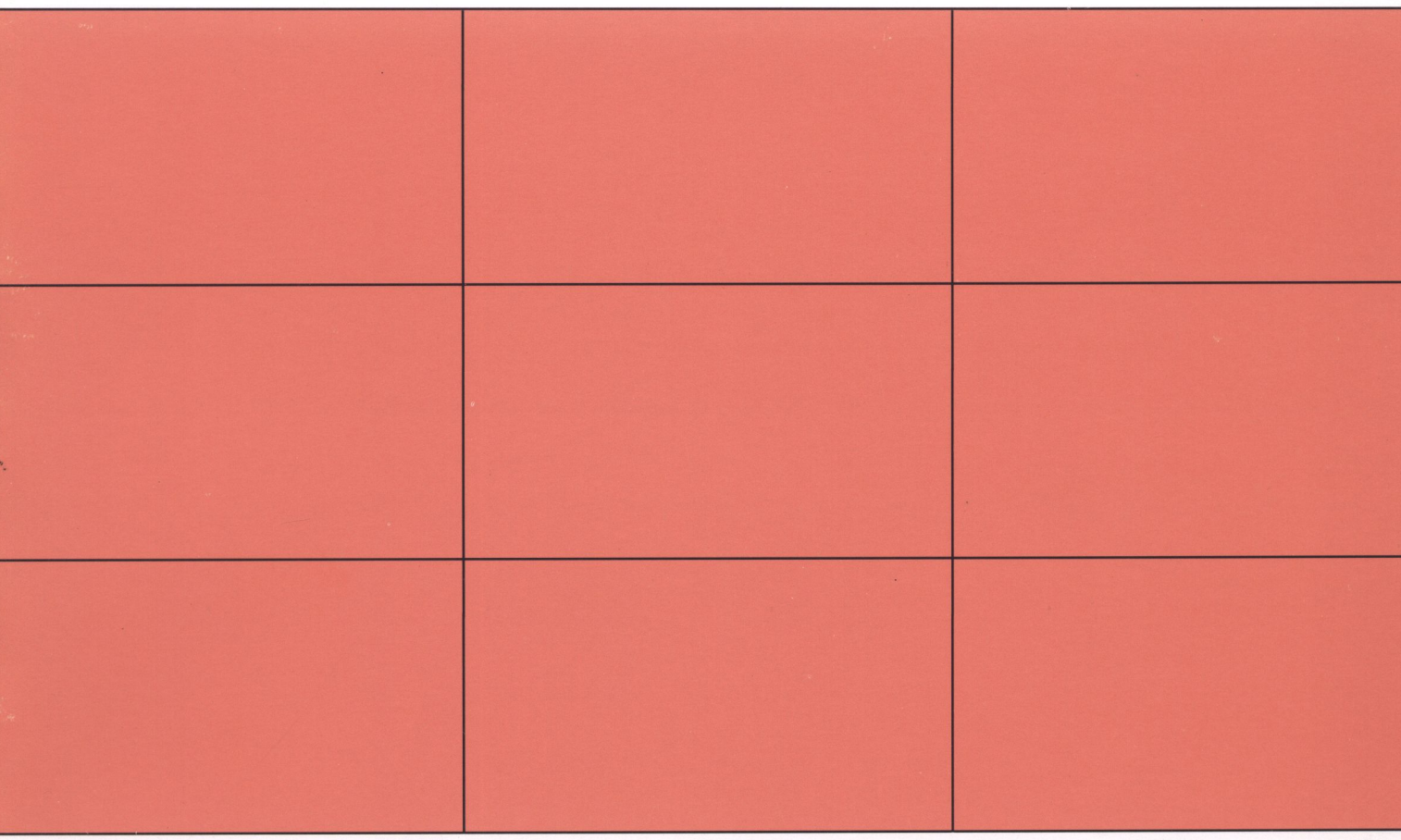
Second Phase Import Substitution in Thailand



SECOND PHASE IMPORT SUBSTITUTION IN THAILAND

Presented to

Asian and Pacific Development Centre

by

Dr. Paitoon Wiboonchutikula

February, 1987

Industry, Trade and International Economic Relations Program

THAILAND DEVELOPMENT RESEARCH INSTITUTE

Bangkok, Thailand

CONTENTS

LIST OF TABLES

SECOND PHASE IMPORT SUBSTITUTION IN THAILAND

Since the late 1970s the government has started to promote and protect more import substituting industries. Due to this trend, three new import substituting industries have been selected for study, namely agricultural machinery, diesel engines, and petrochemical products. The paper begins with a brief synopsis of the stages of industrialization in Thailand, and then traces the development of the chemical and chemical products, nonelectrical machinery, and transport equipment industries. Each of the new import substituting industries is then analysed separately and problems and prospects for import substitution and ASEAN cooperation are given.

1. STAGES OF INDUSTRIALIZATION IN THAILAND

Three decades ago Thailand was virtually a monocrop rural economy. Rice was the only major production and export of the country. Industrialization started in the late 1950s, and the 1960s saw the first significant structural changes in the economy. During this period the manufacturing sector grew much more rapidly than the agricultural sector and its share in GDP more than doubled. There was a policy at that time to promote products substituting for imports. Under this policy, domestic production of a number of consumer goods was protected by tariffs and other promotional measures. The industries under protection in this period included: beverages, tobacco, textiles and textile products, chemical products, and transport equipment. The tariffs were high in these industries, but low in the imports of raw materials and capital goods used for the production of these industries. Since most of these import substituting industries were capital intensive, the protection structure in the 1960s also entailed the high growth of the import of capital goods.

In the early 1970s, the industrialization policy was changed to promote industries producing products to be exported. The promotional measures were rebates on import duties and taxes on imported inputs used in production for export, loans at subsidized rates to exporters provided by the Bank of Thailand (BOT), and additional privileges to promoted firms producing exports. The promoted industries were either natural resource based or labor-intensive, and included the sugar, tapioca, canned fruits and food, textile, clothing, shoes, and a few miscellaneous industries. The growth of these industries could utilize more of the country's abundant resources, such as agricultural products and unskilled labor, and less of the imported capital goods. This period also saw a declining share of consumer goods and an increasing share in imports of intermediate products. Meanwhile, manufactured exports grew vary rapidly from 25 percent in total exports in 1970 to 65 percent in 1980.

In the late 1970s there was another shift in industrial policy. While the policy to promote exporting industries continued, the protection for some import substituting industries was revised. Consequently, since 1979, industries with high growth and increasing shares in total production have included both exporting and import substituting industries. The latter industries were mainly manufacturers of chemical products, machinery, and transport equipment. In early the 1980s, after the discovery of natural gas in the Gulf of Thailand, a large-scale industrial development plan under the Eastern Seaboard Project was also initiated. The project was proposed to develop some natural gas based industries such as fertilizers and petro-chemical products. It was expected that these capital intensive projects would be able to fully utilize domestic resources for the production of these import substituting goods. Initially, the project will induce the import of a large amount of capital goods and some intermediate products used for production. The surplus for export will not be realized until the next decade.1/

It thus seems that Thailand has gone through several different stages of industrial development. For instance, there was a rapid agricultural export expansion after World War II. The first industrial policy of import substitution occurred from 1960 to 1972. Most of 1970s have been spent in export promotion. An attempt to promote some heavy industries producing intermediate and capital goods along with the continuation of the export promotion policy emerged in the late 1970s.

It is this last period, from the 1970s onward called the secondary import substitution period, that will be the focus of this paper. This paper will attempt to explore the characteristics, the problems, and prospects of some heavy industries under government promotion and ASEAN cooperation during this time.

2. DEVELOPMENT OF THREE IMPORT-SUBSTITUTING INDUSTRIES

There are three industries whose imports were large, but domestic production also grew rapidly to replace the imports. These are the chemical and chemical products, nonelectrical machinery, and transport equipment industries.2/ Table 1 shows the development of the three industries in terms of production, imports, and exports from 1970 to 1984.

Despite the above average growth rates of these industries, the relative size of each industry in total manufacturing value-added was still small. In 1984 the share in total manufacturing value-added ranged from 1.5 percent in the nonelectrical machinery industry to about 12 percent in the transport equipment industry, and the total share of all the three industries was less than 20 percent.3/ During the 1970 and 1984 period, the industry which shows the greatest rate of growth

Table 1

Development of Three Import Substituting Industries, 1970-1984

(Per cent)

Share in Total Manufacturing (1)	1970	1975	1979	1980	1981	1982	1983	1984
1. Chemical and Chemical products	6.4	5.4	6.3	6.8	6.9	7.4	7.6	7.7
2. Nonelectrical machinery	2.0	1.5	1.3	1.2	1.2	1.4	1.5	1.5
3. Transport equipment	4.9	6.8	8.4	8.5	9.0	9.0	10.9	11.6

Growth Rates (1)	1970-84	1970-75	1975-80	1980-84
1. Chemical and Chemical products	10.7	5.9	18.6	7.0
2. Nonelectrical machinery	7.7	2.7	11.8	8.9
3. Transport equipment	13.0	14.0	13.8	10.7
Total Manufacturing	8.5	9.1	10.0	6.0

Share in Total Imports (2)	1970	1975	1979	1980	1981	1982	1983	1984
1. Chemical and Chemical products	13.0	13.7	14.9	11.6	12.2	12.6	13.4	12.9
2. Nonelectrical machinery	17.5	17.9	12.8	10.6	11.8	10.8	14.0	14.3
3. Transport equipment	11.9	13.3	7.7	8.3	9.0	9.3	7.0	7.4

Share in Total Exports (2)	1970	1975	1979	1980	1981	1982	1983	1984
1. Chemical and Chemical products	0.2	0.5	0.7	0.7	0.8	0.8	1.1	1.3
2. Nonelectrical machinery	0.1	0.2	0.3	0.4	0.4	0.4	0.6	1.1
3. Transport equipment	0.1	0.5	0.2	0.2	0.2	0.2	0.2	0.2

Self-Sufficiency Ratios (%)*	1970	1975	1979	1980	1981	1982	1983	1984
1. Chemical and Chemical products	45.9	43.2	42.7	48.9	49.6	53.5	49.8	52.2
2. Nonelectrical machinery	13.8	10.3	11.5	12.0	11.5	16.0	12.2	14.1
3. Transport equipment	40.8	46.7	65.0	61.5	62.4	65.5	72.6	71.1

Potential Nominal Rates of Protection (3)	1971	1974	1979	1983
1. Chemical and Chemical products	28-95	15-95	23-96	0-80
2. Nonelectrical machinery	5-16	5-13	0-9	2-30
3. Transport equipment	38-91	40-103	30-150	40-150

Potential Effective Rates of Protection (3)	1971	1974	1979	1983
1. Chemical and Chemical products	33-1,360	17-322	31-334	-17-566
2. Nonelectrical machinery	5-6	4-7	-57-6	19
3. Transport equipment	125-201	147-219	38-1,706	371

Total Factor Productivity Growth Rates (4)	1963-79
1. Chemical and Chemical products	1.6
2. Nonelectrical machinery	-0.63
3. Transport equipment	-2.31
Total Manufacturing	1.07

Sources : (1) National Accounts Division, National Economic and Social Development Board (NESDB).
(2) Department of Customs, Foreign Trade Statistics of Thailand, various issues.
(3) Industrial Management Company, Tax System for Industrial Restructuring, a Report, Bangkok, 1985.
(4) Wiboonchutikula, P., "Changes in Productivity and Efficiency of Manufacturing Industries in Thailand, 1963-19
Industrial Management Company, Bangkok, 1986.

