fibers or materials;
- (2) Environmental standards of pollution emission;
- (3) Shortage of testing and verification capacity regarding functional technology and industrial e-commerce infrastructure;
- (4) SMEs lack of financial support for R&D;
- (5) Lack of human resources on R&D and international marketing;
- (6) Lack of an information intelligence and sharing system for international production, marketing, new technology;
- (7) Marketing problems, such as oversupply of artificial fibers, small domestic market, textile materials production overly focused on garments, over pricing competition, and dependence on high price/quality import products.

Losing comparative advantage of labor-intensive types of international production, the textile enterprises remaining in Taiwan, with government assistance on R&D redirection, strove to transform themselves in manufacturers of high value products. In addition to utilizing their existing advantage of upstream artificial fiber links and the scale of economy, the production of middle and down stream products (i.e. yarn, fiber, cloth, clothes) is more focusing on newly developed materials and technologies.

Nowadays global textile market competition can be classified as low labor cost vs. high unit prices and innovation. Taiwan is taking its position as the latter. Firms and the government are moving to research and development of high-value industrial usage and functional textile products. It is expected that the composition of clothing, home decoration and industrial use of textile products will change from 8:1:1 in 2000 to 6:2:2 in 2010. This transformation will need domestic and international collaboration as well as the cross-industry cooperation.

Table 3: Statistics on Approved Inward and Outward FDI

Unit: US\$ million

| Industries                          | Inward FDI<br>(1952-1990) |        |       | Outward FDI<br>(1959-1990) |        |       | Inward FDI<br>(1952-2004) |        |       | Outward FDI<br>(1959-2004) |        |       | Indirect Mainland<br>Investment<br>(1991-2004) |        |       |
|-------------------------------------|---------------------------|--------|-------|----------------------------|--------|-------|---------------------------|--------|-------|----------------------------|--------|-------|--|--------|-------|
|                                     | Case                      | Amount | %     | Case                       | Amount | %     | Case                      | Amount | %     | Case                       | Amount | %     | Case   | Amount | %     |
| Textile                             | 115                       | 247    | 1.86  | 40                         | 103    | 3.35  | 159                       | 608    | 1.00  | 142                        | 895    | 2.13  | 1,055  | 570    | 1.38  |
| Garment &<br>Footwear               | 206                       | 69     | 0.52  | 20                         | 6.32   | 0.21  | 231                       | 225    | 0.37  | 155                        | 309    | 0.73  | 554  | 347    | 0.84  |
| Leather &<br>Fur Products           | 63                        | 23     | 0.17  | 6                          | 3.93   | 0.13  | 75                        | 205    | 0.34  | 25                         | 75     | 1.77  | 1,155  | 831    | 2.02  |
| Chemicals                           | 458                       | 2,217  | 16.73 | 36                         | 573    | 18.62 | 685                       | 4,479  | 7.40  | 470                        | 1,863  | 4.43  | 2,023  | 2,801  | 6.79  |
| Electronics &<br>Electric Appliance | 807                       | 3,135  | 23.66 | 220                        | 718    | 23.32 | 2,326                     | 14,525 | 24.01 | 2,980                      | 7,730  | 18.38 | 6,009  | 14,044 | 34.05 |
| Total                               | 5,773                     | 13,252 | 100   | 873                        | 3,077  | 100   | 17,066                    | 60,495 | 100   | 10,502                     | 42,068 | 100   | 33,155   | 41,249 | 100   |

Source: Statistics on Overseas Chinese & Foreign Investment, Outward Investment, Mainland Investment, published by Investment Commission, Ministry of Economic Affairs, Taiwan (R.O.C.).

Note: \*Due to the different industrial classification, we can not present the exact inward and outward FDI in textile related chemicals. It is estimated about one-tenth of the chemical firms' outward FDI is engaged in artificial fiber production.

WTO ATC textile quotas in the global market were abolished in 2005. Taiwan's textile industry faces more intense competition and challenges. The government encourages textile enterprises to devote themselves to transform "made in Taiwan" into "invented and innovated in Taiwan". The new R&D focuses are on nano-textile, technical, comfort, health, new synthetic textiles, so as the functional and technical textile testing and evaluation skills. Integrating diversified industry wisdom as "teamwork" into the new materials and products is critical.

