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DISCUSSION PAPER SERIES

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THAMMASAT UNIVERSITY
BANGKOK

THAMMASAT UNIVERSITY

June 1980

FACULTY OF ECONOMICS

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Introduction

This is a partial summary and conclusion, and policy implications derived from a research report namely patterns of growth and Employment in the Thai and Japanese Economies. Interested readers should investigate in a more detail in the main report. What has been presented here is, as already noted, a partial summary and conclusion.

The main method of the analysis of this study is within the framework of the Shift and Share Model with some minor modifications. For the sake of simplicity and understanding the model could be easily explained in terms of horse racing analogy. Industries with relatively high growth could be compared to the front group of the horses in the racing track, and those with relatively slow growth would be the back group of the horses. The study divided the economies into different industries (analogous to different horses), and geographically divided the economies into different regions (analogous to different racing tracks). The main question concerned in this study is what are the front and the back groups of the horses, and in what tracks (regions) are they performing badly or well. By keeping this analogy in mind the reader will realize the central idea of the model, and its interpretation.

The followings will start with the growth, and employment structures of the Thai economy, and lately with the growth and employment structures of the Japanese economies The period of analysis was constrained by availability of employment data particularly with respect to the Thai economy, therefore, only two arbitary periods were chosen in this study.

1.1 Growth Structure of the Thai Economy, 1960-1970, 1970-1975.

Structurally, the growth structure of the Thai economy had shifted away from Agriculture, Transportation and Communication, Services and Administration and Defense and in favor of Manufacturing, Banking, Insurance and Real Estate, Wholesale and Retail Trade, Electricity and Water Supply, Construction, and Mining and Quarrying during the 1960-1970 period. The government policy towards industrialization by promoting foreign and domestic investment, and by building up considerably the infrastructural facilities during the first and second development plans, 1961-1971, seemed to be relatively more favorable for these comparatively fast growing industries.

Similarly for 1970-1975 period, the growth structure was almost the same as that of the 1960-1970, with the exception for construction which became negatively shifted, indicating that the structure had shifted away from construction industry, which was mainly due to the construction of infrastructural facilities during the first two development plans, 1961-1971, had reached the peak, and declined during the 1970-1975 period. In addition, the withdrawal of U.S. military presence during the latter had dereased construction and related activities.

Generally speaking, Manufacturing, Banking, Insurance and Real Estate, and Wholesale and Retail Trade, seemed to be relatively the growth leaders during the 1960-1970, and 1970-1975 periods. Particularly, Manufacturing sector had grown relatively well during the 1972-1974 period, which was due mostly to favorable demand in international market.

Looking aggregately, the growth structure, undoubtedly, had shifted from primary industry toward secondary and tertiary during the 1960-1970 period, with the secondary was mostly favorable, however. The tertiary turned to be the most favorable during the "oil embargo period", which was primarily due to the fact that Manufacturing had been much affected by the instabilities during the period. On the contrary, services were not much influenced.

In a detailed investigation of Manufacturing sub-industries during the 1972-1975 period, the only duration in which data for

Manufacturing sub-industries were available, it was found that Processed Food, Consumers' Durables, and Intermediate Product I were the relatively fast growing sectors, and towards which the growth structure had mostly shifted as far as the Manufacturing sub-industries were concerned.

Among the group of Processed Food, Food Preparation, Meat and Meat Products, Sugar and Confectionary, and Cereal Products were, structurally, most favorable. Similarly, Transportation Equipment in the group of Consumers' Durables was favorable mostly during the 1972-1975 period. Lumber and Plywood, Fuel and Petroleum were structurally, most favorable in the group of Intermediate Product I.

The growth structure were against the following groups: Construction Material, Beverage and Tobacco, and Intermediate Product II. Particularly, in the Intermediate Product II, a very big group, the following sub-industries were mostly unfavorable, namely, Textile, Paper and Paper Products, Rubber and Rubber Products, Metal products, Chemical Products, and Wood Products. These industries seemed to be mostly affected by the period of oil crisis, in which the costs of raw materials, energies, and transportation had climbed up sharply.

1.2 Thailand's Regional Growth Structure.

Turning to regional growth structure of the Thai economy, it was found that Agriculture, and Administration and Defense, were, for all regions, structurally unfavorable during the 1960-1970 period. Similarly, for Services which were growing slowly in most regions, with the exception was for the central. The growth structures of nearly all regions were against Transportation and Communication during the 1960-1970 period, with the exception was for the Northeast. This region seemed to have special characteristics notably different from others at least in one aspect during the 1960-1970; it was the location of five out of seven U.S. airbases during the vietnam-war. Transportation and communication were much facilitated in this region. Also, the Northeast seemed to have relatively more insurgency problems, accordingly, the government seemed to pay much attention to this region. The Northeast, previously, with the most underdeveloped transportation and communication facilities, now probably could be considered one of the best. Oppositely, the South formerly considered to have better transportation facilities, now could be considered the most lagging facilities, and the most lagging region of the country in terms of economic growth.

Another peculiar thing may be worthed to point out is about Mining and Quarrying. The South has long been very famous in Mining and Quarrying. Surprisingly, this study found that the South was the only region having a negative shift in Mining and Quarrying, which indicates that the growth structure was against Mining and Quarrying in the South. The explanation for this peculiar event was that

Quarrying, nowadays, has been increasingly important, particularly, in the regions where construction are booming. This study revealed that all regions, except the South, were structurally shifted in favor of Construction, and Minining and Quarrying during the 1960-1970 period; the South was really the exceptional, where both sectors experienced negative shifts, accordingly, growth structure was against them during the period considered. The implication for the negative shift in the South is that other regions have become more competitive in Mining and Quarrying sector with the South, which was mainly due to the lagging of construction and Quarrying activities in the South itself.

Comparing the growth potentiality of the individual industries across different regions of the Thai economy, using the 1960-1970 data as a basis, it was found that the North and the South seemed to grow relatively well in Agriculture, Forestry, and Fishery. This might have been mainly due to the relative expansions of forestry in the North and Fishery in the South. Other sectors could be roughly ranked as follows: Mining and Quarrying was first for the North, Second for the Northeast, and Third for the Central. Manufacturing was first for the Central, and Second for the Northeast. Construction seemed to be regionally favorable firstly for the Northeast and Secondly for the Central during the period considered. Administration and Defense, was, as expected, booming in the South and in the Northeast, the most troublesome regions with relatively more political and insurgency problems. Finally, Service was expanding comparatively fast in the Central and in the Northeast.

Generally speaking, the South seemed to be the only region with the most lagging economic activities during the 1960-1970 period unexpectedly, the Northeast, previously, the most underdeveloped regions seemed to be more regionally favorable nearly all industries, the exception was only for Agriculture, Forestry, and Fishery, during the 1960-1970 period.

1.3 Policy Implications

As far as economic growth for the Thai economy is concerned, the above identified industries or sub-industries, with relatively high growth potentials, of different regions should be selectively promoted or stimulated further if the higher growth targets are to be achieved. Similarly, the identified lagging industries or sub-industries of different regions or economy should be studied and paid much more attention to them, otherwise they would increasingly, become growth retarding sectors of the economy. Regionally, the government should pay much more attention to the South while maintaining the developments of other regions. Relating to the Northeast now become a region with relative better and improved infrastructural and growth structures, the government should make use of the already invested infrastructural facilities by promoting specifically more investment in this region, doing so may be another way of improving income distribution and the security of the country.

2.1 Employment Structure of the Thai Economy, 1960-1970, 1970-1975.

On the part of employment, it was found that during the 1960-1970 employment structure of the Thai economy had shifted away from Agriculture, Forestry and Fishery, Wholesale and Retail Trade towards the following respective industries namely services, Manufacturing, Administration and Defense, Construction, Transportation, and Communication, Mining and Quarrying, Banking & Insurance and Real Estate, and Electricity and Water Supply. Undoubtedly, if considered by types of industries, employment structure of the economy has turned against primary and in favor of Tertiary and Secondary Industries respectively.

Based on an investigation of manufacturing sub-industries during the 1972-1975, the only period in which data are available, this study found that the following manufacturing sub-industries, which already ranked, were contributing more to employment creation, namely, (1) Textile, (2) Cereal Products, (3) Food preparation, (4) Tobacco, (5) Other textile articles, (6) Metal product, (7) Agricultural and Nonelectrical Machinery, (8) Construction Material, (9) Lumber and Plywood, (10) Chemical Product, and (11) Wood Product. Similarly, if different groups of manufacturing sub-industries are ranked it would be as follow: (1) Intermediate Product II, (2) Processed Food, (3) Consumers' durables, (4) Intermediate Product I, (5) Beverage and Tobacco, and (6) Construction Materials.

2.2 Thailand's Regional Employment Structure.

Turning to regional employment structure it indicated that Agriculture in the Northeast region absorbed relatively more labor than other industries in this region. The other industries, which absorbed comparatively more labor in this region, were as follows: (1) Services, (2) Administration and Defense, (3) Transportation and Communication, (5) Manufacturing, and (6) Construction. On the contrary industry with a very low labor absorption for this region was wholesale and Retail Trade.

