ARE PART-TIME AND FULL-TIME SMALL FARMS DETRIMENTAL TO AGRICULTURE

EVIDENCE FROM TAIWAN, 1972 - 1980

by

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ABSTRACT

Slow agricultural growth in the seventies in Taiwan has induced a second land reform debate which starts from the assumption that small farms, and especially small part-time farms, are less productive than large full-time farms. But very little empirical evidence is presented. This study attempts to investigate the validity of the assumption.

The data is drawn from the 1972-1980 surveys on the North, Mid-, South rice and Sugar regions in the (daily) 'Farm Record Keeping Families' surveys. The differences in production pattern and simple land productivity measures were analysed on the basis of multi-characteristic dummy variable regressions. Total factor productivity was estimated with value-added functions of five family-supplied inputs: paddy and dry cultivated land, male and female labour days and farm assets.

The response of the agrarian structure to the loss of rural workers since 1968 (and more recently of land too), has been a decline in large full-time farming. Our study shows that this process should not be countered artificially because there is no evidence that large full-time farming is superior to small full-time farming and only on dominant land type farms in the regions are small full-time farms more efficient than small part-time farms. Large full-time farms have not responded faster to shifts towards non-staple food demand, nor to mechanization and new intermediate inputs. Land productivity on large full-time farms is substantially lower than on small full-time farms and only slightly higher than on small part-time farms. Farm investment, farm assets and machine stock per hectare are similar across farms and additionally, the returns to scale are constant because the 'custom services' system has made machinery divisible. In some cases, part-time small farms show some total factor efficiency loss against full-time small farms, probably because the recommended farming methods are not appropriate for part-time farms.

Policies should continue to improve the working of the land market but no artificial agrarian restructuring is recommended. The production of supervision-sensitive crops needs small full-time farmers and part-time farming limitations would produce little efficiency gain against the nightmare of labour movements restrictions.

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CHAPTER I

INTRODUCTION

During the colonial period and the early post World War II decades, the small scale farm sector was the mainstay of Taiwan's economy. However, beginning in the late 1960s, the pace of agricultural growth declined significantly. Alarmed by this development, Taiwan's policy makers began a search for the causes of agriculture's sluggish performance. Of the many factors identified as possible reasons, two associated with the agrarian structure of agriculture have received attention recently from Taiwanese planners: (1) declining farm size and (2) a growing tendency of Taiwanese farmers, particularly small farmers, to operate farms on a part-time basis.

Planners react to the small farm size and the part-time farming with alarm because they believe that small farms cannot take advantage of the scale economies associated with mechanization and that part-time farmers cannot, or do not, use their land optimally. Mechanization has been underway in Taiwan since the early 1970s in response to the increasing scarcity of agricultural labour, so that it is currently believed that economies of scale gains are lost on small farms. The expansion of the non-agricultural sectors has enticed more and more farm households into taking off-farm employment, so that it is now believed that land is not optimally used on part-time farms because farming is a residual activity and because land is held as a store of value and for speculative reasons. Imperfections in the land market, caused primarily by the restrictions in the Land Reform Laws of 1949-53, may have hampered market transactions that would have helped consolidate land holdings. The belief that small farms and part-time farming are detrimental to sustained agricultural growth has led planners to call for a second land reform, which would promote more large full-time farming.

Interestingly and surprisingly, the discussion about the need for change in the agrarian structure just described has taken place largely without the support of empirical evidence. And yet, the issues in question are empirical ones. The purpose of this study is to attempt to provide the policy discussion on farm size and part-time farming with the empirical basis it currently lacks. In brief, the study tries to provide answers to the following two questions. (1) Are small farmers in Taiwan less productive than large farms? And (2) is part-time farming less productive than full-time farming?

The study is organized as follows. Chapter two examines major changes in the government's agricultural policy and in the organizational structure of agriculture in the post World War II period. In the context of this brief overview of the historical and institutional background, a set of specific empirical questions are proposed which are answered in the chapters that follow. Chapter three describes and assesses the main data source used in this study: the Annual Report of Farm Record Keeping Families. Chapters four and five, the core of the study, provide the empirical evidence on production and productivity differences between small full-time, small part-time and large full-time farms. Differences in production patterns, land production measures and investment-savings behaviour are presented in chapter four. In chapter five, value-added functions of the family supplied factors are estimated and used to test for scale economies, technical efficiency in part-time farming, and allocative efficiency. Chapter six summarizes the findings and offers some conclusions.