* Note : The self-sufficiency ratio is the size of domestic production relative to total demand, where total demand is defined as domestic production plus imports minus exports.

was transport equipment at 13 percent a year and the one with the smallest rate was nonelectrical machinery at 7.7 percent. The chemical and chemical product industry grew at about 10.7 percent a year.

While the share in total value-added of each industry was small, that in total imports, of which 90 percent were the import of manufactured goods, was much larger. During 1970 to 1984 the shares in total imports of both the chemical and chemical products and the nonelectrical machinery industries were similarly in the range of 11-18 percent of total imports whereas the share of the transport equipment industry was about 7-13 percent. It is however noticeable that their shares decreased over time. The decreases were slow in the chemical and chemical products and nonelectrical machinery industries and were much more rapid in the transport equipment industry. Of all the three industries the share decreased from over 40 percent in 1970 to less than 35 percent of total imports in 1984. The exports from these industries on the other hand show some increases, but their shares in total exports are still negligible.

The fact that these industries were small in terms of the size of domestic production and export but large in imports can be summarized by the self-sufficiency ratios. The ratios show the proportion of total domestic demand which can be obtained by domestic production. A high ratio shows a high level of self-sufficiency of domestic production for utilization and a low ratio shows a high level of reliance on imports. The ratios from the table show the industry with the highest ratio in 1983 was transport equipment, followed by chemical and chemical products, and nonelectrical machinery industries, which is consistent with the discussion above. In other words, the degree of reliance on imports was the highest in the nonelectrical machinery industry

and the lowest in the transport equipment industry. However, the fact that all of their ratios increased over time implies that there were increasing degrees of substitution of domestic production for the imports.

What were the underlying forces behind the increases in the self-sufficiency ratios of these industries? Did the ratios increase in response to the increases in the rates of industrial protection or in the growth of total factor productivity which enabled them to compete with the imports? There are studies showing that the rates of total factor productivity growth (TFPG) of these industries were low, but those with effective rates of protection (ERP) were consistently high over time as shown in Table 1. It can be interpreted that the growth of these industries was made possible by protection from competition from abroad despite the fact that they have not outgrown their infant stage. Under import substitution policies these industries are able to grow behind protective measures as long as the domestic market is not yet exhausted.

There are a few products in these industries that have been actively promoted or considered for promotion under the import substitution policies. The production of small farm tractors in the nonelectrical machinery industry, which has been around for almost two decades with minimal protection, has recently been hampered by Chinese and secondhand Japanese imports. The industry was therefore granted quantitative restrictions and increases in import duties in order to provide insulation from foreign competition. The production of diesel engines in the nonelectrical machinery industry has recently started and is still at the infant stage. It has been heavily protected to substitute for imports. Meanwhile, the domestic production of diesel engines in the transport equipment industry is still pending for promotion. In the chemical and chemical products

industry there will be production of petrochemical products and fertilizers. The programs of these productions under the Eastern Seaboard Project have been approved and is likely to start soon with protection at the initial stage.

The following sections will study these three new import substituting industries, namely agricultural machinery, diesel engines, and petrochemical products.

3. THE AGRICULTURAL MACHINERY INDUSTRY

There are two kinds of farm tractors produced in Thailand--large tractors mounted with engines above 35 hp. and smaller tractors with engines of 8 to 20 hp. The production of large tractors consists of assembling parts and components, mostly imported from the U.S.A., the U.K., and some other European countries. Presently there are five large tractor firms with a production capacity of over 10,000 units a year. Three of these are joint ventures and the rest are the more recently established firms owned by Thais. All obtain assistance from parent companies or their exporters in the form of machines and equipment installation, plant layout, skill training, and standardization. This is in contrast to the production of small farm tractors which are all owned by Thais and which rely on simple indigenous management and technology with high local content. The production of the small tractors entails the construction of tractor bodies to be mounted with purchased diesel engines. Small farm tractors are used for tilling rice fields which consists of over 60 percent of the total arable land. Large tractors are used for cultivating other crops, such as maize, cassava, and pineapple.

This discussion will be focused on the industry producing small farm tractors because it is linked to the largest rice production sector, and there is an increasing number of farmers utilizing small tractors to replace animal power. Besides, the domestic production of small tractors has been rapidly replacing the imports.

The industry started in the 1960s, grew rapidly in the 1970s, but contracted in the early 1980s. Until the recent years, the industry grew under negligible protection and was even able to start exporting products to neighboring countries. However, in the early 1980s it suffered from competition from the Chinese 4/ and secondhand Japanese imports 5/ so the government had to provide assistance by offering various measures of protection so that domestic production could compete with the imports.

3.1 Characteristics 6/

Small tractors for rice farming were introduced to substitute for animal power for the first time in the mid 1950s through imports from Japan. In the mid 1960s local firms modified and started to manufacture the Japanese designs. These were readily accepted because they were more suited to local soil conditions, easier to operate and repair, and less expensive than the imported tractors. The member of firms grew from a few in the mid 1960s to over 80 in the mid 1980s. Nowadays most farmers own tractors and about 90 percent of total sales are produced domestically.

Tractor production in Thailand is labor intensive and until recently, the market was free from government intervention. Other than the common business taxes, which were applied to all industries, subsidies and international trade protection were negligible.7/ Local production is also competitive. Firms are

numerous, products are similar, and entry is relatively easy. With some experience with repairing tractors in machine shops and an initial investment of about US$ 4,000 on machinery and equipment, production can begin.

Both two-wheeled power tillers and small four-wheeled tractors are produced in Thailand. The two-wheeled power tillers are equipped with 8-15 hp. diesel engines and four-wheeled tractors with 15-25 hp. engines. About 60 percent of tractors used by Thai rice farmers are two-wheeled power tillers. They are more appropriate for farmers who transplant paddy in the wet fields. Most four-wheeled tractors are used in the Central Plains where paddy is broadcast rather than transplanted. In 1983, there were 79 tractor producing firms, 62 producing two-wheeled tractors, 3 producing four-wheeled tractors, and 14 producing both. Eighty percent of the firms were located in the Central region, and more than 70 percent of these were in the greater metropolitan areas, which provide better infrastructure, better access to raw materials, and better access to distribution channels.

The demand for farm tractors is seasonal and most firms tend to produce more than one type of farm machine so as to fully utilize their resources throughout the year. For example, a firm may produce small tractors before the planting season, between January and June, and produce rice threshing machines and water pumps during the rest of the year. Most firms are small, employing less than 10 workers, producing less than 500 units per year, and located near farming areas. Their principal activity is assembling parts and components bought from others. Medium-sized firms produce 500-2,000 units annually and employ 10-50 workers. They usually produce other farm machines such as threshers and irrigation pipes in addition to tractors. Large firms are fewer, produce more than 2,000 units annually, and employ 50-200

workers. They are more vertically integrated, producing many parts and components themselves. Most of the medium and large firms are located in the Central region. Although the number of medium and large firms is increasing, the number of small firms is decreasing.8/

Most tractor firms rely on their own self-financing schemes. About 70 percent of all funds invested are from family sources and the remainder is mainly from borrowing in the unorganized financial market. Most firms are also of the family type, owned by only one person. A few of the large firms are partnerships.

3.2 Import Substitution

The small tractor industry has the strongest linkage with the largest agricultural sector which produces rice for exports. 9/ There are studies showing that mechanization helps improve the comparative advantage of rice production and productivity.10/ Since small tractors can also be used with water pumps, harrows, threshers, and other agricultural implements, their use has increased over time. By the early 1980s over 60 percent of farmers in all regions utilized tractors to replace animal power for farming. They were used the most in the Central rice growing region, and the least in the Northeastern part where the soil and climatic conditions are rather poor for farming.11/

Table 2 shows the demand for small tractors grew at about 6 percent a year during 1974-83. Before 1980 the growth rate was much higher at 12.4 percent a year, but during the early 1980s the demand contracted at 8.5 percent a year. Both domestic production and the import of tractors fluctuated, corresponding to the changes in demand during the two periods. The table also shows that most tractors used in Thailand were domestically produced. Except for 1981 and 1982 the self-sufficiency ratios

from 1974 to 1983 were all above 94 percent. The amount of imported tractors was small and the exports were negligible compared to domestic production. On the average the imports were only 9 percent of total domestic production over the past decade. Although the imports are better built, lighter, and able

Table 2 : Demand and Supply of Small Tractors, 1974-84

	1974	1975	1980	1981	1982	1983	1984
Production	27,132	30,442	56,928	75,200	37,560	44,133	n.a.
Import	161	1,569	2,297	13,777	12,699	2,599	1,820
Export	-	2	884	18	28	26	n.a.
Domestic demand	27,293	32,009	58,341	88,959	50,231	46,706	n.a.
Self-Sufficiency ratios	99.4	95.1	97.6	84.5	74.7	94.5	n.a.

Annual Growth Rates of :	1974-83	1974-80	1980-83
Production	5.4	12.4	-8.5
Import	30.9	44.3	4.1
Export	28.5	121.8	-117.5
Domestic demand	6.0	12.7	-7.4

Source: Bank of Thailand, Annual Report on Business and Industrial Conditions, various issues.

Note: n.a. means not available

to perform more functions, they are much more expensive and less suitable for local soil conditions. In fact, since 1975 a small amount of locally produced tractors have also been exported to neighboring countries such as Malaysia, Indonesia, and Laos.

In Thailand the transaction of tractors is usually the greatest during the farming season in the first half of the year. The decision to purchase a tractor by farmers is based on their income from the harvest and prices in the previous year. In 1981 the demand for tractors was particularly high because there was a good harvest, together with a farm price support program in 1980. Domestic production reached the full capacity level and an unusually large amount of Chinese and Japanese tractors was imported to supplement the rapid increase in domestic demand. There were imports of two-wheeled tractors from China at competitive prices and imports of four-wheeled tractors from Japan at prices that were about one-half of the prices of tractors produced domestically. Although the costs of repairs, parts and accessories of the imported Japanese tractors could be much higher than those of the locally made ones, they could provide higher returns if they were used less than 500 hours a year.12/ In fact, the imported tractors replaced the domestic production to 1982.

In 1982 the demand for tractors contracted over 50 percent in response to a bad harvest and a decline in commodity prices in 1981. While some farmers returned to using traditional animal power, some chose to buy the cheaper secondhand imported tractors. As a result, domestic production declined sharply, although the imports were reduced by only 8 percent. The inventory of domestic tractors from production in the previous year also accumulated in 1982. Firms had to seek assistance from the government to compete with imports. The government then offered an increase in the import duty from 5 percent to 30

percent and granted restrictions on the imports of both two-wheeled and four-wheeled tractors to a maximum of 6,082 units a year.13/ It is apparent from the table that imports have sharply declined since protection became effective in 1983. The self-sufficiency ratios have also risen from their decline in 1981 and 1982. It therefore seems that the major competition of local production was the imported low-priced Chinese and the used Japanese products. Without these, domestic production could be substituted quite well for imports under low protection. The evidence is shown by the high self-sufficiency ratios before 1980.