For the North, the following industries absorbed relatively more labor: (1) Services, (2) Administration and Defense, (3) Construction, (4) Transportation and Communication (5) Mining and Quarrying. And industries with a relative low employment creation for the North were: (1) Agriculture, and (2) Wholesale and Retail Trade.

Turning to the South, it was found that the following industries absorbed relatively more labor (1) Services, (2) Administration and Defense, and (3) Mining and Quarrying. On the Contrary. Agriculture, wholesale and Retail Trade, and Manufacturing respectively absorbed comparatively small amount of labor.

Finally, for the Central, industries with relatively high labor absorptive capability are roughly ranked as followed (1) Services (2) Manufacturing, (3) Construction, (4) Administration and Defense, (5) Transportation and Communication, (6) Mining and Quarrying, and (7) Banking Insurance and Real Estate. On the other side of the street, industries with relatively low employment creation were (1) Agriculture, and (2) Wholesale & Retail Trade.

If regional comparision is made with respect to the ability of each industry of different regions to absorb labor, this study revealed that Agriculture was with relatively more labor absorption in the Northeast region. The Central and the North seemed to be favorable for Mining and Quarrying (mostly due to Quarrying). For Manufacturing, the central ranked first and the Northeast ranked second. Similarly, for Construction, the Central came first and the Northeast seemed to be relatively favorable for this industry. Electricity and Water Supply seemed to absorb relatively more labor in the Northeast and the South respectively. Wholesale and Retail Trade did not help much in terms of employment creation, but relatively, it absorbed more workers in the Northeast and in the North. Banking, Finance, Insurance, unbeleivably absorbed more workers in the Northeast and in the North. Transportation and Communication created more employment in the Northeast, while Administration and Defense, expectedly, create more jobs for the Northeast and the South, the two most troublesome regions in terms of insurgency problems. Finally, Services created relatively more jobs in the Central, the North and the Northeast respectively.

2.3 Policy Implications: Employment.

As far as policy implications were concerned in the part of employment in Thailand, the already identified industries or sub-industries, with relatively more labor absorptive capabilities, of different regions should be selectively promoted or stimulated if employment creation is the entire national policy objective. For example, if Agriculture in the Northeast has been actually paid much more attention, and improved by building up more usable irrigation projects and other means it could absorb relatively more labor than those of other regions. Similarly, industries or sub-industries with relatively lagging employment creation should be studied in detail and should be paid more attention to them otherwise they would become permanently employment's lagging sectors of the country. For example, this study indicated that Wholesale and Retail Trade for all regions seemed to create relatively small number of jobs, or employment, which indicated that domestic trade of the country seemed to be mostly underdeveloped. It was not clear whether the government has really tried to promote it. If such policy existed this study has revealed that it was the total failure of such policy of domestic-trade promotion.

3.1 Growth Structure of the Japanese Economy, 1960-1970, 1970-1975.

For the Japanese economy, the growth structure shifted respectively from Agriculture, Mining, Electricity Water Supply and Gas, Transportation and Communication, and Administration towards services, Finance, Insurance and Real Estate, Wholesale and Retail Trade, Construction and Manufacturing during the 1960-1970 period. Growth structure of the 1970-1975 period was not much different from that of the 1960-1970, the exceptions were for Manufacturing, and Administration, which the structure was against the first and in favor the latter during the troublesome 1970-1975 period. This may be an evidence which indicated that Japanese government seemed to try very hard to solve problems during the period of instability.

If looked on the basis of types of industries, it was found that the structure was shifted from primary towards tertiary and Secondary, with the first mostly favored during the 1960-1970 period. But during the 1970-1975, the structure was shifted away from both Primary and Secondary industries towards the Tertiary. This was mainly due to Manufacturing in Japan was heavily affected during the instability period.

A close look at Manufacturing sub-industries of Japan during the instability period, it was found that the growth structure has been shifted respectively away from the following sub-industries:

(1) Textile Mill Product (2) Chemical Allied product (3) Iron & Steel product (4) Petrolum & Coal products (5) Non-ferrous Metal product (6) Pulp, paper and paper product, (7) Rubber Product and (8) Lumber and plywood, and in favor the followings: (1) Fabricated Metal Products (2) Food and Kindred Products, (3) Machinery Equipment, (4) Transportation Equipment (5) Electrical Machinery, Equipment and Supplies, (6) Publishing, Printing and Allied products (7) Apparel other Finished products made from Fabricated & Similar Materials, (8) Furniture and Fixture, (9) Stone, Clay, and Glass Product,(10) Precision Machinery, and (11) Leather, Leather and Fur products.

Looking at the first five sub-industries towards which the growth structure is mostly favorable, it is found that the structure has been shifted mostly in favor of relatively heavy and Electrical Manufacturing sub-industries. On the contrary, Textile Mill product, and other relatively labor intensive sub-industries, seemed to be in trouble, and away from which the growth structure has mostly shifted.

To understand the Japanese economy better, a brief survey of Japanese history of economic growth was done. Historically, various reasons and explanations for the economic miracle of Japan during the post war period were given. Among others are as follows: (1) The largest contribution made by capital, advance in knowledge and technology, (2) economies of scale made possible by expanding markets; (3) the increase in Quantity and Quality of labor, and lastly and importantly (4) the abundant supply of natural resources which Japan benefited from the rest of the world. During the fast growing periods 1950's, particularly during the 1960's, Japan was very advantageous from the relatively cheap imported natural resources from other countries, particularly, from developing countries.

The turning point of Japanese economy seemed to be reached in the early 1970's when the costs of petroleum and other raw materials of the world as well as labor costs at home have essentially risen. The growing nationalism, and the oligopolistic arrangements of the natural-resource-rich countries have put Japan into difficult position.

However, Japan has opened the new chapter of economic growth and has been very farsighted by promoting substantially investments overseas particularly in the sector of naturnal resource and raw material; Mining and Trading are outstandingly promoted overseas, for example. The investment abroad were promoted through various motives, (1) was to promote the export of Japanese merchandise. In order to expand sales, Japan's general merchants and Commercial banks established branch offices extensively in western countries. Also Japanese processing industries were established in Southeast Asia, purchasing semi-manufactured goods from Japan, (2) was to employ the cheaper labor of Indonesia, Malaysia, Celon, Thailand, Formosa, and the Republic of Korea, (3) was to overcome export barriers of America which usually checked the imports of Japanese commodities, (4) was to develop natural resources and to obtain them at low prices. And lastly, (5) to remove domestic pulluting industries out of Japan.

With respect to problem of pollution, petro-chemical and heavy industries contributed most to environment destruction. According to this study, the Japanese firms with relatively low growth potential in Japan and likely to be promoted abroad are: (1) Textile Mill Product (2) Chemical Allied products (3) Iron & Steel (4) Petroleum and Coal products (5) Non-ferrous Metal product (6) Pulp, paper and paper product (7) Rubber product (8) Lumber and Wood product and (9) others. The Growth Structure in Japan seems to be against these industries, as already mentioned.

3.2 Regional Growth Structure of Japan.

Turning to the strength and weakness of Manufacturing sub-industries in different regions of Japan this study revealed as follows: Food and Kindred product: grows relatively well in Kanto, Tohoku, Sikoku, Kyusya, and Thubu, and relatively slow in Kinki, Hokuriku, and Hokkaido. (2) Textile Mill product: Relative strong regions: Hokuriku, Kyusyu, Tohoku, Sikoku, and Tyugoku. Relative weak regions: Kanto, Kinki and Hokkaido. (3) Apparel and Other Finished Product: Relative strong regions: Kanto, Tohoku, Kyusyu, Thubu and Hokuriku. Relative weak regions: Kinki, Hokkaido, and Tyugoku (4) Lumber and Plywood: Relative strong regions: Tyugoku, Kokuriku, Kyusyu, Tohoku, and Sikoku. Relative weak regions: Kanto, Tohoku, Thubu, Hokuriku and Tokai. Relative weak regions: Kinki, Kyusyu and Hokkaido. (8) Chemical and Allied Product: Relative strong regions: Kinki, Kanto, Tokai, Tyugoku, and Thubu. Relative weak regions: Kyusyu, Hokuriku, and Sikoku. (9) Petroleum and Coal Product: Not good for all regions: Relatively good for Kinki and Relatively worst for Kanto, Tyukoku, and Tokai. (10) Rubber Product: Relative strong regions: Tokai, Tohoku, Hokuriku, Thubu and Tyugoku. Relative weak regions: Kanto, Kinki, and Kyusyu. (11) Leather and Leather & Fur Product: Relative strong regions: Kanto, Tohoku, Kyusyu, Thubu, and Hokuriku. Relative weak ones: Kinki, Tyugoku, and Sikoku. (12) Stone Clay and Glass Products: Relative strong regions: Tohoku, Thubu, Sikoku, Hokkaido and Hokuriku. Relative weak ones: Kinki, Tokai and Kanto. (13) Iron and Steel: Relative strong regions: Tyugo, Tokai, and Sikoku, and Hokuriku. (14) Non-ferrous Metal & Products: Relative Strong regions: Hokoriku, Kyusyu and Thugoku: Relative weak ones: Kanto Kinki and Thubu. (15) Fabricated Metal Products: Relative Strong regions: Kinki, Tokai, Kanto, Tohoku, and Tyugoku: Relative weak: Kyusyu and Kokkaido. (16) Machinery and Equipment: Relative Strong regions: Kanto, Tokai, Sikoku, Thubu, and Kyusyu. Relative weak ones: Kinki and Hokuriku. (17) Electrical Machinery, Equipment and Supplies. Relative strong regions: Kanto, Tohoku, Thubu, Tyugoku, and Hokuriku. Relative weakest: Kinki. (18) Transportation Equipment. Relative Strong regions: Kanto, Tokai, Sikoku, Tohoku and Thubu. Relative weak regions: Kinki, Tyugoku, and Kyusyu. And finally (19) Precision Machinery and Equipment. Relative Strong region: Thubu, Tohoku, Kinki, Hokuriku, Hokkaido. Relative weak Regions: Kanto, Tokai, and Sikoku. Roughly ranking, Tohoku, Thubu, and Kanto were the first three leading regions for Manufacturing as a whole. The last three lagging regions were Hokkaido, Kinki, and Kyusyu.