Due to the drastic outward investment to Mainland China and other LDCs, the output value of Taiwan's textile and garment industry has declined in recent years. As shown in Table 4, the structure of total production value share of artificial fiber, textile and garment/accessories has changed from 21:63:16 in 2000 to 33:57:10 in the first season of 2005. It reflects the losing comparative advantages on labor-intensive production, mainly garment and accessories, and then standardized artificial fiber products. Some newly innovated synthetic fibers are still remaining in Taiwan.

Import and export structure in recent years have drastically changed. With total import value NT\$2,688 millions in 2004, garment shares 50%; synthetic fiber and cloth takes 22% each; gauze 18%; accessories 8%. With total export value NT\$12,539 millions, cloth shares 57%; gauze 18%; artificial fiber and garment 10% each and the accessory 5%. It is obvious that a vertical division of labor in textile and garment industry between domestic and overseas factories is prevailing.

Table 4 The Structure Change of Taiwan's Textile Industry

Unit: NT\$ million

| Year          | Synthetic fiber    | Weaving            | Garments          | Total            |
|---------------|--------------------|--------------------|-------------------|------------------|
| 2000          | 122667<br>(21.21%) | 365930<br>(63.28%) | 89702<br>(15.51%) | 578299           |
| 2001          | 113476             | 318998             | 73040             | 505514           |
| 2002          | 122779             | 307383             | 65803             | 495965           |
| 2003          | 139145             | 291224             | 62890             | 493259           |
| 2004          | 161286             | 306905             | 58745             | 526936           |
| 2005<br>(1-3) | 37453<br>(32.6%)   | 65872<br>(57.34%)  | 11551<br>(10.06%) | 114876<br>(100%) |

Source: Industry Production Statistics Monthly, MOEA; cited from IT IS projects, TTRI.

### **III. The Role of Policy and Institution and Their Effects**

The Taiwan government adopted policies in each different stage to provide a suitable business environment for the development of manufacturing industry. Among them, one of the most important was fostering the growth of small and medium sized-enterprises. Industrial-specific policies to respond to internal and external environmental changes were also crucial. This section elaborates those policies and provides some statistical evidence on the impact.

#### **III-1 The Investment Friendly Taxation and Environment**

Taiwan is well known not only for textile exports. Textile products were the number one export value up to 1984. Electronics and electric machinery together has become Taiwan's top export industry (although textiles remain most important source for earning foreign exchanges because its export does not rely on import materials and components). Such export friendly investment environment should contribute to the correct and timely regulation or reform from an agriculture-based economy into an industrialized one.

The first important administrative action taken was tax exemption for export goods in 1954. To encourage export goods to be produced with local materials and thus save foreign exchange, the government regulated low interest rate loans for export firms and implemented high import tax. To protect the infant domestic industries, the average import tax rate of industrial products was 46% in 1957<sup>4</sup>.

Two critical reform packages, (1) trade and foreign exchange system, and (2) 19 articles of economic and finance reform were passed in 1958 and 1959, respectively. Foreign direct investment began. In the following years, "Statute for Promoting Investment" (1960), tax-exempt warehouse /factory system (1962), "Statute for Developing and Managing Export Processing Zones" (1964) were promulgated or established. Those national plans and actions did foster a promising investment environment for foreign and domestic investors.

The policy slogan in the 1970s was "the second phase of import substitution and steady export expansion". For promoting export, China External Trade Development Council was set up in 1970. For deepening the manufacturing R&D, Industrial Technology Research Institute was established in Hsin-Chu County in 1974. To

---

<sup>4</sup> This is a policy applying to all industries at that time.

promote high-tech industries, Hsin-Chu Science Park was established in 1980 and “Statute of Promoting Industry Upgrading” was enacted in 1991. Those economic policies and their revision helped businesses to grow larger and entrepreneurs to run them more professionally.

### **III -2 Development of small and medium sized enterprises**

One profound influence on the economic structure of Taiwan has been the Statute of Developing Small and Medium-sized Enterprises (enacted in 1991). It deserves a special illustration and analysis.