3.3 Demand

It has been suggested in the foregoing section that the demand for small tractors depends on farm incomes in the previous period and the price of tractors relative to the price of bullocks. Using the available data, this section will specify the demand function of tractors to determine the factors which lead to change in the usage of tractors. By adding irrigated land areas as another explanatory variable, the demand function can be written as:

$$\text{Log } DT_t = \alpha_0 + \alpha_1 PDET_t + \alpha_2 PB_t + \alpha_3 FIF_{t-1} + \alpha_4 IR_t + \Sigma_t$$

where DT = Quantity demanded for tractors
PDET = Price of tractors including the diesel engines
PB = Price of bullocks
FIF = Farm incomes per farmers
IR = Irrigated land areas
and Σ t = a subscript indicating the time period

One would expect $\alpha_1 < 0$, implying that as the price of tractors rises, farmers would reduce the use of tractors. Since tractors are substitutable for bullocks, an increase in the price of bullocks should lead to an increase in tractor usage, thus

$\alpha_2 > 0$. The demand is also determined by the farmers' real income per head and the expansion of cultivated land areas. As farmers' purchasing power increases from the rise in commodity prices and a good harvest at the end of the previous year, more tractors should be purchased and it is expected that $\alpha_3 > 0$. Finally, since irrigated land areas are complementary to the use of tractors, $\alpha_4 > 0$.

The above demand function was estimated using ordinary-least-squares regression analysis. Data for the time period 1974 to 1983 are drawn from Table 2 and Appendix Table 1. The results of the estimation are presented below:

$$\text{Log } DT_t = -26.97 - 2.72\ \text{logPDET}_t + 0.36\ \text{logPB}_t + 1.83\ \text{logFIF}_{t-1} + 4.90\text{logIR}_t$$
$$\qquad\qquad (6.54) \qquad (0.62) \qquad\qquad (0.19) \qquad\qquad (0.27) \qquad\qquad (0.84)$$

$$R^2 = 0.97,\ \text{D.W.} = 2.63$$

The parameters of all explanatory variables of the demand function have the hypothesized signs and they are all statistically significant at the 10 level. It seems to support the argument in the previous section that the major determinants of the demand for small tractors are their price, the prices of bullocks, the farmers' incomes, and the irrigated land area.

3.4 Problems and Prospects

The production of small tractors is a small indigenous industry which was, until recently, operated under minimal government assistance. The technology used in production is simple and most firms originated from small machine shops. Their capital-labor ratios are low and this has a large forward linkage effect with the agricultural sector, which absorbs the largest employment and is a major foreign exchange earner. The use of farm machines helps increase the comparative advantage and the productivity of rice production. With favorable farm incomes,

more tractors are used to replace bullocks whose prices have increased over time. There still is potential for the industry to grow in the domestic markets.

The substitution of a locally produced tractor for an imported one could also save some net foreign exchange indicated by the lower measured domestic resource costs (DRC) than the shadow prices of foreign exchange or shadow exchange rate (SER). DRC measures the social opportunity cost of using domestic resources in the production of a tractor locally in order to save a unit of foreign exchange from importing the product. SER measures the amount of domestic resources the country is willing to forego to save a unit of foreign exchange. Therefore, if DRC is less than SER, fewer domestic resources are required to save a unit of foreign exchange than the country on average is willing to pay for the import.14/ Using the input-output coefficients surveyed by the Bank of Thailand (BOT) in 1978,15/ the DRC of the production of a small tractor is estimated to be 10.00 baht per US $ in 1979, but increased to 18.04 baht in 1985. If our input-output coefficients from our own survey in 1986 are used, the DRC was only 10.20 baht in 1978 and 18.23 baht in 1985. The estimated values of DRC using the BOT data are close to the ones using our own surveyed data and they increased over time regardless of the sources of data (See Appendix Table 2 : A and B). When considering that the SER was 22.05 per US $ in 1978 and 28.56 baht in 1985, the country was able to save domestic resources from the domestic production of tractors to substitute for imports, but the foreign exchange savings seemed to be smaller over time. This suggests that domestic firms might have increasing difficulty in competing with imports.

In recent years the industry also has the problems of declining demand due to the decreases in the prices of rice and the limited arable land. Besides measures to increase farm incomes, improve the irrigation system, and increase the use of fertilizers to substitute for land expansion, efforts should be

made to reduce the costs of production and improve the quality of the products. Small tractors usually cannot meet the required standards of quality control. This makes the competition with the imports increasingly difficult in terms of prices and quality. For example, very few firms use jigs or fixtures for controlling quality and repeatability of the products. Parts and components of different brands of tractors are not interchangeable when they have broken down.16/ In Thailand although there is an industrial standard decree, which was established in 1968 and is administered by the Thai Industrial Standard Institute (TISI), the operations are ineffective. TISI lacks adequate personnel and operations budget to prepare standard documents, maintain standards of measurement and test finished products or raw materials to determine if they comply with the required standard of quality imposed by the decree.

In terms of design and technology, there are a few public institutions which conduct researches on tractor design and methods to improve performance, such as the Agricultural Engineering Division (AED), the Industrial Service Division (ISD), and the International Rice Research Institute (IRRI) in the Philippines. However, they do not have an effective linkage with the tractor firms and therefore new technology cannot adequately be diffused for application in the industry. Most firms are reluctant to change technology because it can be costly and the products will not be competitive in the local markets where price competition is keen. They tend to copy the product designs from each other and the foreign models, or make changes according to customers' demands. The emphasis is to lower costs of the products without considering quality improvements. As a result, the industry produces low cost and poor quality products. Most firms are operated by workers without any formal training and who work with rather old or secondhand machines in plants with poor layouts. They also have difficulties in seeking funds for investment in technology due to their small size. A study shows that the TFPG of this industry was low and thus the

competition with the imported products could be difficult without future government assistance.17/ Thus, the prospect for the industry to grow in the absence of protection in the future will hinge crucially upon its ability to increase productivity during the protection period which began in 1982.

3.5 ASEAN Cooperation in Small Tractors Industry

The market for small tractors in the ASEAN region is sizeable and growing rapidly. Besides Thailand, the rate of farm mechanization in all other ASEAN countries, except Singapore and Brunei, was impressive in the past decade and it is likely to proceed at a continuous upward trend. In most ASEAN countries there has also already been a viable manufacturing and fabricating agricultural machinery industry which produces the products to substitute for the imports at varying extents. Thus, in 1979 the ASEAN Agricultural Machinery Federation (AAMAF) proposed the establishment of an ASEAN industrial cooperation project to produce small farm tractors with 15 to 25 HP engines.18/ The tractors were to be produced at low cost, simple to operate, and applicable for wet and dry-land farming.

As stated in the proposal, various benefits are expected from the industrial cooperation. However, from our study of the small tractor industry in Thailand, the benefits are not at all obvious from the first consideration. Because the industry does not require large capital investment or highly skilled manpower, economies of scale do not exist and there should be no gains from enlarging the market to the ASEAN regional level. Now, if we reconsider the problem of low TFPG or slow reduction of the unit cost of the production of small tractors in Thailand, we will realize that these problems are in fact from the inability of the firms to improve the technology of production. This in turn suggests problems related to the development of a new technology such as capital imperfection, market failures, and the requirement of a minimum plant size. It is in the area of

technological development where ASEAN industrial cooperation has a role to play. On the one hand, cooperation in the form of joint venture with non-ASEAN developed countries can help the transfer or the development of the needed improved technology. On the other hand, the cooperation among ASEAN countries can help pool capital and enlarge the market of the product to make the technological development projects feasible. Given the above benefits, ASEAN cooperation in this industry is not without problems. If the project is realized, the existing firms in Thailand will become obsolete and the market structure of the industry will have to be reorganized. The reorganization process can be painful to the existing firms in Thailand and probably those in other ASEAN countries as well. In such a case, a proposal with a compensation scheme for the declining firms should also be considered.

4. THE DIESEL ENGINES INDUSTRY

Diesel engines used in Thailand can be separated into three kinds: (1) diesel engines below 20 hp. for small tractors, water pumps and other agricultural implements, (2) engines of 20 to 68 hp. for marine crafts and large tractors, and (3) engines above 68 hp. for motor vehicles. Before 1980 all of these engines were imported. The demand for diesel engines below 20 hp. grew at 25% a year during the 1970s and by 1980 imports reached 22,187 units. The demand for engines above 68 hp. grew at 16% and the import in 1980 was 55,808 units. With the fast growing imports, the Board of Investment (BOI) has designed measures to start the domestic production of diesel engines below 20 hp. and engines above 68 hp. to substitute for imports. There were three firms producing diesel engines below 20 hp. and another three producing engines above 68 hp. that have been granted promotion from the BOI. Firms of the first kind began production in 1980 and a discussion follows. Firms of the third kind have not yet begun production for reasons to be discussed in Section 4.2.

4.1 Diesel Engines for Agricultural Machinery

4.1.1 Characteristics

The three promoted firms producing diesel engines for agricultural machinery in 1980 were Yanmar, Kubota, and Daedong. The first two firms are Thai joint ventures with the Japanese and started production in 1980. Daedong was with the Koreans and began production in 1981, but the production stopped in less than a year due to some problems of partnership agreement. Daedong later was granted permission from BOI to change the ownership to be wholly owned by Thais and renamed as Thai Diesel Development. It started the production of 5-18 hp. engines in 1984 under the Mitsubishi banner and chief technicians are from Japan.

The three firms were granted the following privileges from the BOI: 20 percent import duties, 20 percent import surcharge, import quotas, up to 90 percent reduction in import duties and business taxes on raw materials used by the firms, and prohibition of the entry of additional firms. In order to increase technology of production, firms are required to change their production process from assembling to pressing and forging, and then to casting in three years from 1981. In addition, their local content was also required to increase yearly from 20 percent to 40 percent, 60 percent, and 80 percent in four years from 1980. According to a BOI Report, firms were able to meet the local content requirement in the first two years because at the early stage of production, investment in parts and components was not large and the technology needed in their production was not complicated.19/ Firms either produce the parts and components themselves or subcontracted to other firms. However, none of them could reach the 60 percent level of local content in 1982 and chances seemed remote for them to reach the 80 percent level in 1983 because there were a few parts which required high

technology and investment.20/ Therefore in 1983 the dates to meet the local content requirement were extended for firms to reach the 60 percent and 80 percent levels in 1986 and 1987, respectively.

In return for the imposition of local content requirement to promoted firms, various protective measures were revised. In 1982 the tariff rate was increased from 20 percent to 30 percent, but the surcharge was reduced to 5 percent. Firms bargained for the surcharge to remain at 20 percent as incentive for them to increase the local content. In 1985 BOI alternatively provided additional tariff reductions on imported raw materials for firms whose local content exceeded the required level at the time specified by the BOI.

4.1.2 Prospects for Growth and Import Substitution

Table 3 shows that diesel engines for agricultural machinery were all imported before 1980. The growth rate of imports in the 1970s was 25 percent a year. During the first four years of production from 1980, domestic output increased at 25.5 percent to substitute for the imports which declined at the rate of 11 percent a year. Under protection from the beginning of production the self-sufficiency ratio was high at 56.5 percent in 1980 and increased to 84.8 percent in 1984. It seems that there is an increasing substitution of domestic production for imports under the increasing protective rates. Firms in the industry were also found to be able to improve their process technologies and increase the local content in their production in response to various incentives provided by the BOI.21/

Table 3 : Demand and Supply of Diesel Engines, 1970-1985

	Diesel Engines for Agricultural Machinery			Diesel Engines for Vehicles	
	Production	Import	Export	Import	Export
1970	-	6,129	18	11,354	-
1975	-	23,220	7	43,897	3
1978	-	75,272	70	52,795	2
1979	-	58,149	167	71,368	11
1980	28,683	22,187	81	55,808	61
1981	101,576	36,031	87	70,490	505
1982	60,849	18,106	193	86,733	174
1983	40,888	13,856	76	116,787	50
1984	79,641	14,307	60	132,938	78
1985	74,500	6,740	-	89,799	77

	Demand	Self-sufficiency Ratios (%)
1980	50,789	56.5
1981	137,520	73.9
1982	78,762	77.3
1983	54,668	74.8
1984	93,888	84.8
1985	81,240	91.7

Growth rates (%)

	Diesel Engines for Agricultural Machinery			Diesel Engines for Vehicles	
	Production	Import	Demand		Import
1970-79	-	25.0	25.0	1970-80	15.9
1980-84	25.5	-11.0	15.4	1980-84	21.7
1970-84	-	6.1	19.5	1970-84	17.6

Sources:
1. Bank of Thailand, Annual Report on Business and Industrial Conditions, various issues.
2. Department of Customs, Foreign Trade Statistics of Thailand, various issues.