3.3 Policy Implications: Growth.

Policy Implications: If economic growth is the entire policy objective, the identified industries, with relatively high growth potentials, of different regions should be further studied and promoted. On the contrary, the identified lagging industries of different regions should also be studied and paid much more attention to them, otherwise they would permanently become the growth retarding industries of the country.

4.1 Employment Structure of Japan.

Turning to Employment of Japanese economy it was found that employment structure of Japan during the 1960-1970 period, has been shifted away from Agriculture, Forestry and Fishery, and Mining and in favor of Manufacturing, Wholesale and Retail Trade, Construction, Services, Transportation and Communication, Finance, Insurance, and Real Estate, Administration, and lastly, electricity, Water Supply and Gas.

During the 1970-1975, the structure has been shifted against the following industries, namely, Agriculture, Forestry and Fishery, Manufacturing, Mining, and lastly Electricity and Water Supply, and in favor of wholesale & Retail Trade, Services, Construction, Administration, Finance & Insurance and Real Estate, and lastly Transportation and Communication.

Comparatively, employment structure for 1970-1975 was worse than that of the 1960-1970; the structure was in favor of Manufacturing, Electricity and Water Supply, and Gas during the 1960-1970, but turned out to be against the mentioned industries during the 1970-1975 period. This indicated that during the period of "oil embargo" the employment in Manufacturing had also been affected hardly, it was, therefore, harder to find jobs in Japan. Accordingly, migration out of Agricultural, Forestry, and Fishery, and Mining seemed to be much slower during the 1970-1975 than that of the 1960-1970 period. The manufacturing as well as other industries seemed to have relatively low labor absorption during the 1970-1975 period.

From a detailed investigation of employment structure in Manufacturing sub-industries of Japan over the longer time span, 1960-1975 period, it was found that employment structure had been shifted away from the following sub-industries, namely, (1) Apparel and other Finished products Made from Fabric and Similar Materials, (2) Textile Mill Product, (3) Lumber and Wood Products, (4) Chemical

Products and (5) Rubber products, and had been mostly in favor of (1) Electrical Machinery, Equipment and Supply, (2) Transportation Equipment, (3) Fabricated Metal Products, (4) Machinery and Equipment, (5) Food and Kindred products, and (6) Publishing, Printing, and Allied Industries, while the others were relatively less favorable.

It was noticed that sub-industries, with relatively more labor intensive, like textile and other identified ones, were most structurally unfavorable. On the contrary, relatively capital intensive sub-industries, like Electrical Machinery and Equipments, and other identified sub-industries, were mostly favorable. This was mainly due to the fact that Japan has been specialized in electrical and heavy industries which were relatively capital intensive. Also, Japan has lost her comparative advantage in relatively labor-intensive sub-industries. Undoubtedly, labor cost in Japan has been very high when compared to that of developing countries. This might be due to the stronger labor unions, the very high cost of living, and the labor shortage in Japan since the 1960's.

The comparative disadvantages in the relatively labor intensive sub-industries of Japan had been shown up clearly in the case of textile, and Apparel and other Finished Product Made from Fabric and Similar Materials, for example. Employment in these two sub-industries in 1975, in fact, were mostly declined from 1960 level. However, it should be noted that unemployment has not yet become the main problem of Japan, since other sub-industries and other sectors could absorbed the released workers. Unemployment rate in this country, therefore, has always been kept under 2%. The recent data of March 1978 showed at 2.02%, which was really low, particularly when compared to 6.7% for the United States during the same month.

However, the comparative disadvantages of labor intensive industries have put the Japanese government into a dilemma. The government dare not let these industries die out, for one thing employment in these industries are very numerous, for the other the democratic government of Japan has to keep their votes in the next election. Therefore, the existences of the textile and others are partly at the expense of the public. Japanese people have to purchase clothings at very high prices due to tariff and other protective measures. The textile industries in Japan are not "infant type" which need protection, like those in developing countries, but they are "the crippled oldman type" which were very much in need of doctors' and the cares of the public. However, how good the doctors are could not eventually save the life of the crippled old man. The better way is to let him die and incarnate somewhere in developing countries.

4.2 Regional Employment Structure of Japan.

Turning to the relative weakness and strength of the Regional Sub-industries in absorbing labor, this study revealed as follows:
(1) Food and Kindred Product: Relatively strong regions are: Tohoku,

Hokkaido, Hokuriku. Relatively weak: Kyusyu, Tyugoku, and Kanto. (2) Textile Mill product: Relatively strong: Kinki, Hokuriku, Kyusyu, Relatively weak: Tokai, Kanto, and Hokkaido. (3) Apparel & Other Finished Product. Relatively strong: Tohoku, Kyusyu, and Sikoku. Relatively weak: Kinki, Kanto, and Tokai. (4) Lumber & Wood Product: Relatively strong: Kyusyu, Tyugoku, and Hokuriku. Relatively weak: Kanto, Thubu, and Tokai. (5) Furniture & Fixture: Relatively strong: Kyusyu, Tokai, and Sikoku. Relatively weak: Kanto, Kindi, and Hokkaido. (6) Pulp, paper and Paper Product: Relatively strong: Kanto, Thubu, and Tohoku. Relatively weak: Kinki, Hokkaido, and Kyusyu. (7) Publishing Printing & Allied Industries: Relatively strong: Kanto, Hokkaido, and Tohoku. Relatively weak: Kinki, Kyusyu, and Hokuriku. (8) Chemical Allied Products: Relatively strong: Tokai, Kanto, Tyugoku. Relatively weak: Kyusyu, Hokuriku, and Hokkaido. (9) Petroleum & Coal Product: Relatively strong: Kanto, Tyugoku, and Kinki. Relatively weak: Kyusyu, Tohoku, and Thubu. (10) Rubber Products: Relatively strong: Tokai, Tohoku, and Sikoku. Relatively weak: Kinki, Kanto, and Kyusyu. (11) Leather & Fur Product: Relatively strong: Tohoku, Kyusyu, and Tyugoku. Relatively weak: Kanto, Si oku, Hokkaido. (12) Stone, Clay & Glass Product: Relatively strong: Kyusyu, Tohoku, and Hokkaido. Relatively weak: Tokai, Kinki, and Thubu. (13) Iron & Steel: Relatively strong: Tyugoku, Tokai, and Sikoku. Relatively weak: Kanto, Kyusyu, and Hokuriku. (14) No-ferrous Metal Products: Relatively strong: Hokuriku, Hokkaido, and

Tyugoku. Relatively weak: Kinki, Sikoku and Tohoku. (15) Fabricated Metal Products: Relatively strong: Tokai, Hokuriku, and Tohoku. Relatively weak: Kanto, Kinki, and Hokkaido. (16) Machinery & Equipment: Relatively strong: Tokai, Thubu, and Kyusyu. Relatively weak: Kinki, Hokuriku, and Tyugoku. (17) Electrical Machinery Equipment: Relatively strong: Tohoku, Thubu, and Hokuriku. Relatively weak: Kanto, Kinki, and Hokkaido. (18) Transportation Equipment: Relatively strong: Tokai, Tyugoku, and Sikoku. Relatively weak: Kanto, Kinki, and Kyusyu. And Finally (19) Precision Machinery and Equipment: Relatively Strong: Tohoku, Thubu, and Hokuriku. Relatively weak: Kanto, Tokai, and Sikoku.

4.3 Policy Implications: Employment

As far as employment in Japanese economy was concerned the above identified or sub-industries with relatively, high employment absorptive polentials, of different regions should be selectively promoted or stimulated further if higher employment targets are to be achieved. Similarly, the identified lagging industries of sub-industries of different regions or economy should be studied and paid much more attention. However, this should not be applied for "the mentioned crippled oldman type" which should let them gradually die out, if the theory of comparative advantage of international trade is to be followed.

5.1 Employment-Income Elasticities for the Thai Economy.

Looking at employment-income elasticities for the Thai economy it was found that the elasticity coefficients for nearly all industries have been small and slightly increased from the 1960-1970 period to the 1971-1973 for most industries. These increases were in responsive to the initial increase in the prices of the products which were faster than the increase in wage rates, as could be seen from the deteriorating in real income of workers in the Thai economy during the 1971-1973 period. Banking Insurance, and Real Estate, Manufacturing, Services, and Administration seemed to be least affected during the "instability period."