CHAPTER II

AGRICULTURE IN TAIWAN

A. INTRODUCTION

The purpose of this chapter is to provide the historical and institutional background to the current discussion in Taiwan about the need for a second land reform, one that would reduce the number of small part-time farms and increase the number of large full-time farms[1]. The chapter begins with a discussion of the major changes in the government's agricultural development policy. The growth in the number of small farms and of part-time farms are next examined in the context of Taiwan's land and labour markets. The chapter concludes with a statement of the size part-time issue that is currently under discussion in Taiwan and an overview of the questions that will be answered in this study.

B. GOVERNMENT POLICY AND AGRICULTURAL DEVELOPMENT

In the post World War II period, agricultural development has come about primarily through the efforts of individual farmers responding to changing economic opportunities. However, the government, by supplying agriculture with the needed infrastructure and by manipulating the economic environment within which farmers operate, has been able to influence both the pace and the direction of agricultural development[2]. In addition, the government has intervened directly at several important junctures and introduced dramatic structural changes to agriculture. There is a feeling in Taiwan that the time may again be ripe for the government to intervene.

In 1949, when it retreated from the mainland to Taiwan, the Chinese Nationalist Government made the political decision to implement its long standing policies on land reform. The hope was that land reform would not only result in a more equitable distribution of land, the major rural asset, but that by giving ownership to cultivators it would motivate them to increase agricultural production and productivity. The land reform was implemented in three stages[3]. In 1949 a very strict Rent Reduction Act was introduced, in 1951 public lands were sold to the tenants and in 1953 the Land To Tiller Act, which enabled tenants to buy the land they cultivated, was promulgated . The result was a vast increase in the number of owner-cultivators, which raised the share of owner-cultivators in total farm households from 32% in 1947 to 64% in 1960[4].

Besides introducing land reform, the government also repaired and extended the agricultural infrastructure (first built during the colonial period), and introduced industrial inputs and new production techniques that were divisible and scale neutral and thus suitable for wide adoption by Taiwan's small farmers. However, government policy in this early period was not only developmental but also extractive. Through its compulsory rice purchase and fertilizer-rice barter program, the government manipulated the terms of trade against farmers and extracted a considerable share of the agricultural surplus. In spite of this, the economic during the 1960s and the first half of the 1970s was, on balance, favourable to agricultural growth.

By the late 1960s, however, the conditions facing Taiwan's farm households had changed considerably. The 1960s was the decade during which Taiwan implemented major economic reforms that encouraged industries to be more outward-oriented. The changes in trade and industrial policies produced spectacular results: real GNP growth during the decade approached double digit figures and the growth in manufacturing production reached 20%. Because the industrial expansion occured primarily in labour-intensive industries, the demand for unskilled labour and semi-skilled workers increased rapidly. At first, the impact of rapid industrialization on agriculture was modest, but by the late 1960s the rural labour market became very tight and agricultural wages began to increase rapidly as many farmers found it more profitable to take employment in the industrial sector than to remain full-time in agriculture. Because industrial growth in Taiwan was not only rapid but also geographically dispersed, many farmers were able to participate in industrial employment without migrating to cities. The rise in wages and continued depressed prices for agricultural products made it increasingly less profitable for farm households to remain in agriculture. Consequently in the late 1960s workers began to shift out of agriculture, either through migration or through the reallocation of labour time from their farm work to non-agricultural employment, so that in 1972 the number of farm workers had declined to 94% of the 1967 level[5]. In this period, farmers adjusted by reducing labour intensive agricultural activities and double cropping. Animal husbandry declined[6] and the area planted in rice had fallen in 1972 to 94% of the 1968 level[7]. The multiple crop index fell from 190 in 1968 to 175 in 1972[8]. Agricultural growth was stalled.

Finally, in 1969, the government acknowledged the need for some fundamental changes in its policies[9]. It abandoned the fourth agricultural plan (1969-72) since surplus extraction and labour-intensive growth were no longer appropriate[10]. The prices of rice and fertilizer were adjusted to turn the terms of trade in favour of farmers, and consequently the ratio of official price to the market price climbed from 75 in 1968 to 108 in 1973[11]. To deal with the problem of rural labour shortages agricultural research was redirected towards developing labour-saving techniques. A major effort was made to find ways to mechanize rice cultivation. Joint projects involving experiment stations, machine producers, importers, Farmers' Associations and farmers were initiated to develop the appropriate machines. Research to develop regional specialization in production was also initiated.