From the table it is interesting to note that demand, domestic production, and imports all declined during 1982-83 following the decreasing demand for agricultural machinery, as discussed in Section 3.3. This seems to suggest that the demand for diesel engines for agricultural machinery has the same arguments as the demand for small tractors and this can be written as:

$$DDET_t = \beta_0 + \beta_1 PDET_t + \beta_2 PB_t + \beta_3 FIF_{t-1} + \Sigma_t$$

where DDET = Quantity demanded for diesel engines for tractors and PDET, PB, FIF, and Σ_t are defined in Section 3.3.

The quantity demanded for the diesel engines for tractors should be negatively related to their own price and their closely complementary product namely tractors: Since we find that the prices of these two products are also highly corrected , we thus specify the quantity demanded for the diesel engines to depend on the price of tractors which has already included the diesel engines and $\beta_1 < 0$. The coefficient β_2 is expected to be positive implying that diesel engines are complementary to tractors and tractors are substitutable for bullocks. As the tractors are used more as a result of the increases in the price of bullocks, the diesel engines for the tractors are also purchased more. Finally, $\beta_3 > 0$ should be positive, implying the demand for diesel engines increased with the rise in farmers' purchasing power.

The estimated demand function using data for 1974 to 1983 from Table 3 and Appendix Table 1 is presented below:

$$DDET_t = 440502.00 - 20.78\ PDET_t + 17.79\ PB_t + 53.99\ FIF_{t-1}$$

$$\qquad\quad (217269.00) \quad (8.46) \qquad (9.07) \qquad (30.34)$$

$$R^2 = 0.68, \quad D.W. = 2.90$$

The demand function for the diesel engines for tractors fits better in linear form. All parameters show the hypothesized signs and are significant at the 10 level. The results of the estimation again support the argument that the demand for diesel engines depends on their price, the price of bullocks, and the farmers' incomes.

The results imply further that the industry has strong forward linkages with both the agricultural machinery industry and the agricultural sector.22/ Although the technique of production is rather capital intensive and the technology of these joint ventured firms are from their parent companies, the transferred technology can be basic infrastructure for local firms to accumulate their own technological capability. Firms also seem to respond well to the incentives provided by BOI for increasing technology.23/ However, the DRC estimated by using our own surveyed data in 1986 is about 36 baht per US dollar in 1984 (See Appendix Table 3 :A and B). It is well above the shadow exchange rate implying that the industry's productivity has to be increased rapidly to enable it to grow without increasing protection from import competition.

4.2 Diesel Engines for Motor Vehicles

4.2.1 Project Progress

So far, domestic production of diesel engines for vehicles has not yet started. Table 3 shows that there was a rapid growth of imports at an annual rate of 17.6 percent in the past 15 years. The high growth of imports of the diesel engines could add up to the balance of trade deficit problem. Since 1978 the government has considered promoting the domestic production of this product to save the foreign exchange and enhance the technological capability of the transport equipment industry.

980, BOI approved the promotion of three joint ventures proposing to produce diesel engines for trucks and buses, namely Thai-Hino, Isuzu, and Siam Nissan Diesel Industrial. However the projects were never carried out because of the disagreement with BOI over the required initial local content. BOI insisted on an initial level of 20 percent with regular progression over five years to 80 percent similar to the requirement applied to firms producing diesel engines for agricultural implements. But the applicants claimed that they could manage only 15 percent at the early stage of production. The projects had also been delayed because BOI later hesitated to provide high protection for the domestic production of diesel engines for heavy vehicles.

In 1985, BOI revived the idea of the domestic production of diesel engines by offering protection and promotion to firms producing diesel engines for small trucks with a maximum capacity of 2,500 c/c and a weight of 1 ton. Promoted firms are required to improve the stage of production process from assembling and machining to forging and casting in three to four years. The local content should be increased over five years in the regular sequence of 20, 40, 60, and 80 percent. Investment in machining and equipment and working capital should be greater than 600 million baht and registered capital 150 million baht. There were four firms applying for the BOI promotion in 1985. Three of them will be joint ventures with the Japanese and the other will be wholly owned by Thais. The project proposals are still under the consideration of BOI.24/

4.2.2 Prospects for Growth and Import Substitution

Since diesel engines for vehicles are still entirely imported, the domestic demand for the diesel engines is given by their imports excluding the reexports. Table 3 shows that the growth of the demand was 17.6 percent a year over the 1970-1984 pericd. The determinants of the demand are hypothesized to be the price of diesel engines relative to the price of gasoline

engines, the real per capita income, and the price of diesel relative to the price of gasoline. This last factor is included because the price of diesel is set by the government to be increasingly lower than the price of gasoline by imposing higher taxes on the latter fuel.25/ As a result, there is an increasing number of diesel engines of small trucks replacing the gasoline engines in vehicles.

The demand function can be written as:

$$\text{Log DDEV}_t = \gamma_0 + \gamma_1 \text{logPDGE}_t + \gamma_2 \text{ logRGPC}_t + \gamma_3 \text{ logPDG}_t + \Sigma_t$$

where DDEV = Quantity demanded for diesel engines for vehicles
PDGE = Price of diesel engines for vehicles relative to price of gasoline engines
RGPC = Real GDP per capita
PDG = Price of diesel relative to the price of gasoline
and Σt = a subscript indicating time period.

The quantity demanded for the diesel engines for vehicles should be negatively related to their own price relative to the price of the substitutable goods namely gasoline engines but positively related to the real per capita income. That is, $\gamma_1 < 0$ and $\gamma_2 > 0$. The coefficient γ_3 is expected to be negative because as the price of diesel relative to the price of gasoline declines, more gasoline engines in vehicles would be switched to diesel engines.

The estimated demand function using the data for the period 1975 to 1984 from Table 3 and Appendix Table 1 is shown below:

$$\text{Log DDEV}_t = 9.74 - 1.04 \text{ logPDGE}_t + 1.45 \text{ logRGPC}_t - 1.34 \text{ logPDG}_t$$

$$(11.46) \quad (0.61) \qquad (0.71) \qquad (0.95)$$

$$R^2 = 0.86, \quad D.W. = 1.66$$

All parameters have the hypothesized signs and are significant at the 10 level. The interesting determinant of the demand function is the price differential of the diesel and the gasoline fuels. It implies that the narrowing of the gap of the domestic prices of the two fuels to be more consistent with the world prices would have a negative effect on the demand for diesel engines for vehicles. This factor can thus be crucial for the consideration of domestic production of diesel engines for small trucks. For the promoted firms to grow, it is necessary that the present domestic price structure of the fuels be maintained. Furthermore, there seems to be little potential for diesel engines to be exported to other countries where such a price differential between the two fuels does not exist.

4.3 ASEAN Cooperation for Diesel Engine Production

The cooperation in production and trade of diesel engines among ASEAN countries is difficult because all except Singapore have already had their own domestic production of engines of various ranges of horsepower under protection. Singapore used to be allocated under the ASEAN Industrial Projects (AIPs) to produce diesel engines ranging from 5 to 20,000 horsepower. The project was to be jointly owned by all ASEAN members and the output for exports in the region would have been under the Preferential Trading Arrangements (PTA). However, the operation of the project never started because no member countries were willing to discontinue their own national diesel engine plans. Besides, Indonesia proposed that Singapore should not produce diesel engines below 500 hp that would compete with Indonesia's own domestic production.26/ Under these circumstances Singapore had to drop the project for an obvious reason. The demand for diesel engines in the region was confined to the small horsepower range. The potential for Singapore to export the products to other member countries would have been very narrow if these countries were to continue to expand their own production of diesel engines of the same range. This is an example of

problems arising from the ASEAN joint-venture of products already established in the member countries. On the one hand, it is very difficult to envisage an ASEAN industrial project competing with the ones already promoted or protected in individual member countries. On the other hand, if a new product is proposed instead to be under the ASEAN industrial cooperation, there is a question of whether national projects should be allowed to be established to compete with the ASEAN projects. If there are too many approved projects, the benefit from the economies of scale of the industry from the regional cooperation will be lost.

5. PETROCHEMICAL INDUSTRY

5.1. The Development of the Petrochemical Project

The consideration for the promotion of the petrochemical industry is from the rapid growth of the plastic and plastic products industry and the discovery of natural gas in the Gulf of Thailand. Despite the recent slowdown due to recession, the plastics and plastic products industry grew at 8.5 percent a year during 1970-1984. The growth of this industry leads to an increasing need of raw materials used for the production of these products. The raw materials used by this industry are polymers obtained by polymerizing basic petrochemicals, mostly olefins. Some of the polymers can be produced domestically, but the olefins are entirely imported.27/ Olefins are the by-products of the refining of oil or natural gas and are produced mainly in North America, Europe and Japan.

In Thailand when natural gas was discovered in the mid 1970s and tapped at the rate of 100 million cubic feet per day, the government saw the opportunity of using domestic natural gas as feedstock for the production of various petrochemical products such as olefins and other downstream products to substitute for imports.28/ In October 1981 a Subcommittee of

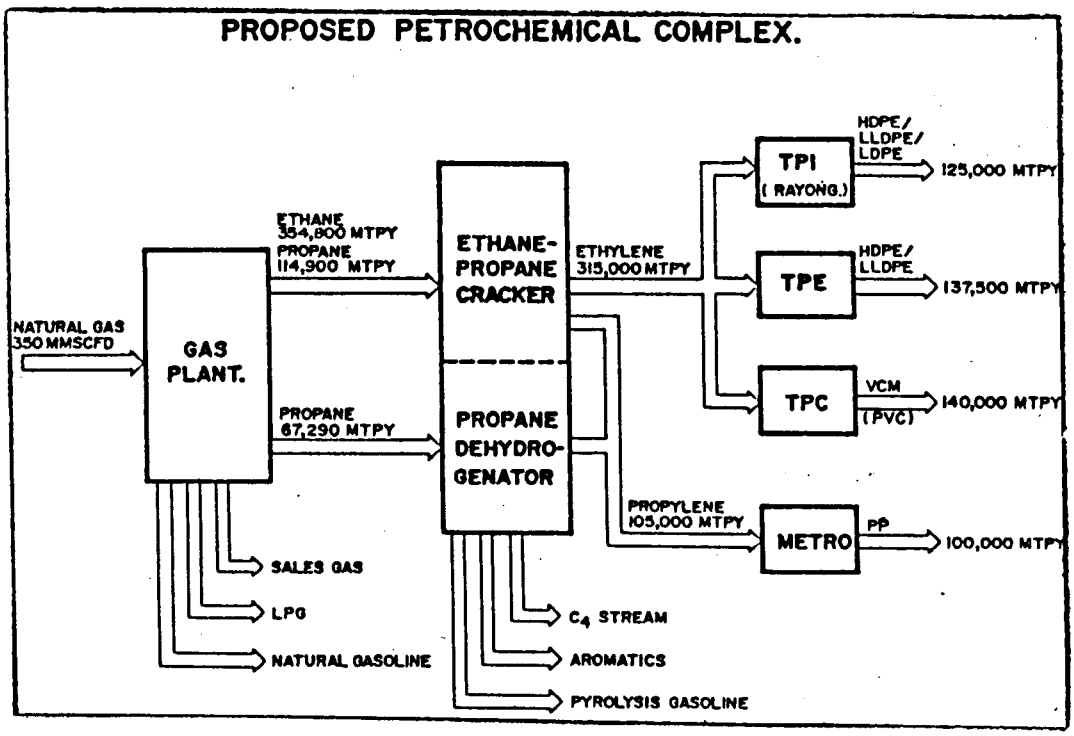
the Eastern Seaboard Committee was formed to assess the viability of the Petrochemical Project and to draw up policy guidelines for its establishment. In June 1982 the Subcommittee concluded that "the Project is a highly attractive business proposition and it will contribute significantly to Thailand's industrial development".29/