From the very beginning of economic development, the government paid attention to maintaining an SME-friendly macroeconomic environment. Major strategies were set up to assist their capital and material supply. Certain amounts of bank loan were designated for SMEs only. Therefore the definition of SMEs has been an important evolving standard along with the growing economy. Appendix I illustrated the evolving definition of SMEs in Taiwan since 1967. It is noticeable that starting 1973 the definition of SMEs for garments, clothing and electronics industry has required the highest regular employee standard – with companies employing under 300 persons. This is due to the labor-intensive nature of manufacturing in the production line. Labor standard was reduced to “not exceed 200 persons” in 1995 which designated an event that Taiwan enters the stage of capital and technology intensive age of manufacturing. As to the definition for paid-in capital, it was changed from NT\$ 5 million in 1967, to NT\$ 20 million in 1977, to NT\$ 40 million in 1982, to NT\$ 80 million in 2000. Such an evolving process illustrated the capital growing capability of SMEs in development process.

Under such regime, textile industry has become one of the most enriched fields for SMEs. As Table 5 illustrates, the small and medium sized firms take 98.81% of total textile enterprises; 55.68% of export and 58.53% of total sales value in 2005. The share of SMEs in various statistic indicators of manufacturing is decreasing. This is the impact of globalization and the innovation age. For maintaining such unique economic structure, Taiwan government currently encourages SMEs involved into the development of tertiary sectors, such as trade, logistics, knowledge management and service industries, especially those serving manufacturing.

Table 5: Taiwan’s garment industrial structure by firm scale

| year            | Number of enterprises | Export sales value<br>(NT\$ million) | Sales value |
|-----------------|-----------------------|--------------------------------------|-------------|
| <b>2001</b>     |                       |                                      |             |
| Total           | 4,801                 | 58,905                               | 139,565     |
| Big enterprises | 50                    | 21,862                               | 49,762      |
| SMEs            | 4,751                 | 37,043                               | 89,803      |
| Share of SMEs   | 98.96                 | 62.89                                | 64.34       |
| <b>2002</b>     |                       |                                      |             |
| Total           | 4,568                 | 56,038                               | 126,754     |
| Big enterprises | 69                    | 22,626                               | 43,414      |
| SMEs            | 4,499                 | 33,412                               | 83,340      |
| Share of SMEs   | 98.49                 | 59.62                                | 65.75       |
| <b>2003</b>     |                       |                                      |             |
| Total           | 4,400                 | 52,951                               | 124,954     |
| Big enterprises | 53                    | 20,835                               | 45,197      |
| SMEs            | 4347                  | 32,115                               | 79,757      |
| Share of SMEs   | 98.80                 | 60.65                                | 63.83       |
| <b>2004</b>     |                       |                                      |             |
| Total           | 4,386                 | 51,807                               | 127,751     |
| Big enterprises | 55                    | 21,930                               | 51,025      |
| SMEs            | 4,331                 | 29,877                               | 76,726      |
| Share of SMEs   | 98.75                 | 57.67                                | 60.06       |
| <b>2005</b>     |                       |                                      |             |
| Total           | 4,382                 | 45,021                               | 119,960     |
| Big enterprises | 52                    | 19,951                               | 49,743      |
| SMEs            | 4,330                 | 25,070                               | 70,217      |
| Share of SMEs   | 98.81                 | 55.68                                | 58.53       |

Source: calculated from White paper of SMEs, MOEA, 2006.

In the 21st century, with an increasingly fierce economic environment domestically and internationally, the government has encouraged SMEs to concentrate on five areas so as to retain their vitality (White paper on Small and Medium Enterprises in Taiwan, 2002):

1. Achieving product segmentation with mainland China in terms of quality and price;
2. e-enablement of government resources<sup>5</sup>;
3. Enhancing competitiveness through public and private sector resource integration;
4. Development of local industries;
5. Keeping a close eye on developments in e-commerce;

---

<sup>5</sup> "e-enablement of government resources" means government encourages SMEs to conduct e-commerce or e-management in their companies so that they can utilize many government resources via internet services providing by various departments of central or local government. As Taiwan is the leading country in e-government, many import, export custom procedure or tax filing can be done electronically. This is an overall policy for SMEs after 2002.

### **III -3 Textile specific policy/regulation and institutes**

To encourage export of textile industry, the Ministry of Economic Affairs regulated several administration measures to help the textile firms in the 1960s, such as the “Cotton-weaving Improvement and Cooperation Program”, “Tax Refund Regulation for Export Goods”, “Textile Export Quota Distribution Schemes” and “Program for Speeding Textile Industry Improvement” etc. Professional textile experts entered the government sector (mainly Ministry of Economic Affairs) to help draft regulations for various issues and a long-term plan that were an important backup for textile development in Taiwan.