By 1972-73 the results of public and private research became available. Locally made appropriate machines were introduced and their adoption was promoted[12]. The extension services trained farmers to operate and to maintain agricultural machines. Farmers Associations as well as private companies were involved in the development of a supply network for machines and spare-parts. The agricultural organizations, previously limited to providing short term loans, were now allowed to provide to farmers the medium term (7 year) loans needed for buying machines. Joint ownership of machines was promoted but proved not very popular. However, specialization developed as farmers with machines began to give 'custom services'[13] for those without machines (a development that was unexpected but nevertheless welcomed by planners). Agricultural machines were used primarily as a substitute for labour during peak seasons of the rice production. Rice transplanters, rice combines, dryers and threshers became available in 1970 and by 1980 a total of 110538 rice-related machines were in use[14]. At the same time, rice varieties which were appropriate for mechanical handling were extended and nurseries were started to supply boxed rice seedlings. The use of herbicides was promoted to reduce the need for weeding, an extremely labour-intensive and physically demanding activity.

Developing labour-saving technology for the non-rice crops proved more difficult; efforts were instead directed to a reduction of losses from natural disaster, disease and price instability. Improved cultivation techniques were promoted and herbicide resistant strains were developed. Where possible, typhoon protection methods and more village-wide pest and disease control were promoted. To provide greater price stability, farmers, processors and exporters were encouraged to sign seasonal contracts. To improve the regional distribution of income, an effort was made to make slopeland production more productive and profitable[15].

In the 1970s, farmers also had to adjust to changes in consumer demand. As per capita income increased, the demand for non-staple food also increased, and Taiwan's farmers responded to these changes. Thus, fruit production was 22% and vegetable production 48% lower in 1972, but rice production 4% and sweet potato production 177% higher in 1972 than in 1980[16]. The adjustments in production were also in response to shifts in the export pattern. Fresh fruit export quantity was 157% (banana 125%, canned pinapple 175%) and sugar 27% higher in 1972, but vegetable exports were 45% lower in 1972 than in 1980. Rice exports also increased. In 1972, 1% of the rice production was exported; by 1980, 17% of its production was exported[17]. The expansion in rice exports occurred despite the fact that rice production in 1980 was slightly lower than that in 1972. Clearly, domestic consumption patterns had changed dramatically. Despite these adjustments, agricultural growth between 1972 and 1979, at 3.5% per year, still compared unfavourably to the 4.5% per year growth rate established during 1951-1970[18].

Dissatisfied with the lower rate of growth, Taiwan's agricultural planners, searching for other ways to accelerate agricultural growth, began to voice their belief that the increasing number of small and part-time farms were the chief constraints to faster agricultural growth. We now turn to examine these structural characteristics.

C. FACTOR MARKETS AND FARM ORGANIZATION

The near disappearance of large farms and the rise of part-time farming can be easily documented. Table 2.1 shows that, between 1972 and 1980, small farms (those with less than 1 hectare of land) consistently accounted for over 70% of Taiwan's farms. In this same period the share of large farms (those with 2 or more hectares) declined from

Table 2.1: 1960, 1970, 1975, 1980 The NUMBER of HOUSEHOLDS CLASSIFIED by TYPE of WORK and by SIZE OF FARM

		1960	%	1970	%	1975	%	1980	%
Full time	(FT)	384501	48	276959	30	157043	18	91209	10
With sideline:	(PT)	423099	52	639007	70	729012	82	800054	90
- mainly farm	(PT.A)	241060	30	371434	41	422131	48	306335	35
- mainly sideline	(PT.NA)	182039	22	267573	29	306881	34	493719	55
Total		807600	100	915966	100	886055	100	891263	100
less than 1 ha	(S)	515817	66	629063	72	618119	71	633708	73
1 ha and less than 2 ha	(M)	183751	24	176216	20	181464	21	174020	20
2 ha and more	(L)	76434	10	741119	8	66817	8	64539	7
Total cultivating		776002	100	879398	100	866400	100	872267	100
non-cultivating		31598		36568		19655		18996	