The Subcommittee proposed that the Petrochemical Complex be located adjacent to the Gas Separation Plant in the Mab Ta Pud Industrial Estate in Rayong Province. The Complex should consist of five units. The first unit is to use products from the gas separation plant, ethane and propane, as feedstock to produce upstream basic petrochemical products of ethylene and propylene. The remaining four units will use products from the upstream unit as raw materials to produce downstream products such as polymers and plastic products (see Figure 1). The upstream unit should be jointly financed by both the public and the private sectors whereas the downstream plants should be wholly owned by the private sector. In February 1984, with the approval of the Eastern Seaboard Committee, the National Petrochemical Corporation (NPC) was founded with an initial registered capital of 70 million baht. NPC will supply basic petrochemicals of ethylene and propylene as raw materials to the downstream industries which will produce polymers such as low-density and high-density polyethylene, polyvinyl chloride, polystyrene, and polypropylene.

To assist the Project, the government will provide infrastructural facilities such as highways, railways, harbors, electricity, and water supplies at subsidized rates. It will also furnish the following promotional privileges: tax exemptions on imported machinery and equipment, a grace period of taxation, provision of barriers to new entry, liberal policy on project remittances for foreign investors, and extra import duties to prevent dumping from abroad.

The NPC feasibility study expects the Project to be both technically and economically viable if the upstream plants can reach their full capacity level of production by the late 1980s and the future prices of polymer products increase by 3.3 percent from 1984 to 1995. If the prices remain at the present low level, the Project will be economically viable provided the current duties of 40 percent imposed on imported polymers is maintained. The project is also expected to save US$ 355 million a year of foreign exchange from imports of polymers. By utilizing our own natural gas as feedstock, the production of petrochemicals would increase the value-added of the feedstock by fourfold.

Figure 1 : Configuration of Petrochemical Complex



Source : National Petrochemical Corporation

The growth of the petrochemical industry can also stimulate the growth of the plastic processing and plastic products industries. For more than 1,000 plastic processing plants in the ccuntry, all of which rely only on imported materials, the supply of plastic resins from the Petrochemical Complex would provide the assurances of raw material availability and price stability which is not currently pcssible. These favorable factors would enable the plastic processing industry to improve its productivity and thereby increase its growth rate.

The Petrochemical Complex will also provide job opportunities to more than 3,000 people directly and possibly another 5,000 in related activities, such as in transportation and other services sectors. The increased activities in the plastic processing industry will also provide more than 20,000 additional job opportunities to the existing 15,0C0 currently employed.

From the technical viewpoint, the Petrochemical Complex will bring about a whole new technology concerning organic chemical processing and synthesis. Technologies used in the development of the Petrochemical Complex are summarized in Table 4. The transfer of this new branch of technology will nct only benefit industrial development but also stimulate and promote R & D activities in academic institutes at large, for example, in the fields of catalyst engineering, polymer science, and product diversification. The modern complex will also provide the best opportunity for training and internship of young engineers and scientists.30/

Table 4

Summary of Technologies used in Petrochemical Complex

Unit	Technology	Catalyst/Absorbent
Upstream Unit CO_2 Remover	Amine Scrubber UCAR-Amine Guard	MEA Inhibited MEA Solution
H_2 Purification	Pressure Swing Absorbtion	Molecular Sieve
Dehydrater	Pack-Bed with Absorbent	Alumina or Molecular Sieve
Caustic Scrubber	Scrubbing Column	Caustic Solution
C_2-Hydrogenation	Gas Phase Catalytic C_2 Acetylene Converter	Palladium or Nickel Catalyst Palladium on Alumina
C_3-Hydrogenation	Gas/Liquid Phase Catalytic C_3 Acetylene Converter	Palladium Catalyst Palladium on Alumina
Propane Dehydrogenation	Catalytic Dehydrogenation	Platinum on Alumina Base
Downstream Unit Polyethylene	Gas Phase/ Slurry Polymerization	Chromium/Molybdenum/ Titanium-Containing Catalysts
Polypropylene	Liquid Phase Polymerization	Titanium on Magnesium Halide/Organometallic Component/Lewis Base (Electron Donor)
Caustic Soda	Asahi Glass Flemion Process	Ion-Exchange Membrane
VCM Oxycholorination (Ethylene Dichoride EDC)	Fluidized Bed Reactor	Micro-Spherical Catalyst of Cu-Al Compounds

Source: Lurgi Gmbtt and Trichem Consultants Ltd., Feasibility Study: Part B: Definition of Complex of Upstream Unit, 1983.

5.2 An Assessment of the Project

Although there is no domestic production of upstream petrochemical products, a few downstream petrochemical products are produced domestically under protection. They are polyvinyl chloride, low-density polyethylene, and polystyrene. The number of firms in these industries are very few and their competing imports are subject to a duty of 40 percent plus a 20 percent surcharge. The imports of both the upstream and downstream products are mainly from Japan, the U.S.A., the Netherlands, and some newly industrialized countries. While the shares of the imports from Japan and the U.S.A. are declining, those from some European and newly industrialized countries are increasing. In fact the shares of total production of petrochemical products of both the U.S.A. and Japan in the world markets have declined in recent years and have been replaced by the increasing production from other countries, such as Canada, Saudi Arabia, and some NICs. Thailand is also about to start production to replace imports. It is interesting to assess the production situations in the world markets and point out the possible difficulties facing the Thai production.

The petrochemical industry was first developed in the U.S.A. before World War II and the U.S.A. became the major producer of the products from the end of the War to the late 1970s. In the 1960s when plastics and plastic products were widely used to substitute for wood and metal products, the chemical and petrochemical industries in both the U.S.A. and Europe grew at a rapid rate. In the mid 1960s Japan started production and later joined the world export markets. Unfortunately, in the 1970s there were a few increases in energy prices together with world recessions. As a result the demand for the products declined in response to the increases in the petrochemical product prices and the decline in real income. From the early 1980s traditional producers such as the U.S.A., Japan, and some European countries restructured the industry to supply less of the upstream products

and to increase the production of some specialty chemicals, such as resins, solvents, lubricant additives, and pharmaceuticals. Meanwhile, Canada, Saudi Arabia, and some NICs diversified their oil refining sector to petrochemical production. In the mid 1980s there were problems of low demand and excess capacity of production again. Most producers either tried to diversify the production or reduce the costs by looking for the cheapest sources of feedstocks.31/

Given the current unfavorable world demand and prices in the petrochemical industry, Thailand is about to start petrochemical production. The basic rationale is mainly from the availability of the recently discovered natural gas feedstock and the increasing demand for ethylene and propylene in the production of downstream products, which are in turn the raw materials for the production of plastics and plastic products. The Petrochemical Project can utilize domestic natural gas and at the same time provide a regular supply of downstream products by relying less on these imports.

The rationale of backward linkages into the country's natural resources and forward linkages into other sectors may be justifiable, but there are still doubts on the timing of the launch of the Project. Should it be postponed and instead the import of the products continue until the prices of petrochemical products rise again? Besides, there is another problem of higher costs than in other countries in extracting the offshore natural gas and transporting it almost 600 kilometers to shore. The advocates of the Project however argue that local natural gas is of better quality. It is rich in heavy hydrocarbons (ethane, propane, and butane) and is still 30-40% cheaper than oil which is the feedstock used by most countries who have suffered losses in recent years.

Despite the justification, other problems facing the industry remain. Will we be able to convert this huge debt to finance this project into income-earning assets in the future? How long will the natural gas last and what strategy do we have after its exhaustion? In addition, there is the familiar question pertaining the validity of the infant industry argument for protection. Since all of these upstream and downstream industries will be established under 40-60% tariff protection plus additional surcharges, how long do we expect the industries to grow and then be able to survive on their own? How much are the welfare losses to local plastics and plastic products industries which have to suffer higher prices for the lower quality inputs supplied by the upstream industries? What are the policy instruments that should be adopted to protect these industries in the most efficient or the least costly way? How can the project be monitored so that once mistakes are found, the project can be discontinued or revised? Finally, are there economies of scale in this industry32/ and how can ASEAN cooperation help to realize such scale economies?

At this initial stage of project implementation, the government has found it appropriate that the work schedule of the project be flexible. The government should prepare to reduce the size or delay the projects which are adversely affected by the declining oil and petrochemical prices. Meanwhile, projects on the construction of infrastructures should continue so that when the petrochemical industry is in a more favorable state, the project can be reactivated without further delay.

5.3 Scope for ASEAN Cooperation in Petrochemical Industry

Proposals for ASEAN industrial cooperation in the production of petrochemical products, mostly downstream, were available as early as 1978.33/ The production of PVC paste resins and VCM terminals was proposed under the AIC scheme to be located in Indonesia. A few other by-products of the petrochemical industry were discussed in the ASEAN Chemical Industrial Club and proposed under the AIJV scheme to be located in different ASEAN countries. First, the production of cholorinated parafin wax was proposed to be located in Singapore or Indonesia which already have parafin wax refining capabilities. Second, freon of both types, namely solvent freon and refrigerator freon, were proposed to be located in Thailand which has available fluorspan, a raw material used in the production of freon. Third, the production of acetylene black was to be a Philippines/Thailand joint venture and located in both countries. The first plant, which has already been in operation in the Philippines, was supposed to be expanded to serve Philippine and the Indonesian markets. The second plant envisioned to be constructed in Thailand was to supply the markets in Thailand, Singapore, and Malaysia. All these plans have not, as yet, proceeded any further than pending for more studies. In fact, under the recent world recession, the drop in the demand for petrochemical products worldwide, and the concurrent development of the ASEAN countries' own national projects, the discussion of the cooperation of the production of these products seems to sound less enthusiastic.

Presently, besides Thailand, all ASEAN countries have or are planning the development of their own petrochemical complexes. The status of each country's project varies as follows34/ : Singapore's fully integrated petrochemical complex has been completed and has been in operation since 1984. Indonesia has already had plants producing polyvinyl-chloride and polystyrene and has plans to develop the upstream plant. The project is now

scaled down in response to falling oil revenues. Malaysia continues the plan of their petrochemical development to better utilize their own abundant natural gas despite the depressed petrochemical markets. The Philippines, before the recent political difficulties, has investigated the feasibility of establishing their own petrochemical facilities.