Besides industry-specific regulations, the government also set up two important institutions to deal with textile related issues. One is the Taiwan Textile Federation, in charge of quota distribution and marketing tasks (daily administration and short-term functions). The other is an institution for long-term growth and development planning purpose.

The organization now named the Taiwan Textile Research Institute (TTRI) originally developed from the technical department of Taiwan Cotton Spinners Association and was separated from TCSA and became an independent organization named Taiwan Textile Testing Center in December 1959. In June 1971, it was renamed the China Textile Testing and Research Center. The emphasis was on quality control, testing and certification. From 1980 onwards, more emphasis was put on research and development of textile processing. CTTRC was restructured and renamed the China Textile Institute in October 1989. CTI took the major role of technical R&D projects and technical guidance authorized by MOEA. This was done in order to serve the textile industry and promote industry-upgrade. The major R&D tasks after 2000 stress the use of R&D technology in producing technical, functional, and comfortable textiles and further concentration on promoting industrial services. The CTI was given its current name TTRI in September 2004 so as to discrete the confusion of textile institute of China on international occasions.

Among TTRI’s various functions, it is worth mentioning the technology services: technical guidance and talent training, testing and certification services, and industrial services. Those services can be provided to less developed countries while levying charges. Taking talent training as examples, there are five categories for training courses:

- 1) Apparel and home textiles development technology.

- 2) Technical textiles development technology.
- 3) Key manufacturing technology.
- 4) Textile evaluation and testing technology.
- 5) High textile technology.

On May 15, 2006, after nine years of planning, the first subsidiary institute of TTRI was inaugurated in Yuen-Lin County to serve the textile enterprises in Southern Taiwan. The whole Institute is now aiming to achieve one of the most important international textile R&D and technical service institutes, especially for Asian countries.

For R&D on raw materials and yarn formation and products development, TTRI stresses the following new areas in near future: Far infrared textile, Anti-static textile, UV-Cut textile, Electromagnetic shielding textile, Anti-bacterial and fungi textile, Anti-Mite textile, Nano-Textile.

The critical factor that influenced the successful technology upgrading and expansion of textile and garment industries was the goal of expanding product scope and related professional skill training education system in 1960s and 1970s. Being a country that lacks natural resources, Taiwan government and business leaders pay great attention on technology education. Following the first man-made fiber by CMFC in 1964, five technology senior high schools or colleges was established and have department of textile. Those schools focus on technology learning and innovation ability on various technology/knowledge through education systems laid the foundation of Taiwan's various export-oriented industries in 1980s which also benefited the demand of new textile materials and machinery.

### **III -4 Development of complementary industries**

Inter-industrial collaboration in developing Taiwan's textile related materials and products has been a significant features. During the 1960s, the first locally produced sewing-machine was made. However textile machine still had to be imported; at that time the machinery industry tried to produce some textile machine components needed for urgent repairs. In the 1970s, Taiwan started the production of simple tool-making machine. Gradually the whole set of complicated tool-making machine and textile machines were developed in 1980s and then entered the level of precision instruments and machinery in 1990s.

Such important complementary machine technology proved to be very helpful

for the innovation and development of those high-tech textile materials and products from the late 1990s up to now. As shown in Figure 1, Taiwan's textile technology had been developed following the line of market demand: cotton and wool weaving skill in 1960s; synthetic fiber technology in 1970s; filament take-off in 1980s; high-speed filament, hyper-thin fiber in 1990s; 2000 and after, multiple function materials, nano technology, instant response and function design techniques are now developing.