Source: Census data

Table 2.2: FARM HOUSEHOLDS by TYPE of WORK and SIZE in 1980 and 1975

			Number of Households per Type						% Households per Size				% Households per Work Type			
Year	Size	Total	FT	%	PT.A	%	PT.NA	%	Total	FT	PT.A	PT.NA	Total	FT	PT.A	PT.NA
1980																
	-1 ha	633708	45054	5	170159	20	418445	48	100	7	27	66	73	50	56	87
	1-2 ha	174020	28046	3	94556	11	51418	6	100	16	54	30	20	31	31	11
	2+ ha	64539	16302	2	39067	4	9220	1	100	25	61	14	7	19	13	2
1980	Cultivators	872267	89402		303782		479083		100	10	35	55	100	100	100	100
1975																
	-1 ha	618119	80436	9	267599	31	270084	31	100	13	43	44	71	52	64	93
	1-2 ha	181464	50650	6	112937	13	17877	2	100	28	62	10	21	33	27	6
	2+ ha	66817	23981	3	39331	5	3505	.04	100	36	59	5	8	15	9	1
1975	Cultivators	866400	155067		419867		291466		100	18	48	34	100	100	100	100

Source: Agricultural Census, 1980, 1975

Note: FT : full-time farmer (all family income comes from the farming activity)

PT.A : part-time, mainly farmer (more than half of the family income comes from the farming activity)

PT.NA: part-time, mainly sideline (less than half of the family income comes from the farming activity)

10% to 7%. However, the most dramatic change was the rapid expansion of part-time farming[19]. Between 1970 and 1980, the proportion of farms classified as 'full-time' (defined as providing more than half of the family income) declined from 71% to 45%. Tables 2.1 and 2.2 also document another widely observed phenomenon in Taiwanese agriculture, the strong inverse relationship between farm size and part-time farming. As the farm size declines, part-time farming increases. For example, in 1980 66% of small farmers were also part-time farmers while only 14% of the large farmers were part-time farmers. The data also suggests that part-time farming has increased for farms of all sizes over time.

The government is particularly concerned about the growing number of small part-time farmers. But the distribution of farm households is influenced by many factors. Because developments in the labour and land markets have played a particularly influencial role, the discussion below shall focus on these two markets of Taiwan.

C.1 <u>Farm size and the land markets</u>[20]

How land is organized is determined in part by forces outside the farming households. Below we consider some of the external factors: the land laws, the inheritance customs and the demand for land for residential and commercial use.

The land laws that affect the distribution of land are the 1949 Rent-Reduction Act (RRA) and the 1953 Land-to-Tiller Act (LTT). The RRA not only reduced the rent but also gave tenants strong rights on the land they cultivate. Rent is set at 37.5% of the 1948 yield[21]. The law also stipulates a minimum six year lease[22], the right to renew the the contract if farming is the tenant's only source of income and if the landlord does not intent to cultivate the land himself[23], and that the contract be registered with the government[24]. Furthermore a tenant who has worked a piece of land for 8 years has the right to apply to the local land commission to purchase the land at its statutory value[25].

The purposes of the Land-to-Tiller Act were to distribute the land ownership to the cultivators and to prevent ownership concentration from reoccuring. Under the Act, farmer-tenants were allowed to buy the land they cultivated with their family. Landlords were allowed to retain 3 chia (=2.91 ha) of paddy land or 6 chia of dry land for cultivation or lease[26]. However, if the retained land is leased, the LTT act allows the tenants to ask the Land Commission for permission to buy the land[27]. Cultivators were allowed to own more than 3 chia of paddy land, but all families who bought land under the Land-to-Tiller Act could lose their land to the government without compensation if they rent out the land[28].

Table 2.3: OWNERSHIP OF THE FARM LAND

Year	full Owner (1)	part owner (2)	full ten (3)	Household (4)	Population (5)	Area	Area per HH (6)
	(%)	(%)	(%)	(#)	(#)	(Ha)	(Ha)
1947	32	28	41	553308	3578175	834000	1.51
1960	64	21	14	785592	5373375	869223	1.11
1972	78	12	10	879526	5947325	898603	1.02
1976	82	9	9	867547	5563354	919680	1.06
1979	85	7	8	898341	5638810	915393	1.02
1980	83	10	7	872267	5287596	907353	1.04
	(1)	(2)	(3)	(4)			(5)

Source: PDAF Agricultural Yearbook

Note: (1) percentage full land owners of the households
(2) percentage part owners
(3) percentage full tenants
(4) number of farming households
(5) population on the farms
(6) area per farming household

The land reform was very succesful. Tenancy (except where the landlord is the state) has virtually been eliminated. Table 2.3 shows that the share of owner-cultivators in total farm households increased from 32% in 1947 to 78% in 1972. while the share of tenants declined from 41% in 1947 to 7% in 1980. Because land was distributed over so many households, the average farm size also declined. In 1980 the average farm size was 1.02 hectare, and only 7% of farm households operated farms larger than 2 ha.