The top fifteen Manufacturing sub-industries with relatively high labor income ratios are as follows: (1) Paper and Paper Product (2) Leather (3) Wood Product (4) Textile (5) Chemical Products, (6) Agricultural and Nonelectrical Machinery, (7) Metal Product (in the group of Intermediate Product II), (8) Glass and Glass product, (9) Rubber and Rubber Products, (10) Furniture, (11) Other textile articles, (12) Chemical Material (13) Tobacco, (14) Construction Materials, and (15) Cereal Products.

5.2 Employment-Income Elasticity of Japanese Economy.

Employment-income elasticities of Japanese economy were also low during the 1960-1970 period. Relatively, speaking the following industries were having relatively high coefficients, namely Transportation and Communication, Construction, Manufacturing, Finance, Insurance and Real Estate, and Electricity, Water Supply and Gas. The industries with relatively low employment-income elasticities were Agriculture, Mining, Wholesale and Retail Trade, Administration, and Services. During the instability 1970-1975 period Manufacturing, Electricity, Water Supply and Gas, and Transportation and Communication seemed to be mostly affected which could be seen from the decline in elasticity coefficients from the 1960-1970 period. Other sectors were also affected, but to a lesser extent. Exceptionally, Administration seemed to have relatively high employment-income elasticities regardless of the instabilities. Generally speaking, employment-income elasticities for the Japanese economy had declined from the 1960-1970 period to the 1970-1975 period, which is contrary to what has happened in the Thai economy. The major difference lies on the fact that in the Japanese economy real wage has been increasing during the "instability period", which is opposite to what has happened in Thailand. The sub-stitution of capital for labor must be less in the Thai economy. Labor intensive industries have been less affected by the oil embargo for the Thai economy than for the Japanese. Similar conclusions could be made for regional study as well. That is to say region with relatively more labor abundant seemed to be least affected by the oil embargo or wage-price spiral event. Employment-income elasticities seemed to be more in the region with relatively abundant labor. Labor intensive industries like textile and other identified industries have been much in trouble in Japan during the oil embargo and Wage price-spiral event. Workers released from the troublesome industries, however, could be totally absorbed into heavy and modern industries in Japan. Unemployment, therefore, has not yet been the problem of Japanese economy. Unemployment problem seemed to be more concerned with the Thai economy. This is due to (1) the slow rate of growth of industrial employment particularly in modern sectors, (2) the relative rapid growth of population and labor force (3) high women's labor for-e participation and (4) a highly unequal income distribution, and a low demand for the products of the labour intensive industries, for example. Generally speaking, employment income-elasticities in both Thailand and Japan are low, but the factors mentioned above make unemployment situation in Thailand relatively worse.

THAMMASAT UNIVERSITY

FACULTY OF ECONOMICS

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June 1980

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THE CONSEQUENCES OF SMALL RICE FARM
MECHANIZATION ON RURAL EMPLOYMENT,
INCOME AND PRODUCTION : ANALYTICAL FRAMEWORK

BY

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This paper was presented at the Second Workshop on "The consequences of Small Rice Farm Mechanization on Rural Employment, Income and Production" at the International Rice Research Institute, Los Banos, Philippines, October 1-4, 1979.

Introduction

It is evident in many of the Third World countries that mechanization is about to gain a foothold among traditional farmers engaged in semi-subsistence agriculture. Our empirical observations witness a wide impact of farm mechanization on three main aspects of agricultural sector: output, employment, and income. However, there is not a great deal of empirical investigations assessing these impacts in detail so that a great number of quantitative and qualitative questions can be answered in general, let alone those on the Philippines, Indonesia, and Thailand.

To be able to test several hypotheses concerning the effects of farm mechanization on output, employment, and income systematically, it is essential that we develop a comprehensive model embracing the three related aspects. It is then only natural that the production function comes to our mind.

We realize that we may not be able to answer several of the hypotheses as required immediately. However, actually these hypotheses can be easily tested by standard statistical tests both parametric and nonparametric. Using the production function technique, previous verifications of the hypotheses by non-economic statistical methods can be confirmed and rectified.

Our main strategy is, firstly, to construct basic production functions with each representing a technical relationship between inputs and output at each technology type classified according to mechanization level and water use, and mechanization level and farm sizes.

Secondly, parameters estimated from these production functions will then be incorporated into the labor and income models, which are subsequently developed, so that the linkages between the three aspects are embodied in our overall comprehensive model.

It should be noted at this point that we are at a disadvantage to a certain degree in the analysis where cross-section data are used. Among a few limitations, the uses of prices and wages become ineffective since they are more or less constant during the period of time when the data are collected, and all sample households are faced with the same wage and price levels.

Definition of Activities

With regard to the analysis of consequences of farm mechanization, we employ the following definitions:

"Off-farm work" means work on other people's farms or on agricultural jobs outside one's farm. This includes all types of field activities (e.g. plowing, harrowing, planting, weeding, harvesting, etc.), livestock activities (e.g. herding, feeding, grazing, milling, etc.) and general farm activities such as fencing, transporting, marketing, etc.

"Non-farm work" refers to work in non-agricultural sectors such as industry, commerce, etc. This includes work in forestry, fishery, industry, commerce, handicraft cr services.

"On-farm work" means work on one's own farm or on agricultural jobs inside one's farm. This includes all activities as stated in "off-farm work", except that they are undertaken in one's own farm.

Inputs

The demand and supply for various types of inputs will be divided into five different periods or levels of farm operations (l=1, 2, 3, 4, 5), that is:

(1) Land and seeds preparation (l=1)

(2) Planting (l=2)

(3) Cultivation, e.g, fertilizer and pesticide application,

weeding, controlling of water levels in fields, etc. (1=3)

(4) Harvesting (1=4)

(5) Threshing (1=5)

The demand for inputs at this level depends on the level of work or paddy to be threshed and the method of threshing. Since the amount of paddy to be threshed can not be accurately measured in the study, the amount of threshed paddy will be used as a proxy instead. This creates a problem since conceptually the output of threshed paddy should also depend on labor use including labor from farm operation level 5 or threshing. Such a problem becomes insignificant if there is a relatively constant relationship between threshed and unthreshed paddy. For then, it can be defined that the production process involves two stages. One covers farm operation levels 1 to 4. The other only level 5.

The first stage means that we have a production function involving only inputs up to harvesting and output in unthreshed form. With the percentage of post-harvesting loss from threshing being constant due to the constant relationship between threshed and unthreshed paddy, output of threshed paddy can be used as a reasonable proxy.

All in all, each input pertinent to the production function will be the summation of its uses in operations 1 to 4. Its uses in operation 5 will therefore be excluded from the production function.

Technology Classification

Dimension of technology can be classified according to:

(1) The level of mechanization

(a) animal

(b) animal and machine

(c) power tiller

(d) tractor

(2) The level of water control

(a) rain-fed

(b) irrigated

Mechanization Level and Water Use

Combining the different levels of mechanization and water control, eight possible types of technology can be categorized as follows:

(1) Animal-rainfed

(2) Animal-machine-rainfed

(3) Power tiller-rainfed

(4) Tractor-rainfed

(5) Animal-irrigated

(6) Animal-machine-irrigated

(7) Power tiller-irrigated

(8) Tractor-irrigated

Level of Water control \ Level of Mechanization	Animal	Animal-Machines	Power-Tiller	Tractor
Rainfed	i=1	i=2	i=3	i=4
Irrigated	i=5	i=6	i=7	i=8

Production Function

Using the production function technique, let the general form of the production function be

$$QR_i = QR_i(LR_i, NR_i, FR_i, BR_i, MR_i, VR)$$

where

QR_i = output of havested paddy on farms employing technology type i (tons)

LR_i = planted area of rice on farms employing technology type i (hectares)

NR_i = labor use for rice production on farms employing technology type i (man-hours)

FR_i = current inputs for rice production used on farms employing technology type i (kgs.). They may consist of fertilizer, insecticide, pesticide, herbicide etc.

BR_i = animal use for rice production on farms employing technology type i (animal-hours)

MR_i = machine use for rice production on farms employing technology type i (machine-hours)

VR = dummy variable for rice variety

VR = 1 if modern variety is used

VR = 0 if traditional variety is used

Formulating the production function, two sets of regression equation will be run, one for each of the seasons: dry and wet. During the wet season in Thailand, both rain-fed rice growing and the first crop of irrigated rice growing can be done. In the dry season, however, only the paddy of irrigated second crop can be grown.