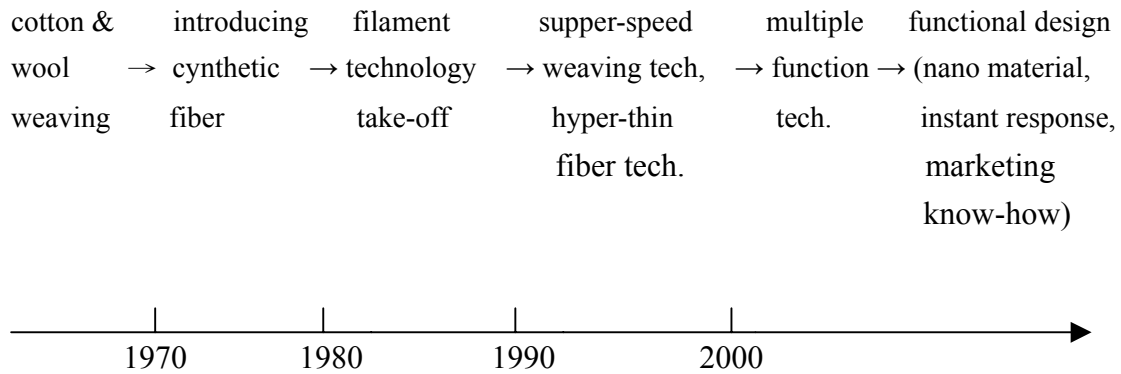


Figure 1 Technology Development Trend of Taiwan's Textile Industry  
 Source: Hsie-Tang Chiu, Strategic Planning Report for Textile Field (2003).

#### IV. Labor Market

A Labor Standards Law was promulgated in 1984 and the Council of Labor Affairs established in 1987. Taking care of labor affairs and movement gradually came onto the administrative agenda of Taiwan government.

##### IV-1 Work hours and wages

Taiwan's comparative advantage in manufacturing is seen to lie in instant response to client's orders. The famous model of "just in time" production needs a highly cooperative labor management system so as wage/salary payment. Earnings of employees normally can be divided into "regular monthly wage" plus "overtime wages" or "performance bonus". In the manufacturing sector, regular monthly wages normally are as high as about 80% of total monthly earnings. If services and other industries are included, the proportion is about 82%. This reflects the fact that wage/salary system for manufacturing labors is more flexible. Besides, working hours are also different from industry to industry.

“The lower the skill level, the lower the earnings” is the iron rule of the labor market. In the labor-intensive textile and garment industries, workers work longer hours while earning less. In 2004, the average monthly work for textile workers was 192.9 hours and average earnings NT\$30,943. For the manufacturing sector as a whole, work averaged 183.5 hours and earnings averaged NT\$40,611. It means textile workers working 9.4 more hours nonetheless earning only 76.2% of the wage of average workers in the manufacturing sector. If the statistics include workers in construction and service sectors, the average monthly earnings go up to NT\$43,021. Textile and garment workers earn only 71.9% of them. However this is still 1.95 times of minimum wage (NT\$15,840 since 1997).

Table 6: The Firm and Labor Statistics of Textile & Garment Industry in Taiwan

| Year | No. of Firms | Employees (thousand) | Average Monthly Work Hours | Average monthly earnings (NT\$) | Labor turn over ratio |      |
|------|--------------|----------------------|----------------------------|---------------------------------|-----------------------|------|
|      |              |                      |                            |                                 | Enter                 | Exit |
| 2000 | 7,301        | 238.49               | 202.7                      | 29,490                          | 1.60                  | 2.03 |
| 2001 | 7,090        | 218.03               | 190.1                      | 29,160                          | 1.19                  | 1.94 |
| 2002 | 7,101        | 205.33               | 190.6                      | 29,708                          | 1.60                  | 1.78 |
| 2003 | 6,924        | 198.05               | 190.7                      | 29,987                          | 1.40                  | 1.60 |
| 2004 | 6,062        | 193.40               | 192.9                      | 30,943                          | 1.24                  | 1.45 |

Source: 1. Domestic & Foreign Express Report of Economic Statistics Indicators.

2. Monthly Bulletin of Earnings and Productivity Statistics, Directorate-General of Budget, Accounting and Statistics, Executive Yuen, Republic of China.

#### IV-2 Labor unions and incidences

There are now 4,093 labor unions in Taiwan, of which 1,109 (27%) are industrial (with 593,907 members) and 3,024 (73%) are occupational (with 2,370,704 members)<sup>6</sup>. Assuming that each worker is a member of only one union at a time, then the union participation rate of total employed workers (9,942 thousand persons by the end of 2004) is nearly 30%. Among the industrial unions, manufacturing unions are 795 (71.9%).<sup>7</sup> and then transportation, warehousing and telecommunications shares

<sup>6</sup> The total proportion of the top 3 categories of labor disputes is more than 102% because some disputes have more than one cause. The remaining 8 categories vary from 1.5% to 5% respectively.