Since the early 1970s the ownership pattern has remained stable (table 2.3) and so has the size distribution of management units. It would appear that the land reform laws not only have prevented reconcentration of ownership, they may also have prevented the land market from playing its proper allocative role. The main problems which the land reform laws have created are the following.

Under the present laws, the leasing of land is perceived to be highly risky[29]. Farmers fear that they may loose ownership if they rent out land under a formal rental contract for longer than one year. Thus land is rented out at most for one year and usually unofficially[30]. This means that farmers who have found non-agricultural employment may nevertheless continue to farm their land on a part-time basis rather than rent out the land and risk the loss of ownership[31]. Since 1978, to encourage more land to enter the rental market, the government has introduced several new institutional arrangements to circumvent the land reform laws. One arrangement allows the land owner to arrange for another farmer to operate his land as a 'contract farmer'. This gets around the land reform laws because, strictly speaking, a 'farming contract' is not a rental contract[32].

Table 2.3 suggests that these new arrangements may already have had an effect. For the first time, the share of part-owner farmers has been on the rise. But table 2.4 shows that during 1977-80, newly renting or contracting households are but a small fraction of total farm households, suggesting that the rental market is still very thin even with the introduction of the new contracting arrangements.

For many reasons, land sales are also rare. Before a piece of land can be sold, permission must first be obtained from the land commission. The underdeveloped mortgage market and the stringent conditions imposed on mortgages also discourage land sales[33].

Beside the imperfections in the land markets, there are other pressures that keep farms small in Taiwan. Chinese inheritance customs divide land equally among male heirs[34]. Furthermore, rapid industrial growth has steadily taken bits of land from farms located near urban areas. The demand for residential construction has also put pressure on farm land[35]. With the cost of land reclamation and slope land development very high, very little land is being added. The farm size depends on the rate of loss of farm land and of farming households. From 1972 to 1976, farm land and farm households increased more or less proportionally (table 2.3). But between 1976 and 1980, farm land has declined more rapidly than has the number of farm households, so farm size has declined.

In summary, three major factors have influenced farm size in Taiwan: the land reform laws, the inheritance custom and the increased demand for farm land for non-agricultural uses. The land reform laws have imposed severe constraints on the operation of the land market, making it difficult to increase farm size for management purposes. The inheritance

Table 2.4: CHANGES IN LAND HOLDINGS BY SIZE OF FARM AND BY REASON

in 1975

Size	Purchase		Rent In		Sold		Rent Out		Total Number	
	HH	HA	HH	HA	HH	HA	HH	HA	HH	%
-1 ha	2882	339	866	325	5488	1826	542	303	558264	65
1-2 ha	1838	707	683	377	1559	799	322	160	197324	23
2+ ha	1023	801	362	335	823	387	99	76	110812	13
Total	5743	2247	1811	1037	7870	3022	963	539	866400	
%	.77	.30	.24	.14	1.06	.41	.13	.07	100	

in the 1977-80 Period (3 years together)

Size	Purchase	Renting	Contract	Sold	Rent Out	Contract	Total Number	
	HH	HH	HH	HH	HH	HH	HH	%
-1 ha	25516	2907	2909	8269	781	4845	633708	72
1-2 ha	5061	683	646	1767	225	831	4845	20
2+ ha	1976	317	257	1161	134	404	64539	8
Total	32553	3297	3821	10996	1140	6080	872267	100
%	3.73	.45	.44	1.26	.13	.70		

Source: Agricultural Census, 1975, 1980
b HH: households
c HA: area
d % : percent of the total number of households (or area)

custom encourages land fragmentation. Finally, between 1976 and 1980, because of increased demand for industrial and residential land, land was leaving agriculture at a faster rate than farm households.

The consequences for the farm sector are thought to be these: (1) other things equal, a net decrease in land will mean slower agricultural growth in the future, (2) the more uniform distribution of land is likely to contribute to a more equal distribution of income in rural Taiwan, and (3) the increasing number of small farms may result in production inefficiency if there are scale ecomomies in agriculture. One purpose of this study is to shed light on the third consequence.