For the wet season, the regression equation set of rice crop will consist of:

$$QR_1 = QR_1(LR_1, NR_1, FR_1, BR_1, VR)$$
$$QR_2 = QR_2(LR_2, NR_2, FR_2, BR_2, MR_2, VR)$$
$$QR_3 = QR_3(LR_3, NR_3, FR_3, MR_3, VR)$$
$$QR_4 = QR_4(LR_4, NR_4, FR_4, MR_4, VR)$$
$$QR_5 = QR_5(LR_5, NR_5, FR_5, BR_5, VR)$$
$$QR_6 = QR_6(LR_6, NR_6, FR_6, BR_6, MR_6, VR)$$
$$QR_7 = QR_7(LR_7, NR_7, FR_7, MR_7, VR)$$
$$QR_8 = QR_8(LR_8, NR_8, FR_8, MR_8, VR)$$

The regression equation set for rice crop of the dry season will comprise:

$$QR_5 = QR_5(LR_5, NR_5, FR_5, BR_5, VR)$$
$$QR_6 = QR_6(LR_6, NR_6, FR_6, BR_6, MR_6, VR)$$
$$QR_7 = QR_7(LR_7, NR_7, FR_7, MR_7, VR)$$
$$QR_8 = QR_8(LR_8, NR_8, FR_8, MR_8, VR)$$

Each regression equation will employ data of farm households utilizing that technology type (cell). However, there might not be sufficient farm households in all cells so that all these regression equations can be run. To be able to ensure this, a larger sample size is required.

Mechanization Level and Farm Sizes

With respect to the interaction of farm size and the farm mechanization, we can use the similar approach to answer several quantitative and qualitative questions.. Tha farm size can be separated into 3 groups:

(a) large size

(b) medium size

(c) small size

Together with one of the formerly classified dimension of mechanization, there are twelve possible types of technology as follows:

(1) Animal-large size

(2) Animal-machines-large size

(3) Power-tiller-large size

(4) Tractor-large size

(5) Animal-medium size

(6) Animal-machines-medium size

(7) Power-tiller-medium size

(8) Tractor-medium size

(9) Animal-small size

(10) Animal-machines-small size

(11) Power-tiller-small size

(12) Tractor-small size

Farm size \ Level of Mechanization	Animal	Animal-Machines	Power-Tiller	Tractor
Large	k=1	k=2	k=3	k=4
Medium	k=5	k=6	k=7	k=8
Small	k=9	k=10	k=11	k=12

The similar approach is again used by formulating the production function.

The general form of the production function is:

$$QR_k = QR_k(LR_k, NR_k, FR_k, BR_k, MR_k, VR)$$

where "k" signifies each of the twelve technology types employed on farms. The symbols are identical with those previously defined.

Again, two sets of regression equations of rice crop will be run: one for each of the seasons.

For wet season, the set consists of

$$QR_1 = QR_1(LR_1, NR_1, FR_1, BR_1, VR)$$
$$QR_2 = QR_2(LR_2, NR_2, FR_2, BR_2, MR_2, VR)$$
$$QR_3 = QR_3(LR_3, NR_3, FR_3, MR_3, VR)$$
$$QR_4 = QR_4(LR_4, NR_4, FR_4, MR_4, VR)$$
$$QR_5 = QR_5(LR_5, NR_5, FR_5, BR_5, VR)$$
$$QR_6 = QR_6(LR_6, NR_6, FR_6, BR_6, MR_6, VR)$$
$$QR_7 = QR_7(LR_7, NR_7, FR_7, MR_7, VR)$$
$$QR_8 = QR_8(LR_8, NR_8, FR_8, MR_8, VR)$$
$$QR_9 = QR_9(LR_9, NR_9, FR_9, BR_9, VR)$$
$$QR_{10} = QR_{10}(LR_{10}, NR_{10}, FR_{10}, BR_{10}, MR_{10}, VR)$$
$$QR_{11} = QR_{11}(LR_{11}, NR_{11}, FR_{11}, MR_{11}, VR)$$
$$QR_{12} = QR_{12}(LR_{12}, NR_{12}, FR_{12}, MR_{12}, VR)$$

where each equation utilizes data of farm households of each cell. The members of each cell comprise both rain-fed and irrigated-first crop rice growers.

Similarly, for rice crop of the dry season, there are twelve regression equations:

$$QR_1 = QR_1(LR_1, NR_1, FR_1, BR_1, VR)$$
$$QR_2 = QR_2(LR_2, NR_2, FR_2, BR_2, MR_2, VR)$$
$$QR_3 = QR_3(LR_3, NR_3, FR_3, MR_3, VR)$$
$$QR_4 = QR_4(LR_4, NR_4, FR_4, MR_4, VR)$$
$$QR_5 = QR_5(LR_5, NR_5, FR_5, BR_5, VR)$$
$$QR_6 = QR_6(LR_6, NR_6, FR_6, BR_6, MR_6, VR)$$
$$QR_7 = QR_7(LR_7, NR_7, FR_7, MR_7, VR)$$
$$QR_8 = QR_8(LR_8, NR_8, FR_8, MR_8, VR)$$
$$QR_9 = QR_9(LR_9, NR_9, FR_9, BR_9, VR)$$
$$QR_{10} = QR_{10}(LR_{10}, NR_{10}, FR_{10}, BR_{10}, MR_{10}, VR)$$
$$QR_{11} = QR_{11}(LR_{11}, NR_{11}, FR_{11}, MR_{11}, VR)$$
$$QR_{12} = QR_{12}(LR_{12}, NR_{12}, FR_{12}, MR_{12}, VR)$$

with each equation using the data of the members in each cell. Within each cell now, the members are only the irrigated second crop rice growers.

Apart from the production of rice on farms employing technology i, QR_i, there exists the production of other crops and livestocks on the same farms, QO_i; however, they are assumed given, hence, no production functions will be formulated for these other crops and livestocks.

DETERMINATION OF FACTOR USE

LAND

The demand for land is not too useful a concept in this study since demand is to a large extent constrained by the available supply of land which in the area of study is relatively fixed. This is because there are no new or virgin land in the area surveyed. It is not possible to expand the total supply of land in the area although it is possible to utilize less than the available supply of land. At the micro level, expansion of land supply of a farm is possible through the purchase of land from other farms. But even then, it is probably true that in the shortrun this would not be an important factor. As such, actual use of land, therefore, depends on the demand for land when such demand is less than the available supply and on the supply of land when actual demand equals or exceed available supply. The only qualification is that it might be possible to rent land from others. This factor will be taken into account in specifying the model. In addition, distinction must be made between land use for the main crop and for other crops. Taking into account these factors, land use determination may be specified as follows:

1. Land and seed preparation (1=1)

$$L_{ij1} = L_{ij1}(LS_{ij} + LH_{ij}, b_{ij1})$$

$$LR_{ij1} = L_{ij1} - LO_{ij1}$$

$$LS_{ij1} = \overline{LS}_{ij1}$$

$$LH_{ij} = \overline{LH_{ij}}$$

$$b_{ij1} = \overline{b_{ij1}}$$

$$LO_{ij1} = \overline{LO_{ij1}}$$

where L_{ij1} = land area prepared by farm j employing technology i (hectares)

LS_{ij} = land holding area of farm j employing technology i (hectares)

LH_{ij} = land rented by farm j employing technology i (hectares).

LR_{ij1} = land area prepared for rice production by farm j employing technology i (hectares).

LO_{ij1} = land area prepared for other nonrice production by farm j employing technology i (hectares).

b_{ij1} = proportion of holding and rented area which could not be utilized due to floods, drought, etc., on farm j employing technology i.

2. Planting (1=2)

$$LR_{ij2} = b_{ij2} LR_{ij1}$$

where LR_{ij2} = planted area of rice on farm j employing technology i (hectares).

b_{ij2} = proportion of land area prepared for rice which could not be planted due to floods, drought, etc., on farm j employing technology i.

3. Cultivation (1 = 3)

$$LR_{ij3} = b_{ij3}LR_{ij2}$$

where LR_{ij3} = cultivated area of rice of farm j employing technology i (hectares).

b_{ij3} = proportion of planted area of rice which could not be cultivated due to floods, drought, insect damage, rodent damage, etc., on farm j employing technology i.

4. Harvesting (1 = 4)

$$LR_{ij4} = b_{ij4}LR_{ij3}$$

where LR_{ij4} = harvested area of rice on farm j employing technology i (hectares).

b_{ij4} = proportion of cultivated area of rice which could not be harvested due to floods, drought, insect damage, rodent damage, etc., on farm j employing technology i.

5. Threshing (1 = 5)

The area required for threshing is usually quite small and not related to harvested area. Land use in this category can, therefore, be overlooked.

LABOR

The determination of labor demand for the first four levels of farm operations are assumed to depend on the level of work to be done as measured by land area covered and the level of mechanization as measured by machine time employed relative to the level of work. Labor demand will be in total form including demand for rice crop production and other on-farm activities such as production of other crops, tending buffaloes, etc. The equations, therefore, include both land used in rice and nonrice crop production and a variable for the number of buffaloes since this latter factor requires labor time in raising and caring. For farm operation levels 1 and 3, the level of total current input use (both for rice and nonrice crops) relative to total land use area is used to measure whether the intensity of current input use will have an effect on labor demand.

In determining labor demand for farm operation level 5 or threshing, it is assumed that demand depends on the level of work as measured by threshed paddy[1] and the method of threshing.

[1]Actually, unthreshed paddy should be used, but due to the inability to measure this factor, threshed paddy is used as a proxy instead. (See page 4)

Determining labor supply is much more complex than labor demand. This is because labor supply may be distinguished according to its uses and its sources. In this study two main sources of labor supply are employed. They are family and non-family labor. For family labor, this may be used for on-farm, off-farm and non-farm purposes. Non-family labor include labor supplied by farm owners to other farms and landless labor.