If all these ASEAN countries start petrochemical production and try to protect their own domestic markets, the prospect for each country to export any surplus products to other countries in the region would be unlikely. On the other hand, if they would like to export the products to countries outside the ASEAN region, they will have to compete rigorously with each other. Therefore, the possibility of realizing the economies of scale or the elimination of excess capacity of the industry in each country would be difficult. In this regard there is room for ASEAN cooperation, particularly in the production of some downstream products which require simpler technology and less capital intensive technique of production. This can be done through the allocation of different products to member countries and to ensure that members do not duplicate the designated production activities in their territories. With an appropriate kind of industrial cooperation it can pool skilled manpower, enterprises, investment, and technology to make the integrated petrochemical complex fully feasible on the regional basis. Besides, it can provide large enough markets for the economies of scale and downstream product diversification. The cooperation is expected to eliminate the problem of excess capacity, promote intra-ASEAN trade, and can probably, fasten the maturity of the industry so that it can export to other non-ASEAN countries earlier.

6. CONCLUSION

Since the late 1970s the government has started promoting and protecting more import substituting industries. Three industries, namely small farm tractors, diesel engines, and the petrochemical industries are studied in this paper.

The tractor industry was able to substitute for imports without protection or assistance from the government for over a decade before 1980 because of its distinct characteristic and low price. However, due to the industry' s slow productivity growth, it has suffered since the early 1980s from the competition of low-priced secondhand products imported from abroad. The industry needed protection from the government to continue its production, especially in the present difficult time of low farm prices and incomes.

The diesel engines for agricultural machinery industry started domestic production to substitute for imports in 1980. It is still at the infant stage and recently more protection has been granted for the industries to meet the requirements of appropriate technology and local content. There has still been no indication of how soon the industry will be able to outgrow its infant stage. Meanwhile, there are two more projects concerning import substitution to be started soon. They are the production of diesel engines for small motor vehicles and the production of petrochemical products. The growth of diesel engines for the small vehicles industry seems to depend on the price structure of diesel and gasoline fuels. More motor vehicles are mounted with diesel instead of gasoline engines partly because the price of diesel has been set to be much lower than the price of gasoline. In order to ensure the growth of this industry, it is necessary that the present fuel price structure be maintained. The potential for the products to be exported is narrow because they cannot be exported to countries where the prices of fuels are closer to the world prices.

The petrochemical project is a large and capital intensive project which requires financing from abroad. Domestic production can certainly add value to the recently discovered natural gas in the Gulf of Thailand and it can also provide a regular supply of feedstock to the plastics and plastic products industry. However the project's feasibility seems to decrease under the present declines in energy prices and world demand. Since the project will take a long time to recoup the returns, the question of dynamic comparative advantage of the project has to be seriously evaluated. In addition, the strategy of what to do after the domestic energy is exhausted has to be spelled out.

Having stated the problems of these import substituting industries, how can the prospect for growth be better under ASEAN cooperation? First regional import substitution could generate gains from greater expansion, specialization, and diversification of production. Second, it can increase productivity by maximum utilization and more efficient use of the available resources in addition to improved technology. Now what kinds of policy tools should be used to protect and promote the regional import substitution industries? First, there should be free trade or preferential tariff provision to enable the industries to gain from the enlarged market. Second, ASEAN members should be encouraged to pool resources such as capital and skilled manpower, and technology, which are necessary inputs for the production of secondary import substitution industries. Third, the sourcing of intermediate products used in the production of these industries should be under minimum trade restrictions in order to obtain minimum production cost. Fourth, it is probably inevitable to have protection of the regional market from competition from similar products of non-ASEAN countries at the early stage of developing the industries. In which case, there should be protective measures such as subsidies, tariffs, or anti-dumping surcharge, which are imposed

uniformly in the region for these particular products. Finally, to benefit from economies of scale, no more plants should be allowed to be established in the region until the existing ones become efficient or productive enough to export.

Appendix Table 1:A

Data Base

	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
1. Price of Tractors (baht)	n.a.	15,819	17,501	18,515	18,812	20,275	23,510	25,838	26,571	27,909	28,084	n.a.
2. Price of Bullocks (baht)	1,855	3,149	3,494	3,743	4,040	3,728	4,435	6,735	9,455	9,087	8,391	7,832
3. Price of Tractors including Price of Diesel Engines for Tractors	n.a.	15,819	17,501	18,515	18,812	20,275	23,510	25,838	26,571	27,909	28,084	n.a.
4. Farm Income per Farmers (baht)	3,755	3,397	2,431	2,054	2,161	2,196	2,335	2,542	1,897	1,633	1,788	1,759
5. Irrigated Areas (1,000 rais)	12,334	12,770	13,058	15,278	16,088	17,137	18,040	18,843	19,934	20,730	21,459	22,226
6. Price of Diesel Engines for Motor Vehicles (baht)	4,152	4,513	6,303	7,625	7,164	7,724	7,764	7,508	8,722	8,420	7,946	8,458
7. Price of Gasoline Engines (baht)	1,889	1,602	2,612	2,483	2,788	2,495	2,855	2,948	3,724	3,566	3,501	3,910
8. Real GDP per Capita (baht)	4,509	4,596	4,917	5,215	5,460	5,873	6,091	6,304	6,555	6,683	6,934	7,227
9. High Speed Diesel (baht/litre)	1.070	2.216	2.330	2.330	2.578	2.640	3.865	6.447	7.343	7.390	7.061	6.700
10.Premium Gas (baht/litre)	2.310	3.620	3.574	3.620	4.100	4.841	6.599	9.586	11.912	13.450	12.726	11.700

Sources :
(1). Estimated by TDRI, use secondary source from Bank of Thailand, Report on Business and Industrial Conditions, various issues. Department of Customs, Foreign Trade Statistics of Thailand, various issues.
(2). Department of Business Economics.
(3). Estimated by TDRI, use secondary source from Bank of Thailand, Report on Business and Industrial Conditions, various issues, Department of Customs, Foreign Trade Statistics of Thailand, various issues.
(4). Office of Agricultural Economics, Agricultural Statistics of Thailand, various issues. Bank of Thailand, Quarterly Bulletin, various issues.
(5). Division of Program Coordination and Budget, The Royal Irrigation Department.
(6). Department of Customs, Foreign Trade Statistics of Thailand, various issues.
(7). Department of Customs, ibid.
(8). National Economics and Social Development Board, National Income of Thailand, various issues.
(9). National Petroleum Committee.
(10).National Petroleum Committee.

Note : n.a. means not available.

Appendix Table 1 : B

Demand Functions of Agricultural Machinery, Diesel Engines for Agricultural Machinery and Diesel Engines for Motor Vehicles

1. Demand for Agricultural Machinery (Year 1974-1983)

$$\log Dt_t = -26.79 - 2.72\log PDET_t^{**} + 0.36\log PB_t^{*} + 1.83\log FIF_{t-1}^{***} + 4.90\log IR_t^{***}$$

$$(6.54) \quad (0.62) \quad (0.19) \quad (0.27) \quad (0.84)$$

$$R^2 = 0.97, \quad D.W. = 2.63$$

2. Demand for Diesel Engines for Agricultural Machinery (Year 1974-1983)

$$DDET_t = 440502.00 - 20.78PDET_t^{**} + 17.79PB_t^{**} + 53.99FIF_{t-1}^{*}$$

$$(217269.00) \quad (8.46) \quad (9.07) \quad (30.34)$$

$$R^2 = 0.68, \quad D.W. = 2.90$$

3. Demand for Diesel Engines for Vehicles (Year 1975-1984)

$$\log DDEV_t = 9.74 - 1.04\log PDGE_t^{*} + 1.45\log RGPC_t^{**} - 1.34\log PDG_t^{*}$$

$$(11.46) \quad (0.61) \quad (0.71) \quad (0.95)$$

$$R^2 = 0.86, \quad D.W. = 1.66$$

Source: Computed by data in Appendix Table 1:A

Note : * Significant at the 10 level
** Significant at the 5 level
*** Significant at the 1 level

Appendix Table 2 : A

Cost Structure of Two-Wheel Tractors

I/O COEFFICIENT	I/O CODE	Over all import tariff (1978) percent	Over all import tariff (1985) percent	BOT (1978)	SURVEY (1985)
1. Cclour	029	41.21	44.41	0.01099	0.01500
2. Petroleum Product	030	14.95	7.53	0.00000	0.00140
3. Gaskets	031	26.16	34.97	0.00989	0.01140
4. Transmission	031	35.68	44.29	0.01627	0.01000
6. Sheets of Iron	031	24.87	33.25	0.00000	0.00000
7. Rods of Iron	035	5.14	7.67	0.07695	0.00000
8. Bars of Iron	035	5.14	7.67	0.01913	0.00000
9. Sections of Iron	035	5.14	7.67	0.02880	0.00000
10. Another Materials	035	5.58	17.67	0.32211	0.15000
11. Gears	035	5.14	7.67	0.03298	0.00000
12. Roller Bearings	037	42.61	34.97	0.07256	0.25000
13. Chain	037	26.16	34.97	0.05936	0.06860
14. Nuts & Screws	037	41.11	49.84	0.05717	0.01000
15. Wheels	037	41.11	49.84	0.02067	0.00500
16. Steering Wheels	040	83.3	103.66	0.00000	0.00000
17. Hydrolic	040	83.3	103.66	0.00000	0.00000
18. Electricity	040	83.3	103.66	0.00000	0.00000
19. Water	045			0.04331	0.01950
20. Communication	046			0.00000	0.00050
21. Advertising	052			0.00000	0.00120
22. Unclassified	055			0.00000	0.02600
23. Wages & Salaries	058	32.38	32.38	0.04156	0.20000
24. Land	201T			0.10993	0.15000
25. Construction	203L			0.00000	0.00700
26. Machinery	203C			0.00000	0.00530
27. Motor Vehicles	038	19.4	27.66	0.02331	0.01020
28. Business Tax (.055)	040	171.37	232.97	0.00000	0.00390
	204	5.5		0.05500	0.05500
OUTPUT VALUE		3.83	16.54	1.0C000	1.00000

Source : Bank of Thailand, Report on the Survey Agricultural Machinery Industry, Bangkok, 1979 and from survey 1985.