<sup>7</sup> The next three important unions are transportation, warehousing and telecommunications which add up 10.5% (116 unions) of 1,109 total industrial unions. There is subcategory statistics below manufacturing for study.

10.5% (116 unions). Among occupational unions, technicians and related workers have 994 unions (32.9%); service and sales persons 596 (19.7%); unskill workers and laborers 362 (12%).

As to union incidences, the reported cases had been decreasing in recent years: 14,017 cases in 2002; 12,204 cases in 2003; 10,838 cases in 2004. In 11 categories of employee vs. company disputes, wages disputes (48.8%), contract disputes (44.76%) and disputes related to accidents at work (8.5%) are the top three causes. The other causes such as retirement, labor insurance, management, work hours, welfare premium, union, job discrimination are about 150 to 500 cases per year. The number of several new types of disputes which can not be categorized and classified as others is rising. In 2004, other disputes are 1,241 cases. According to officials who deal with labor disputes, workers in textile and garment industries are less involved in union activism than others. The peak period of union activity was from 1987 to 1989 when many factories closed down and moved to China or other foreign countries. The annual statistics report of Council of Labor Affairs reported the labor disputes of textile and garment industry as follows (unit: cases):

|      | Textile | Garments | Electronics |
|------|---------|----------|-------------|
| 1989 | 139     | 85       | 155         |
| 1990 | 124     | 100      | 160         |
| 1991 | 76      | 62       | 188         |

## V. Conclusion and Implications

The development of Taiwan's textile and garment industry can be identified as six stages: recovery (1945-51), cotton product development (1952-61), export expanding and product scope emerging (1962-71), growth (1972-81), maturation and technology upgrading (1982-91), transformation, outward investment, and innovation (1992 up to now).

During the process of economic development, in addition to SME's entrepreneurship of high self-esteem, government official's professional and administrative ability in regulating and manage economic and trade affairs is also crucial. This paper points out the importance of regulating investment friendly environment: (1) tax and financial reform regimes for better macroeconomic environment, (2) Bank loan, land and labor supply market for SME so as to foster their ability on trade, investment and labor management, (3) industry-specific

policy/measures and institutes, (4) development of complementary industries in different stages. Other precious lessons excerpt from the development of Taiwan's textile and garment industries is that those policies should be equally applicable to local and foreign companies. Many LDC governments forget to provide a comparable SME-friendly macro-environment for their local firms. They think planning and developing economic special zones to attract FDI will automatically lead to industrial development and sustainable economic development. It is wrong. Taiwan fostered so many successful SMEs along the path of attracting FDI which led to vast outward investment to China and other developing countries.

Drawing from Taiwan's experience, a sustainable economic and industrial development is attained by governments that take greater care to foster the policy and institutional reinforcement of market economy. Many other important issues, such as school education on hard working attitude (work ethics), professional education on skill building and quality control, open financial market for SME friendly etc, take other papers for elaboration.

After two decades of global division of labor in manufacturing industries, current international textile and garment market have changed dramatically. The textile manufacturing supply chain is globalizing. Regional synergies (e.g. AGOA and AFTA) may influence the decision of development partners and supply chain network of one country. However there is one important government function in the development process always deserving great effort: to review industrial policies and institutions in its entirety whenever a major component of industrial environment is altered substantially. The appropriate choice or combination of different regimes can vary with the relevant technological and demand conditions, with the skills and resources, with the efficiency of tax systems and capital markets, and with the strength of other prevailing institutions.