The supply of family labor for on-farm work is assumed to depend on the potential supply of family labor, the size of the potential labor supply relative to the total actual use of land and the preference of the farm family between work and leisure. It is most probably true that the higher the potential family labor force, the larger will be the level of labor supplied under an existing structure. Potential labor supply will be measured during periods of peak demand for labor when it is believed that farm family labor is insufficient to meet the total demand for labor. The second factor of relative potential labor supply to land use is used as a proxy to measure the relative pressure exerted on the farm family to supply labor. On farms with a relative large amount of labor compared to land, there is probably less pressure on the family to provide labor and vice versa. In order to measure the preference between work and leisure, the level of machine use, income and education are employed, since these factors may reflect or have an influence on work preference.

Use of family labor on-farm may again be subdivided between rice crop production and other types of work. The latter will be assumed fixed in the model since it is beyond the scope of the study and to include them would make the model a lot more complex and difficult to handle. Because other types of work not directly related to rice crop production is assumed to remain constant, the supply of family labor for rice crop production may be determined from the total supply of family labor for on-farm work.

The supply of family labor for off-farm employment is assumed to depend on the potential family labor supply left from supplying for on-farm work and on work preference. Work preference is again measured by machine use, income and education.

For the supply of family labor for non-farm employment, this is beyond the scope of this study and insufficient data exist to prevent the determination of this variable. It is, therefore, assumed fixed in the model.

Besides family labor, non-family or hired labor may also be employed for on-farm production on a particular farm. This is assumed to depend on the total level of available labor supply outside of the farm concerned within the area. To take account of the different levels of demand for such labor among farms, the actual proportion of labor use from this supply pool will be employed. It is acknowledged here that this is not the best way to determine hired labor employed for on-farm purposes, but since a lot more data are required and many pertain to non-farm variables, the present specification will be retained.

From the point of view of a particular farm, the total available non-family labor supplied for hire is but family labor offered for off-farm employment of all farms except those offered by the family itself and the supply of landless laborers. Since the supply of landless labor cannot accurately be determined with available farm data, it will also be assumed to be an exogenous variable within the model.

For the first four levels of farm operations, the demand and supply of labor are specified as follows:

$$ND_{ij1} = ND_{ij1}(LR_{ij1}, LO_{ij1}, BF_{ij}, M_{ij1}/L_{ij1}, F_{ij1}/L_{ij1}TP)$$

$$NS_{ij1} = NSF_{ij1} + NSH_{ij1}$$

$$NSF_{ij1} = NSF_{ij1}(NSFP_{ij1}, NSFP_{ij1}/L_{ij1}, M_{ij1}, Y_{ij}, E_{ij})$$

$$NSFR_{ij1} = NSF_{ij1} - NSFO_{ij1}$$

$$NSH_{ij1} = C_{ij1}NSN_{j1}$$

$$NSN_{j1} = \sum_{i=1}^{8} \sum_{j=1}^{n} NSO_{ij1} - NSO_{ij1} + NSS_{1}$$

$$NSO_{ij1} = NSO_{ij1}(NSFP_{ij1} - NSF_{ij1}, M_{ij1}, Y_{ij}, E_{ij})$$

$$LO_{ij1} = \overline{LO}_{ij1}$$

$$BF_{ij} = \overline{BF}_{ij}$$

$$NSFO_{ij1} = \overline{NSFO}_{ij1}$$

$$NSS_{1} = \overline{NSS}_{1}$$

where ND_{ijl} = total demand for labor for on-farm employment of farm j employing technology i during farm operation l. (man-hrs.)

NS_{ijl} = total supply of labor for on-farm employment of farm j employing technology i during farm operation l. (man-hrs.)

NSF_{ijl} = supply of family labor for on-farm employment of farm j employing technology i during farm operation l. (man-hrs.)

NSH_{ijl} = supply of non-family labor for on-farm employment of farm j employing technology i during farm operation l.

$NSFP_{ijl}$ = potential supply of family labor of farm j employing technology i during farm operation l. (man-hrs.)

$NSFR_{ijl}$ = supply of family labor for on-farm rice crop production of farm j employing technology i during farm operation l. (man-hrs.)

$NSFO_{ijl}$ = supply of family labor for other on-farm nonrice related activities of farm j employing technology i during farm operation l. (man-hrs.)

NSN_{jl} = total available supply of labor outside of farm j with in the area during farm operation l. (mand-hrs.)

NSO_{ijl} = supply of family labor for off-farm employment of farm j employing technology i during farm operation l. (man-hrs.)

NSS_l = supply of landless labor within the area during farm operation l. (man-hrs.)

BF_{ij} = number of buffaloes on farm j employing technology i. (heads)

M_{ijl} = machine use of farm j employing technology i during farm operation l. (machine-hrs.)

F_{ijl} = current input use of farm j employing technology i during farm operation l. (kgs.)

Y_{ij} = income level of farm j employing technology i. (baht)

E_{ij} = education level of household head of farm j employing technology i. (grade)

C_{ijl} = proportion of total available supply of labor outside of farm j within the area utilized by farm j employing technology i during farm operation l.

n = total number of farms included in the study.

TP = dummy variable for planting (l = 2) only : broadcasting = 0; transplanting = 1.

For the last level of farm operation or threshing, the demand and supply of labor may be determined as follows:

$$ND_{ij5} = ND_{ij5}(QR_{ij},\ LO_{ij5},\ BF_{ij};\ TT)$$

$$NS_{ij5} = NSF_{ij5} + NSH_{ij5}$$

$$NSF_{ij5} = NSF_{ij5}(NSFP_{ij5}, NSFP_{ij5}/QR_{ij},\ M_{ij5},\ Y_{ij},\ E_{ij})$$

$$NSFR_{ij5} = NSF_{ij5} - NSFO_{ij5}$$

$$NSH_{ij5} = C_{ij5}\ NSN_{j5}$$

$$NSN_{j5} = \sum_{i=1}^{8} \sum_{j=1}^{n} NSO_{ij5} - NSO_{ij5} + NSS_{5}$$

$$NSO_{ij5} = NSO_{ij5}\ (NSFP_{ij5} - NSF_{ij5},\ M_{ij5},\ Y_{ij},\ E_{ij})$$

$$LO_{ij5} = \overline{LO_{ij5}}$$

$$NSFO_{ij5} = \overline{NSFO_{ij5}}$$

$$NSS_{5} = \overline{NSS_{5}}$$

where TT = dummy variable for method of threshing :

traditional = 0; power thresher =1.

<u>CURRENT INPUTS</u> (e.g. fertilizer, insecticide, pesticide, herbicide, etc.)

Since the use of current inputs applies mainly during farm operation levels 1 and 3, only these levels will be considered. It will be assumed that the supply of current inputs are infinitely elastic with respect to their prices at the farm level. This means if farmers are willing to pay the prevailing market price of current inputs, they can get all the inputs they want. In such a case, the actual use of current inputs will be determined by their demand. The amount of current input use will cover only those used for rice crop production.

1. Land preparation (1=1)

$$F_{ij1} = F_{ij1}(LR_{ij1}, LO_{ij1}, Y_{ij})$$

$$FR_{ij1} = F_{ij1} - FO_{ij1}$$

$$FO_{ij1} = \overline{FO_{ij1}}$$

where F_{ij1} = total demand for current inputs of farm j employing technology i during land and seed preparation. (kgs.)

FR_{ij1} = demand for current inputs for rice production of farm j employing technology i during land and seed preparation. (kgs.)

FO_{ij1} = demand for current inputs for nonrice related activities of farm j employing technology i during land and seed preparation. (kgs.)

2. Cultivation (1=3)

$$F_{ij3} = F_{ij3}(LR_{ij3}, LO_{ij3}, Y_{ij})$$

$$FR_{ij3} = F_{ij3} - FO_{ij3}$$

$$FO_{ij3} = \overline{FO_{ij3}}$$

where F_{ij3} = demand for current inputs of farm j employing technology i during cultivation. (kgs.)

FR_{ij3} = demand for current inputs for rice production of farm j employing technology i during cultivation. (kgs.)

FO_{ij3} = demand for current inputs for nonrice related activities of farm j employing technology i during cultivation. (kgs.)

MACHINE

For machine owners, it is probably true that the available supply of machine-hours is usually in excess of self demand while for contractors, supply of machine service is probably available if farmers are willing to pay the prevailing market charge rate. If this is true, it can be safely assumed that the supply of machine-hours is infinitely elastic with respect to the price of machine service. This assumption will be taken in the study. Similar to current inputs, actual use for the first four levels of farm operations are assumed to depend on the level of work to be done as measured by the size of land involved; the availability of family labor as measured by the potential family labor supply and the total available supply of labor outside of the farm concerned within the area divided by the level of work or land involved; and the ability to afford purchasing machine service as measured by income.

Machine use will also be divided between rice and nonrice related employment. For the latter, it is again assumed exogenous.

1. Land and seed preparation (l=1)

$$M_{ij1} = M_{ij1}\left[LR_{ij1},\ LO_{ij1},\ (NSFP_{ij1} + NSN_{j1})/L_{ij1},\ Y_{ij}\right]$$

$$MR_{ij1} = M_{ij1} - MO_{ij1}$$

$$MO_{ij1} = \overline{MO_{ij1}}$$

where M_{ij1} = total demand for machine use of farm j employing technology i during land and seed preparation. (machine-hrs.)