Appendix Table 2 : B

Calculated Domestic Resource Costs of Agricultural Machinery (two-wheel tractors)

Output and Inputs	Code	BOT (data 1978)			Survey (data 1985)		
		Domestic price	World price (1978)	World price (1985)	Domestic price	World price (1978)	World price (1985)
Output Value	Pdj	1.00000	0.96311	0.85807	1.00000	0.96311	0.85807
Domestic business tax on output	bdj	0.05500			0.05500		
Primary factors							
Wage and Salary	ATV	0.10993			0.15700		
Depreciation in Thai	ATVT	0.00000			0.00530		
Depreciation in Foreign	ATVF	0.02331	0.01952	0.01826	0.01410	0.00998	0.00916
Direct inputs							
Tradable inputs	AT	0.76844	0.66734	0.62766	0.72140	0.56171	0.55168
Non-tradable inputs	ANT	0.04331			0.04720		
Indirect inputs							
Tradable inputs	ANTT	0.02814	0.02404	0.02514	0.02024	0.01673	0.01696
Non-tradable inputs	ANTN	0.00165			0.00476		
Wage and Salary	ANTV	0.01442			0.02581		
Depreciation	ANTVF	0.00165	0.00138	0.00129	0.00192	0.00161	0.00151
Business Tax	bdi	-0.00254			-0.00024		

Domestic Value Added (DVA) = Pdj (1-bdj) - AT - ATVF - ANTT - ANTVF

World Value Added (WVA) = Pdj/dj - AT/D - ATVF/D - ANTT/D - ANTVF/D

$$DRC = \frac{DVA}{WVA/OER}$$; OER = Official Exchange Rate

$$ERP = \frac{DVA}{WVA} - 1$$

Note : "Divided D" means at world prices

	BOT (data 1978)		Survey (data 1985)	
	(1978)	(1985)	(1978)	(1985)
DVA (baht)	0.12346	0.12346	0.18733	0.18733
WVA (baht)	0.25084	0.18573	0.37309	0.27876
OER (baht/US $)	20.31	27.13	20.31	27.13
SER (baht/US $)	22.05	28.56	22.05	28.56
DRC (baht/US $)	10.00	18.04	10.20	18.23
ERP (C) (Per cent)	-50.78	-33.53	-49.79	-32.80
NRP (Per cent)	3.83	16.54	3.83	16.54

Appendix Table 3:A
Cost Structure of Diesel Engines, 1984

	I/O COEFFICIENT	1984 Over all import tariff	1984 domestic prices	1984 world prices
1	Production cost		0.770246	
2	CKD	39.01	0.356869	0.256730
3	Direct inputs	39.01	0.011706	0.008406
4	Indirect inputs	39.01	0.170799	0.122858
5	Oil	7.53	0.039800	0.037012
6	Other materials	7.67	0.137704	0.127894
7	Electricity		0.007502	
8	Wage & salary in Thai		0.017452	
9	Wage & salary in Foreign		0.001649	0.001649
10	Land		0.001011	
11	Construction		0.005853	
12	Machinery	27.66	0.018251	0.014296
13	Motor vehicle	232.97	0.001649	0.000495
14	Sale & Management costs		0.080185	
15	Wage & salary		0.013675	
16	Advertising		0.006545	
17	Other services		0.059966	
18	Business tax		0.026551	
19	Interest		0.040758	
20	Income tax		0.002075	
21	Net profit		0.080185	
	Output Value	38.08	1.000000	0.724217

Source : From survey 1986.

Appendix Table 3 : B

Calculated Domestic Resource Costs of Diesel Engines
for Agricultural Machinery (two-wheel tractors)

Output and Inputs	Code	1984	
		Domestic price	World price
Output Value	Pdj	1.000000	0.724217
Domestic business tax on output	bdj	0.028626	
Primary factors			
Wage and Salary in Thai	ATV	0.031126	
Wage and Salary in Foreign	ATLF	0.001649	0.001649
Depreciation in Thai	ATVT	0.006862	
Depreciation in Foreign	ATVF	0.019899	0.014791
Direct inputs			
Tradable inputs	AT	0.716877	0.552903
Non-tradable inputs	ANT	0.074012	
Indirect inputs			
Tradable inputs	ANTT	0.018767	0.014633
Non-tradable inputs	ANTN	0.009559	
Wage and Salary	ANTV	0.046788	
Depreciation	ANTVF	0.002780	0.002177
Business Tax	bdi	0.001970	

Domestic Value Added (DVA) = Pdj (1-bdj) - AT - ATLF - ATVF - ANTT - ANTVF
World Value Added (WVA) = Pdj/dj - AT/D - ATLF/D - ATVF/D - ANTT/D - ANTVF/D

$$DRC = \frac{DVA}{WVA/OER}$$; OER = Official Exchange Rate

$$ERP = \frac{DVA}{WVA} - 1$$

Note : "Divided D" means at world prices

	1984
DVA (baht)	0.211398
WVA (baht)	0.138062
OER (baht/US $)	23.61
SER (baht/US $)	25.04
DRC (baht/US $)	36.16
ERP (C) (Per cent)	53.12
NRP (Per cent)	38.08

Appendix Table 4 : A

Formula of Backward and Forward Linkage Coefficients [1/]

Formulas for computed backward and forward linkage coeffients are

$$Uj = \frac{(1/n).Zj}{(1/n^2)\sum_{j=1}^{n} Zj} \qquad (j = 1,2,\ldots\ldots,180) \qquad \ldots\ldots\ldots\ldots (1)$$

$$Ui = \frac{(1/n).Zi}{(1/n^2)\sum_{i=1}^{n} Zi} \qquad (i = 1,2,\ldots\ldots,180) \qquad \ldots\ldots\ldots\ldots (2)$$

when

Uj = Index of the power dispersion showing backward linkage effects
Ui = Index of the sensitivity of dispersion showing forward linkage effects.
Z = Leontief inverse matrix

and formula for standard devistion coefficient is

$$Vj = \frac{\sqrt{[1/(n-1)]\sum_{i} [(Zij - (1/n)\sum_{i} Zij]^2}}{(1/n)\sum_{i} Zij}$$

$$Vi = \frac{\sqrt{[1/(n-1)]\sum_{j} [(Zij - (1/n)\sum_{j} Zij]^2}}{(1/n)\sum_{j} Zij}$$

1/ P. N. Rasmussen, Studies in Inter-Sectoral Relations, (Amsterdam : North-Holland Publishing Company), 1965. pp. 62-63.

Appendix Table 4 : B

Estimates of Backward and Forward Linkage Coefficients

	1975	1980
Backward Linkage (Uj)		
I/O 112 Engines and turbines	1.5443	1.0145
	(6.2853)	(7.6836)
I/O 113 Agricultural machinery and equipment	0.7282	0.7153
	(11.0837)	(10.7327)
Forward linkage (Ui)		
I/O 112 Engines and turbines	1.1917	1.2339
	(8.1214)	(6.3834)
I/O 113 Agricultural machinery and equipment	1.2535	1.2556
	(6.5720)	(6.2439)

Source : Computed from Imput-Output table year 1975 and 1980.
Note : Data in parenthesis are standard deviation.

FOOTNOTES:

1/ A more detailed discussion of the stages of industrialization in Thailand can be found in Akrasanee, N., "Thailand Industrial Sector Background Report," prepared for the World Bank, 1982.

2/ Import-substituting industries are defined as ones which are viable under high rates of effective protection. The shares of the three industries were 49.8, 12.2, and 72.6 percent under the effective rates of protection of 60.0, 52.4, and 48.9 percent respectively in 1983. The data are from NESDB, National Income of Thailand, various issues, and The Industrial Management Co., Ltd., Industrial Restructuring Study, Bangkok, September, 1985, p. 89.

3/ The shares of production in textiles and garments and food processing industries in the total manufacturing sector were 20.1 and 13.1 percent respectively in 1984. It is however noticeable that the size of these three intermediate and capital goods industries are similar to other ASEAN countries with similar range of per capita income.

4/ For political reasons there was an absence of both diplomatic and trade relations between Thailand and China from the early 1950s. After the diplomacy was established again in 1975, there has been an increasing international trade between the two countries. By the early 1980s China in fact became Thailand's fifth largest trade partner in terms of imports into Thailand.

5/ According to our firm interviews the demand for imported Japanese tractors had decreased tremendously during 1978-1980 in response to the increases in the import prices after the yen appreciation at 25 percent in 1978 and the decline in farm incomes during the period. A large amount of lower-priced secondhand Japanese tractors were thus imported in the early 1980s to replace the more expensive new ones and compete with the local production.

6/ The discussion of this section is updated and revised from the results of the small tractor firms survey in 1980 which are presented in Wiboonchutikula, P., "The Total Factor Productivity Growth of the Agricultural Machinery Firms in Thailand, 1960-79," in Consequence of Farm Mechanization in Asia, ADC/IRRC, Los Banos, The Philippines, 1982, pp. 51-60.

7/ Before 1982 the tractor industry obtained little protection from competing imports. There was a 5 percent import duty and the effective rate of protection (ERP) was 15 percent. In the late 1970s there was a firm granted BOI's promotional privileges. Unfortunately the firm was too capital intensive and too modern under a given scale of production, and it could not compete with the rest which rely on techniques consistent with local resource endowments. Since then no other firms producing small tractors have granted any more BOI promotion. Only two firms producing large tractors are still under the BOI promotion.

8/ According to Friedman, these exiting small firms (or excessively large ones) represent firms which are technically and economically inefficient. The size to which firms are concentrating should represent the optimal scale. See Friedman, M., "Comment", from Universities National Bureau Committee for Economics Research, Business Concentration and Price policy, Princeton University Press, 1955. pp. 230-37. For the farm tractors industry in Thailand, the optimal size should be firms employing 50-200 workers.

9/ According to the formulas for computering the forward and backward linkages shown in Appendix Table 4: A, the effects are high when the coefficients are greater than unity (the average). If the standard deviation coefficient is low it implies that the linkages are spreaded to a wider range of industries than when the coefficient is high. The computed forward linkage of the agricultural machinery industry shown in Appendix Table 4 : B was about 1.26 percent and the standard deviation was only around 6 to 6.5 percent using either the 1975 or the 1980 input-output table. However, the industry's backward linkage was less than unity, and the standard deviation also shows that it has linked with a narrower range of industries. Therefore the forward linkage of the industry seemed to be stronger than the backward linkage.

10/ See Sukharomana, S., "Domestic Resource Cost of Agricultural Mechanization in Thailand: A Case Study of Small Rice Farms in Supanburi," in Consequences of Farm Mechanization in Asia, op. cit., pp. 61-71.

11/ They are the results from the survey conducted by the Office of Agricultural Economics, Ministry of Agriculture and Co-operatives, "The Use of Animal Power and Agricultural Machinery in Farming," Report No. 31, Bangkok, 1984.

12/ The results are drawn from a study by the Office of Agricultural Economics, Ministry of Agriculture and Co-operatives, "The Cost-Benefit Analysis of the Use of Domestically Produced Tractors and the Imported Second Hand Tractors," Report No. 120, Bangkok, 1985.

13/ See Bank of Thailand, Annual Report on Business and Industrial Conditions, Bangkok, 1982, pp. 358-371.

14/ There has been a vast collection of literature on the subject since 1960 such as Bruno, M., Interdependence, Resource Use, and Structural Changes in Israel, Jerusalem, Books of Israel, 1963, Krueger, A., "Evaluating Restrictionist Trade Regiones: Theory and Measurement," The Journal of Political Economy, Vol. 80, No. 1, January, 1972, pp. 48-62, and Pearson, S.R., Akrasanee, N., Nelson, G.C., "Comparative Advantage in Rice Production: A Methodological Introduction," Food Research Institute Studies, Vol. 15, No. 2, 1976, pp. 177-221.

15/ Bank of Thailand, Report on the Survey of Agricultural Machinery Industry, Bangkok, 1979.

16/ For more details, see Chintayarangsan, R., Thampitakkul, B., Satawit, K., Sripaipan, C., "Industrial Restructuring in Machinery Industry," a Report, The Industrial Management Co. Ltd., Bangkok, 1985.

17/ See Wiboonchutikula, P., "The Total Productivity Growth of the Agricultural Machinery Firms in Thailand, 1960-79," and Wattanutchariya, S.," Economic Analysis of Farm Machinery Industry, "in Consequence of Farm Mechanization in Asia, op. cit., pp. 51-60 and pp. 39-50.

18/ See Paterno, V. T., "ASEAN Industrial Complementation", a Report, VIENNA, UNIDO, 1982 and Lee, S. Y., "ASEAN Industrial Joint Venturs in the Private Sector", a Report, VIENNA, UNIDO, 1982.

19/ See Board of Investment, Annual Report: Promoted Firms, Bangkok, 1983.