## Reference

1. Acemoglu, D, S. Johnson, and J. Robinson "Institutions as the Fundamental Cause of Long-Run Growth," in *Handbook of Economic Growth, Vol 1A*. Philippe Aghion and Steven Durlauf, eds. Amsterdam: North-Holland, 385-472.
2. Akamatsu, K. "A Historical Pattern of Economic Growth in Developing

- Countries”, *Developing Economics*, 1 (1962).
3. Armstrong M. and D.E. M. Sappington “Regulation, Competition, and Liberalization”, *Journal of Economic Literature*, Vol. 44(2) 325-366 (2006).
  4. Beard, T. R., D. L. Kaserman, and J. W. Mayo “Regulation, Vertical Integration and Sabotage,” *Journal of Industrial Economics*, 49(3) 319-333 (2001).
  5. Burgess, R., and N. Stern “Taxation and Development,” *Journal of Economic Literature*, 31(2) 762-830 (1993)
  6. CEPD *Sector Development Plan for Taiwan’s Textile Industry (1980 to 1989)* (in Chinese), Council for Economic Planning and Development, Executive Yuen, pp.197 – 198 (1980).
  7. Chieh, Ming-Juan *The Development of Taiwan’s Machinery Industry* (in Chinese), National Policy Report, NPR Foundation (2002).
  8. Chiu Chen, Lee-in “The Economic reunion of Taiwan and the Mainland China – The Impact on Industrial Development” *CIER Discussion Paper* 9203, (1992).
  9. Chiu Chen, Lee-in “Economic and Political Interaction across the Taiwan Strait Facing the Trend of Economic Integration in East Asia” *KIEP CNAEC Research Series* 04-05 (2004).
  10. Chiu, Hsien-Tong *Strategic Planning Report for Textile Field* (in Chinese) (2003).
  11. Chow, Shien-Wen *Taiwan Economic History* (in Chinese), Kai- Ming Book Publisher, Taipei, pp. 530-569 (1980).
  12. Fei, JCH Gustav Ranis, SWY Kuo “The Growth and the Family Distribution of Income by Factor Components”, *The Quarterly Journal of Economics* 50 (1978).
  13. Fei, JCH G Ranis, SWY Kuo *Growth with Equity: The Taiwan Case*, World Bank, Oxford University Press (1979).
  14. Galenson, Walter (ed.) *Economic Growth and Structural Change in Taiwan*, Cornell University Press (1979).
  15. Henisz, Witold J. “The Institutional Environment for Economic Growth,” *Economics and Politics* 12(1) 1-31 (2000).
  16. Kuo, Shirley G Ranis, J Fei *The Taiwan Success Story*, Westview Press, Bolder, Colorado (1981).
  17. Kuznets, Simon “Growth and Structural Shifts”, in *Economic Growth and Structural Changes in Taiwan: The Postwar Experience of the Republic of China*, edited by Walter Galenson, Ithaca, N.Y. and London: Cornell University Press, 1979.
  18. Lin, Chung-Hwa *A Study of Cotton Textile Industry in Free China* (in Chinese), Tai-Chung, pp. 5 – 20, 1978.
  19. Meier Gerald M. & James E. Rauch *Leading Issues in Economic Development* (7<sup>th</sup> edition), Oxford University Press (2000).

20. Ranis, Gustav (ed.) *Taiwan: From Developing to Mature Economy*, Westview Press (1992).
21. SMEA *White Paper on small and Medium Enterprises in Taiwan*, Small and Medium Enterprise Administration & Chung-hua Institution for Economic Research, 2002.
22. SMEA *White Paper on small and Medium Enterprises in Taiwan*, Small and Medium Enterprise Administration & Chung-hua Institution for Economic Research, 2005.
23. TTRI “New Ideas in Technology, New Future of Textiles” (2005).
24. Lee, P., C. T. Lu, H. H. Lee *Special Issue of Taiwan’s Textile Industry* (in Chinese), Commercial Times Inc., Taipei, pp. 1-3 (1952).
25. Lin, Chung-Zhen “The Study on Textile Development Policy in Taiwan”, National Science Council (830301H001036) (1994).
26. Lin, Bun-Hsung “A Study on the Development of Cotton Textile Industry in Taiwan”, *Bank of Taiwan Quarterly*, 21:1 pp. 111-137 (1970).
27. Ying, Tsung-Jung “A Decade of US Aid and Taiwan’s Economic Development”, *Bank of Taiwan Quarterly*, 12:1, pp.71 (1961).
28. Wong, J. R. *How we created economic miracle*, Reading Times Publisher, Taipei, p. 25 (1978).
29. Chang, Mao-Hsio “The Development of Taiwan’s Textile Industry”, *Bank of Taiwan Quarterly*, 33:4 pp.30-46 (1982).
30. Chow, Chia-Ming “The Prospect and Current Situation of Taiwan’s Chemistry Fiber Industry”, *Bank of Taiwan Quarterly*, 32:2 pp.1-18 (1981).
31. Porter, M. E. *Competition in Global Industries*, Boston, Harvard Business School Press (1986).
32. Suzuki, K. “Changing Flying Geese: Measuring Structural Change in East Asia with Asian International Input-Output Table”, Stockholm School of Economics, Sweden, Working Paper 172 (2003).
33. Dowling, M. and C. T. Cheng “Shifting Comparative Advantage in Asia: New Tests of the “flying geese” model”, *Journal of Asian Economics*, 11 pp. 443-463 (2000).