MR_{ij1} = demand for machine use for rice production of farm j employing technology i during land and seed preparation. (machine-hrs.)

MO_{ij1} = demand for machine use for nonrice related activities of farm j employing technology i during land and seed preparation. (machine-hrs.)

2. Planting (1=2)

$$M_{ij2} = M_{ij2}\left[LR_{ij2}, LO_{ij2}, (NSFP_{ij2} + NSN_{j2})/L_{ij2}, Y_{ij}, TP\right]$$

$$MR_{ij2} = M_{ij2} - MO_{ij2}$$

$$MO_{ij2} = \overline{MO_{ij2}}$$

where M_{ij2} = total demand for machine use of farm j employing technology i during planting. (machine-hrs.)

MR_{ij2} = demand for machine use for rice production of farm j employing technology i during planting. (machine-hrs.)

MO_{ij2} = demand for machine use for nonrice related activities of farm j employing technology i during planting. (machine-hrs.)

For the Thai case, planting does not involve any significant use of mechanization. M_{ij2} may, therefore, be deleted.

3. Cultivation (1=3)

$$M_{ij3} = M_{ij3}\left[LR_{ij3}, LO_{ij3}, (NSFP_{ij3} + NSN_{j3})/L_{ij3}, Y_{ij}, TP_{ij}\right]$$

$$MR_{ij3} = M_{ij3} - MO_{ij3}$$

$$MO_{ij3} = \overline{MO_{ij3}}$$

where M_{ij3} = total demand for machine use of farm j employing technology i during cultivation. (machine-hrs.)

MR_{ij3} = demand for machine use for rice production of farm j employing technology i during cultivation. (machine-hrs.)

MO_{ij3} = demand for machine use for nonrice related activities of farm j employing technology i during cultivation. (machine-hrs.)

M_{ij3} can also be left out for the Thai case due to the lack of mechanization at this level.

4. Harvesting (l=4)

$$M_{ij4} = M_{ij4}\left[LR_{ij4}, LO_{ij4}, (NSFP_{ij4}+NSN_{j4})/L_{ij4}, Y_{ij}, TP_{ij}\right]$$

$$MR_{ij4} = M_{ij4} - MO_{ij4}$$

$$MO_{ij4} = \overline{MO_{ij4}}$$

where M_{ij4} = demand for machine use of farm j employing technology i during harvesting. (machine-hrs.)

MR_{ij4} = demand for machine use for rice production of farm j employing technology i during harvesting. (machine-hrs.)

MO_{ij4} = demand for machine use for nonrice related activities of farm j employing technology i during harvesting. (machine-hrs.)

Harvesting machines are also nonexistent in Thai agriculture at present and, therefore, will be dropped from consideration.

5. Threshing (l=5)

$$M_{ij5} = M_{ij5}(QR_{ij}, BF_{ij}, TT)$$
$$MR_{ij5} = M_{ij5} - MO_{ij5}$$
$$MO_{ij5} = MO_{ij5}$$

where M_{ij5} = total demand for machine use of farm j employing technology i during threshing. (machine-hrs.)

MR_{ij5} = demand for machine use for rice production of farm j employing technology i during threshing. (machine-hrs.)

MO_{ij5} = demand for machine use for nonrice related activities of farm j employing technology i during threshing. (machine-hrs.)

TT = dummy variable for methods of threshing: traditional = 0; power threshers = 1.

The demand for machine use during threshing is assumed to depend on the level of work to be done and the method of threshing. The level of work is again measured by threshed paddy. Classification of methods of threshing involves only two methods due to insufficient sample size to make a more detailed study possible. But this weakness may be supplemented by an ongoing study on threshers in Thailand.[2]

EMPLOYMENT

The word employment as measured by the number of persons having jobs in more developed countries is not too useful a concept for less developed countries' agricultural sectors where the level of labor utilization is more of a concern. Family members on a farm in these countries would not consider themselves unemployed although the amount of work done might be very little. This problem is generally known as a form of disguised unemployment. To study phenomenon, the following equation may be used to measure the level of disguised unemployment:

$$U_{ijl} = \frac{NSFP_{ijl} - NF_{ijl}}{NSFP_{ijl}}$$

where U_{ijl} = the proportion of potential family labor left unutilized by farm j employing technology i during farm operation l.

NF_{ijl} = total actual use of family labor by farm j employing technology i during farm operation l. (man-hrs.)

[2] Renu Pathnopas, "The Economics of Rice Threshing Machines in Thailand : A Case Study of Chachoengsao and Supanburi Provinces," Ongoing Thesis, Faculty of Economics, Thammasat University.

In addition, unemployment in LDC's agricultural sector is more of a seasonal phenomenon. It is useful, therefore, to study the level of utilization of farm family labor during different periods of time. Comparisons of disguised unemployment among different periods would, therefore, give us some insight with regard to the effect of mechanization on the structure of seasonal employment. Mechanization may increase disguised unemployment if it substitutes labor, but it may decrease such unemployment if it results in double cropping.

Off-farm employment and the demand for landless labor is also affected by the seasonal nature of demand. The effect of mechanization on such employment should also be studies in order to measure the ability of farm mechanization to generate employment within and outside of the farm sector or, if the reverse, to reduce such employment.

In studying employment of landless labor, both the level of labor utilization and the number employed will be used. The level of utilization may tell us the level of disguised unemployment but the number may tell us something about the labor absorptive capacity of Thai agriculture.

It is assumed in the study that the demand for labor on a particular farm will first be met by family labor. Any demand unable to be met by family labor will be assumed to come from either other farms or landless labor. The change in utilization of labor from other farms will not result in changes in numbers employed on these farms but will have an effect on the level of disguised unemployment there. For landless labor, it is possible that both numbers and the utilization levels may change.

IMPACT OF FARM MECHANIZATION ON INCOME AND INCOME DISTRIBUTION

Farm mechanization can affect income in various ways. Before discussing possible effects, it is necessary first to define the income concepts that will be used in this model.

Farm household income (YH) comprises farm income (YF), off-farm agricultural income (YO), and non-farm income (YN). Thus, for farms employing technology i,

$$YH_i = YF_i + YO_i + YN_i \qquad (1)$$

Farm income (YF_i) is the income derived from activities on one's own farm, while off-farm income and non-farm income are, respectively, income derived from off-farm and non-farm activities as defined earlier.

The next step is to investigate the determinant of each component of farm household income and particularly to see how mechanization affects each of the components and causes relative changes in the proportion of each. Thus, the income distribution effect will be examined at two levels:

1) The change in relative factor shares in farm income.
2) The change in relative sizes of the components of household income.

Farm Income

Farm income is the return to the farm family from operating the farm after deducting the costs of production.

$$YF_i = YFR_i + YFO_i \qquad (2)$$

where YFR_i = net farm income from rice crop of farm employing technology i.

YFO_i = net farm income from other crops and livestocks of farm employing technology i

$$YFR_i = PR \cdot QR_i - CR_i(QR_i) \qquad (3)$$

$$YFO_i = \overline{YFO_i} \qquad (4)$$

where PR = farm gate price of paddy in baht/ton

QR_i = output of harvested paddy (ton)

$CR_i(QR_i)$ = paid out costs of production for rice, which consist of fixed costs and variable cost.(baht) Fixed costs include land rent, land tax, and interest on capital.
Variable costs include cost of current inputs such as fertilizer, seeds, insecticides, pesticides, herbicide; fuel for water pumps and tractors; rental of machine; and wages paid to hired labor.

If this accounting concept of cost is used, the return to farm family employing technology i would consist of:

imputed wage for family labor (IW_i)

imputed rent for owned land (IR_i)

depreciation on capital (DK_i)

residual (X_i)

i.e., $$YFR_i = IW_i + IR_i + DK_i + X_i \quad (5)$$

Alternatively, the factor share approach can be used. In this case, the total value of rice of farms employing technology i is devided among various factors of production: land, labor, capital, current inputs, and profit.

$$PR \cdot QR_i = R_i + W_i + K_i + VF_i + \pi_i \quad (6)$$

where R_i = payment to land = payment to landlord in the form of rent plus imputed rent for owned land

W_i = payment to labor = payment to hired labor plus imputed value of farm family labor

K_i = payment to capital = machine rental plus imputed value of services of own capital equipment

VF_i = payment for current inputs

π_i = operator's profit $= (PR \cdot QR_i) - R_i - W_i - K_i = VF_i$

The share of land $= \dfrac{R_i}{R_i + W_i + K_i}$

The share of labor $= \dfrac{W_i}{R_i + W_i + K_i}$

$$\text{The share of capital} = \frac{K_i}{R_i + W_i + K_i}$$

According to the marginal productivity theory of distribution each input is paid the value of its marginal product and total output is just exhausted, i.e., long-run maximum profit is zero under perfect competition.

$$\text{Thus,} \quad r = MP_L \cdot P \qquad \text{where } MP_L = \frac{\partial QR}{\partial L}$$

$$w = MP_N \cdot P \qquad MP_N = \frac{\partial QR}{N}$$

$$d = MP_M \cdot P \qquad MP_M = \frac{\partial QR}{\partial M}$$

$$\text{and} \quad (PR \cdot QR_i) - VF_i = rL_i + wN_i + dM_i$$

$$\text{The share of land} = \frac{rL_i}{rL_i + wN_i + dM_i}$$

$$\text{The share of labor} = \frac{wN_i}{rL_i + wN_i + dM_i}$$

$$\text{The share of capital} = \frac{dM_i}{rL_i + wN_i + dM_i}$$

1) Change in Relative Factor Shares in Farm Income

The shares of land, labor, and capital derived from the factor share approach will be compared with those derived from the production function of farms employing technology i under perfect competition assumption. In the case that Cobb-Douglas production function is used, the value of production elasticities estimated is the share of factors.