20/ There were nine items specified by the BOI for firms to meet the local content requirement. Firms have already met the requirement on seven items namely cam gear, idle gear, rocker arm (in and ex), idle shaft, cam shaft, and cylinder liner, but the items of connecting rod and cylinder head were still all imported because of the lack of technology needed for their domestic production.

21/ See Board of Investment, Annual Report : Promoted Firms, op. cit.

22/ In fact both the forward and backward linkage effects of the diesel engines industry are quite high. Appendix Table 4 : A and B shows that in 1980 the forward and backward linkage coefficient were 1.23 and 1.01 percent respectively with rather low standard deviation.

23/ In fact, the prices of locally produced diesel engines are also lower than those in other ASEAN countries from 31 percent to 81 percent depending on the size of the engines.

24/ See Board of Investment, Annual Report: Promoted Firms, Bangkok, various issues.

25/ Diesel is taxed much lower than gasoline for the purpose of avoiding the high costs in the transportation and fisheries sectors in which diesel is heavily used.

26/ See Wong, J., "Regional Industrial Co-operation: Experiences and Perspective of ASEAN and the Andean Pact," a Report, VIENNA, UNIDO, 1983, pp. 48-49.

27/ In 1985 the import of olefins was 44,299 tons and the average polyolefins (LDPE, HDPE and PP) imported were approximately 150,000-160,000 tons. The import of olefins began in 1977 and the average polymers grew at 10.9 and 2.4 percent a year during 1970-1977, and 1977-1984 respectively.

28/ The natural gas separation plant in Rayong province constructed by the Petroleum Authority of Thailand is able to produce 220,000 tons of propane, and 354,850 tons of ethane annually to be feedstocks for petrochemical production.

29/ See the Eastern Seaboard Development Committee, Prospectives: Thailand's Petrochemical Complex, 1982.

30/ See Lurgi Gmbtt and Trichem Consultants Ltd., Feasibility Study: Part B: Definition of Complex & Upstream Unit, prepared for National Petrochemical Corporation Ltd., 1983.

31/ See UNIDO, "Industry in a Changing World", Special Issue of the Industrial Development for the Fourth General Conference of UNIDO, Vienna, UNIDO, 1983.

32/ A recent study shows that cost differentials of different plants are increasingly be explained by factors other than scale. From the study, the pattern of technological change in the petrochemical industry during th 1960s and the first half of the 1970s is quite different from the 1980s in terms of plant scales. During the previous two periods there was a bias in favor of increasing scale of plant in order to introduce new processes products. In the 1980s as a result of uncertainties as to the availability and prices of feedstocks, there seemed to be increasing diseconomies of scale of highly inflexible large plants. The focus of technological improvement was thus turned to improve existing technology by boosting yields, shifting input or output mix, and cutting energy consumption. In fact, leading petrochemical multinationals such as ICI, Dupont, and Union Carbide are already scaling down their plants and This can also partly explain the surge in the petrochemical projects in nonindustrialized countries with smaller markets but less expensive feedstocks than some industrial countries. See F. C. Sercovich, "State-owned Enterprises and Dynamic Comparative Advantage in the World Petrochemical Industry", Discussion Paper No. 96, Harvard Institute of International Development, harvard University, 1980.

33/ See Paterno, V. T. "ASEAN Industrial Complementation and Lee, S. Y., "ASEAN Industrial Joint Ventures in the Private Sector", op. cit.

34/ See Far Eastern Economic Review, Vol. 128, No. 24, 20 June 1985, pp. 104-111.

REFERENCES

Akrasanee, Narongchai, "Thailand Industrial Sector Background Report", prepared for the World Bank, 1982.

Bank of Thailand, "Annual Report on Business and Industrial Conditions", Bangkok, various issues.

_____, Report on the Survey of Agricultural Machinery Industry, Bangkok, 1979.

Board of Investment, Annual Report: Promoted Firms, Bangkok, various issues.

Bruno, M., Interdependence, Resource Use, and Structural Changes in Israel, Jerusalem, Books of Israel, 1963.

Chintayarangan, R., B. Thampitakkul, K. Satawut, and C. Sripaipan, "Industrial Restructuring in Machinery Industry", a report, The Industrial Management Co., Ltd., Bangkok, 1985.

Eastern Seaboard Development Committee, Prospectives: Thailand's Petrochemical Complex, 1982.

Far Eastern Economic Review, Vol. 128, No. 24, June 20, 1985, pp. 104-111.

Friedman, M., "Comment", from Universities National Bureau Committee for Economics Research, Business Concentration and Price Policy, Princeton University Press, 1955.

Industrial Management Co., Ltd., Industrial Restructuring Study, Bangkok, September, 1985.

Krueger, A., "Evaluating Restrictionist Trade Regimes: Theory and Measurement", The Journal of Political Economy, Vol. 80, No. 1, January, 1972, pp. 48-62.

Lee, S. Y., "ASEAN Industrial Joint Ventures in the Private Sector," a Report, UNIDO, Vienna, 1982.

Lurgi Gmbtt and Trichem Consultants Ltd., Feasibility Study: Part B: Definition of Complex & Upstream Unit, prepared for National Petrochemical Corporation Ltd., 1983.

NESDB, National Income of Thailand, various issues.

Office of Agricultural Economics, Ministry of Agriculture and Co-operatives, "The Cost-Benefit Analysis of the Use of Domestically Produced Tractors and Imported Second Hand Tractors", Report No. 120, Bangkok, 1985.

_____, "The Use of Animal Power and Agricultural Machinery in Farming", Report No. 31, Bangkok, 1984.

Paterno, V. T., "ASEAN Industrial Implementation", a Report, UNIDO, Vienna, 1982.

Pearson, S.R., N. Akrasanee, and G.C. Nelson, "Comparative Advantage in Rice Production: A Methodological Introduction", Food Research Institute Studies, Vol., 15, No. 2, 1976, pp 177-221.

Sercovich, F.C., "State-owned Enterprises and Dynamic Comparative Advantage in the World Petrochemical Industry", Discussion Paper No. 96, Harvard Institute of International Development, Harvard University, 1980.

Sukharomana, S., "Domestic Resource Cost of Agricultural Mechanization in Thailand: A Case Study of Small Rice Farms in Supanburi", in Consequence of Farm Mechanization in Asia, ADC/IRIC, Los Banos, The Philippines, 1982, pp. 61-71.

UNIDO, "First Worldwide Study on the Petrochemical Industry: 1975-200", prepared by the Sectoral Studies Section International Centre for Industrial Studies, 1978.

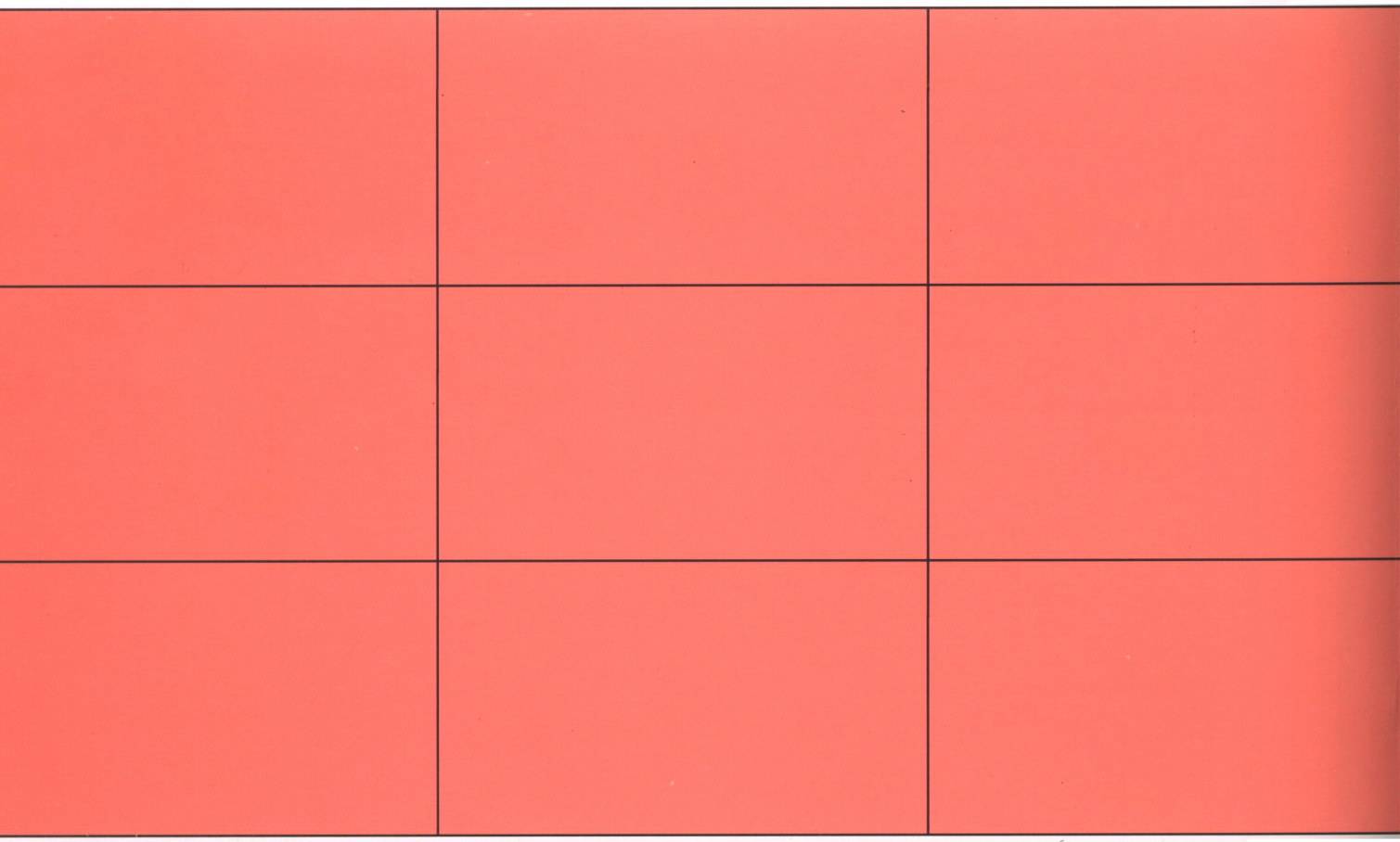
_____, "Industry in a Changing World. Special Issue of the Industrial Development for the Fourth General Conference of UNIDO", VIENNA, UNIDO, 1983.

_____, "Second Worldwide Study on the Petrochemical Industry: Process of Restructuring", for Second Consultation Meeting on the Petrochemical Industry, 1981.

Wattanutchariya, S., "Economic Analysis of Farm Machinery Industry", in Consequences of Farm Mechanization in Asia, ADC/IRIC, Los Banos, The Philippines, 1982, pp. 39-50.

Wiboonchutikula, Paitoon, "The Total Factor Productivity Growth of the Agricultural Machinery Firms in Thailand, 1960-79", in Consequences of Farm Mechanization in Asia, ADC/IRRI, Los Banos, The Philippines, 1982, pp. 51-60.

Wong, J., "Regional Industrial Co-operation: Experiences and Perspective of ASEAN and the Adean Pact", a Report, UNIDO, Vienna, 1983.



Thailand Development Research Institute Foundation

565 Ramkhamhaeng 39, Wangthonglang, Bangkok 10310 Thailand
Tel: (662) 7185460; Fax: (662) 7185461-62; Web site: http://www.info.tdri.or.th