## Appendix I The Evolving Definition of SMEs in Taiwan

| Industry          | Manufacturing  | Construc-<br>tion | Mining &<br>quarrying   | Commerce, transportation<br>services and other services  |
|-------------------|--|-------------------|---|--|
| September<br>1967 | Capital under NT\$ 5 million; and regular employees under 100 persons.   |                   |   | Annual operating revenue under NT\$ 5 million; and regular employees under 50 persons.   |
| March<br>1973     | Registered capital under NT\$ 5 million and total assets not exceeding NT\$ 200 millions, or registered capital under NT\$ 5 million and the number of regular employees in accordance with the standards as below:(1) under 300 persons for garments, clothing and electronics industry; (2) under 200 persons for food products industry; (3)under 100 persons for others. |                   |   | No change.   |
| August<br>1977    | Paid-in capital under NT\$20 million and total assets amount not exceed NT\$60 million, and the number of regular employees not exceed 300 persons.  |                   | Paid-in capital under NT\$20 million and the number of regular employees not exceed 50 persons. | Annual operating revenue under NT\$ 20 million; and regular employees under 50 persons.  |
| February<br>1979  | No change.   |                   | Paid-in capital under NT\$40 Million.   | No change.   |
| July<br>1982      | Paid-in capital under NT\$40 million and total assets amount not exceed NT\$120 million  |                   | No change.  | Annual operating revenue under NT\$ 40 million.  |
| November<br>1991  | No change, except for extending industry terms into construction.  |                   | No change   | No change  |
| September<br>1995 | Paid-in capital under NT\$60 million; or regular employees not exceed 200 persons.   |                   |   | Total operating revenue in the proceeding year not exceeds NT\$80 million; or its regular employees not exceed 50 persons(extending industry terms to agriculture).  |
| May<br>2000       | Paid-in capital not exceed NT\$ 80 million;<br>Or regular employees not exceed 200 persons.  |                   |   | Total operating revenue in the proceeding year not exceed NT\$ 100 million; or its regular employees not exceed 50 persons(extending industry terms to agriculture). |

Source: Small and Medium enterprise Administration, Ministry of Economic Affairs.

## Appendix II: One day in-house training course suggested by TTRI

Date: 14th. September 2005

| Timing        | Content   | Lecturers      |
|---------------|---|----------------|
| 14th Sept.    |   |                |
| 09:30-10:30   | New Era of Global Textile Industries  | Dr. S. F. Chiu |
| 10:30-11:00   | Tea Break   |                |
| 11:00-12:00   | Technology – Applications of Nano – technology for textiles (Including Sports and cause wear) | Dr. W. T. Chen |
| 12:00-13:30   | Lunch Break   |                |
| 14:00-15:00   | Technology – Development of Technical textiles(including Mobtech and Buildtech)               | Mr. Y. P. Shih |
| 15:00-15:30   | Tea Break   |                |
| 15:30 – 16:30 | R&D Activities – Taiwan Textile Research Institute  | Dr. S. F. Chiu |

### 2. Course fee included

2.1 Lecture Payment ( US\$ 500 each topic (one hour)): 4 topics x US\$500 per topic = US\$ 2000

2.2 Flight fee for 3 lecturers : US\$ 800 per lecturer x 3 = US\$ 2400

2.3 Daily expense for three lecturers = US\$ 100 x 3 lecturers x 3 days = US\$ 900

(We do expect to arrive on 13<sup>th</sup> and leave on 15<sup>th</sup>.September

→ Total course fee = US\$ 2000 + US\$ 2400 + US\$ 900 = US\$ 5300

\*Two-days hotel fee and local transportation for three lecturers is paid directly by THTI