The purpose of the comparison is in order to see whether farm mechanization has any effect on relative shares of various factors and whether mechanization brings the relative shares closer to the ideal perfect competition results.

The hypotheses to be tested are as follows:

a) The change in relative factor shares come about mainly through the change in the payments to machine and labor. Since in the sample villages machine is used only at the land preparation and threshing stages (operation levels 1 and 5) it will have little effect on the use and therefore costs of current inputs or payment to land.

b) Machine replaces labor in land preparation stage (l=1), indicated by a lower $N_{l=1}/L_{l=1}$ on mechanized than on non-mechanized farms. This will reduce payment to labor (hired or imputed depending whether hired or family labor is being replaced) but increase the payment to machine (capital).

c) Machine increases labor use in threshing stage (l=5), indicated by a higher $N_{l=5}/Q$ on mechanized than on non-mechanized farms. The ratio of labor hours per unit of threshed output is used here instead of labor hours per unit of land in operation level 1 because at the threshing stage land is no longer a factor determining output once the harvest is done.

Thus, an increase in the share of capital relative to that of labor will be an indicator of a redistribution of farm income from labor to capital owner.

2) Change in the Level of Farm Income from Rice Crop

Mechanization can affect the level of farm income from rice through change in output, change in output price, or change in the cost of production.

i) The change in output can arise from increased productivity of labor ($Q = Q/N \cdot N$) or increased productivity of land ($Q = Q/L \cdot L$). These changes can be observed from a comparison of production functions of mechanized and non-mechanized farms.

Since the factors affecting yield and output per man-hour are mostly the same as those appearing in the production function, an estimation of the production coefficients will provide information on land and labor productivities. Thus, there is no need to estimate the productivity equations directly.

i.e. from $QR_i = QR_i(LR_i, NR_i, FR_i, MR_i, BR_i, VR_i)$

$$\frac{QR_i}{L_i}, \frac{QR_i}{N_i}, \frac{\partial QR_i}{\partial L_i}, \frac{\partial QR_i}{\partial N_i}$$ can be derived.

ii) The change in price of output will take place if mechanization increases output significantly so as to depress its price (to what extent depending on the elasticity of demand for rice). However, since the data used are cross-section data, the price of paddy in the village will be the same or almost the same for all farmers. The only comparison that can be made is across villages. Paddy prices may differ between highly mechanized village and one with low level of mechanization. But this difference may be due to factors other than level of mechanization. Thus, the price effect will not be considered here.

iii) Following the hypotheses stated in part 1, the change in production costs resulting from mechanization is likely to be in the form of relative changes in wages paid to hired labor and machine rental or other machine-related costs. Both, however, may increase if machine increases hired labor, either as a result of increased total labor use or as a substitution for family labor who is now released for off-farm work. What actually happens again rests on the effect of mechanization on total labor use as well as on the family labor/hired labor proportion.

Since $CR_i = CR_i(QR_i)$, total cost will increase as output increases. It is hypothesized, however, that cost per unit of output will decline, i.e., that output increases more than cost increases.

Off-Farm Income

Mechanization can affect off-farm income of households

a) by releasing family labor for off-farm or non-farm work. In this case, family labor is either displaced by machine or by hired labor.

b) by enabling farmers to earn additional income from hiring out machine or animals to other farmers.

Thus, $YO_i = YO_i\,({}^{NF}i/_{N_i}\ ,\ MH_i,\ NDH_{i-j}\ ,\ BH_i,\ LH_i)$ (7)

where NF_{i/N_i} = proportion of man-hours of family labor to total labor used on farms employing technology i

MH_i = machine-hours hired out on other farms by farms employing technology i

NDH_{i-j} = man-hours of hired labor demanded by all farms other than farm j

$= \sum_i \sum_j ND_{ij} - ND_{ij} - \sum_i \sum_j NSF_{ij}$

BH_i = animal-hours hired out on other farms by farms employing technology i

LH_i = land in rai rented out to other farmers by farms employing technology i

and $NF_{i/N_i} = NF_{i/N_i}\,(NSF_i,\ NSH_i)$

Non-farm Income

As in the case of off-farm income, the change in non-farm income of households depends on the extent to which family labor is released from farms as a result of mechanization. Instead of working on other farms, family labor now free from its own farm work may spend time on such activities as fishery, cutting firewoods, weaving baskets, employment in factories, trading goods and services, etc.

$$YN_i = YN_i\,({}^{NF}i/N_i,\ TG_i,\ NN_i) \qquad (8)$$

where TG_i = dummy for engagement in trading activities of farm employing technology i

NN_i = man-hours spent on non-farm activities by farm employing technology i

After determining the impact of mechanization on each component of farm family income, the resulting changes in relative sizes of the components will be investigated and compared among various types of farms.

Since inequality of income in the agricultural sector usually arises from unequal distribution of land and difference in factor productivity, causing difference in efficiency among farm sizes, it would be interesting to further investigate the impact of mechanization among farm size classes. In order to do so, the sample farms have to be restratified by substituting the level of water control by farm size classes. These new cells are subscripted k. All steps of analysis for this part run parallel to those for farms employing technology i.

The results from the previous sections will permit calculation of the gini coefficients for the sample villages by assuming that the sample farms employing technology i well represent the conditions faced by all farms employing technology i in the village.

$$G = 1-2\left[\sum_{1}^{n} (f_m - f_{m-1})\ (y_{m-1}) + \tfrac{1}{2} \sum_{1}^{n} (f_m - f_{m-1})\ (y_m - y_{m-1})\right]$$

where G = gini concentration ratio

f_m = cumulative percentage of number of households of the income class m

y_m = cumulative percentage of household income of the income class m

m = 1, 2 ... n = number of income classes

G = o means perfect equality

G = 1 means perfect inequality

The gini coefficient calculated for the sample villages will then be compared with that of the region/country previously calculated by others in the years prior to mecchanization or with any other comparable gini coefficients in order to determine any effect that mechanization may have on income distribution.

Appendix 1

Production Function

Intuitively, the production function describes the transformation of a set of inputs into output. More specifically, and for each combination of inputs and output, it represents the minimum quantity of inputs that yields a given quantity of output. For a group of homogeneous producing economic units, we can note the production function as

$$Q = Q(x_1, x_2, x_3, \ldots\ldots x_n)$$

where Q = observed output of producing economic units

$x_h (h = 1,2,\ldots\ldots n)$ = inputs

The vital part of the investigation under this technique is the choosing of a specific algebraic form to describe this function. The choice among numerous alternative forms is usually made on the basis of such criteria as compliance with a priori notions about the engineering and the economic laws of production; computational manageability, and so on.

One of the strongest candidates of algebraic form for the production function is the Cobb-Douglas whose popularity is largely attributed to its basic consistency with the established body of economic theory, especially to its computational simplicity.

Cobb-Douglas Production Function

The Cobb-Douglas production function takes the form of

$$Q = A.x_1^{a1}, x_2^{a2}........x_n^{an}$$

where A = a constant term for the existing technology

$a_h(h = 1,2,...n)$ = coefficient of input x_h

The marginal product of input $h(MP_h)$ is $(a_h.\frac{Q}{x_h})$ while the average product of input $h(AP_h)$ is $\frac{(MP_h)}{a_h}$.

The partial elasticity of production with respect to input is defined as

$$\left(\frac{x_h}{Q}.\frac{\partial Q}{\partial x_h}\right) = \frac{x_h}{Q}.MP_h$$

$$= \frac{x_h}{Q}.a_h.\frac{Q}{x_h}$$

$$= a_h$$

Therefore, a_h denotes the percentage change in output in response to a percent change in input h while other inputs are held constant. Consequently, $\left(\sum_{n=1}^{n} x_h\right)$ is the degree of homogeneity of the Cobb-Douglas function, and also the degree of returns to scale.

Under the assumption of perfect competition both in input and output markets, the price of each input will be equal to the marginal value product of that factor (necessary condition for producer equilibrium):

$$P_h = VMP_h$$

$$= (MP_h).P$$

where P_h = price of input h

P = price of output

$$= a_h \cdot \frac{Q}{x_h} \cdot P$$

$$\therefore \quad \frac{P_h}{P} = a_h \cdot \frac{Q}{x_h}$$

$$\therefore \quad a_h = \frac{x_h \cdot P_h}{P \cdot Q}$$

Therefore, a_h also represents the share of input h in the total output. Moreover, it is well known that, in fact, the Cobb-Douglas function is a special case of CES function.

In Cobb-Douglas function, the elasticity of substitution of any two inputs will always be equal to 1.