To alleviate some of the problems created by the 1949 and 1953 land reform laws, several changes have been proposed. The experimentation with new rental arrangements, such as contract farming, has already been mentioned. Another proposal is to raise the amount of land that farm households may own, while placing a lower limit on farm size. A law to prohibit land speculation, a capital gains tax on land, and a heavy punitive tax on uncultivated farm land have also been suggested[36]. Another proposal is to facilitate land sales by making long term credit more accessible. The intent of all these suggestions is to increase the number of large full-time farms. Later chapters shall analyze the pattern of production by the size of farm and the degree of farm households' participation in farming. Hopefully, the analysis will suggest some of the likely impacts of land ownership consolidation.

C.2 Part-time farming, household labour supply and the rural labour market

Of the many factors that have influenced the development and the organization of part-time farming in Taiwan, four deserve special attention: the nature of Taiwan's labour market, the extended family system, the increased specialization and division of labour in agricultural production made possible by new technologies, and the growing demand for rural labour from the non-agricultural sectors[37]. Note that in this study a part-time farm household is defined as one that earns at least 50% of its income from off-farm sources (or allocates at least 25% of its labour to off-farm activities), and off-farm sources (activities) are not necessarily non-agricultural sources (activities). In other words, off-farm employment may involve working on someone else's farm.

Taiwan's labour market works reasonably well, with no sign of the distortions or imperfections that can sometimes be observed in other less developed countries. The island is served by a well organized transport system (made up of railroads, highways and an extensive feeder road system, and having a large bus system), perhaps the best in

Asia after Japan. It also has an efficient communication system. Newspapers, radios and televisions are all widely available in all parts of the island. There are no restrictions on movements within the island. Minimum wage laws exist but are not strictly enforced except in a few areas (e.g. export processing zones), so effectively they do not exist for most of the economy. In brief, labour is mobile, news of employment opportunities travels fast and rural workers are responsive to new economic opportunities.

Because of strong family ties and a traditional respect for the elderly, the typical rural household in Taiwan today is still composed of three or four generations[38]. Young adults remain at home until marriage, and even after marriage, at least one son remains in the parent's household. This household structure provides for the care of the elderly as there are no pension plans. In the past four decades, the number of primary and secondary schools has expanded rapidly in rural Taiwan. Traditionally, Taiwanese have placed a high value on education so that, when rural income improved and made it possible for more parents to send children to school, enrollment increased rapidly and those attending schools also remained longer in the school system. Thus, in a typical extended family, the younger members are much better educated than members of an older generation. The younger members, therefore, have better access to economic opportunities outside the family farm. However, many of those who have found employment outside the family farm have continued to be part of the farm household. In this fashion, the extended family system has contributed to the increase in the share of farm households with income from off-farm activities.

Another influence on the development of part-time farming has been the growth in 'custom services' provided by farmers who specialize in one or several aspects of crop production[39]. This type of specialization has always existed in rural Taiwan. For example, in the 1960s, groups of farmers used to travel up the island (from South to North) during the transplanting season helping with the transplanting of the rice seedlings. However, in the 1970s the importance of 'custom services' increased significantly as many farmers invested in specialized machines and equipment and began to offer their services to those who didn't have them. Thus, it became possible to hire one farmer to prepare the field with a tiller, a second to transplant the rice seedling with a transplanter and a third to harvest the rice with a harvester or combine. The system has started to go into other activities in response to the increasing sophistication of the production technology. For example, insecticide use is expanding and with it the supply of specialized workers[40] and their equipment, and other activities such as pruning also increasingly need specialized knowledge. This expansion of the 'custom services' system introduces an element of specialization of activity and may become increasingly important. These members of the farming community, by specializing in their agricultural activity, distribute the gains from specialization (human capital) across farms and also increase the divisibility of large pieces of farm equipment. Thus the development of a market for 'custom services' has increased part-time farming by providing off-farm agricultural work for one group of farmers while allowing another group of farmers to continue to operate their farms while engaged in full-time employment outside of agriculture.

Perhaps the most important influence on the development of part-time farming has been the rapid increase in the demand for rural labour from the non-agricultural sector[41]. Since the early 1970s, rapid industrial development has greatly expanded the opportunities for year-round employment for rural workers, particularly young workers. The expansion of non-agricultural activities was not concentrated only in the large cities but has occurred in a decentralized pattern, so that many rural workers could switch occupation without changing their residence. It is also important to note that the non-agricultural sector provides its workers on the average with more days of employment (27 days per month[42]) than the agricultural sector (16 days per month). However, the non-agricultural sector tends to hire the young and the better educated, and indeed, with industrialization, farming in Taiwan has become increasingly the occupation of the old and the less educated.

Tables 2.5 and 2.6 compare the age and the education distributions of workers in agriculture with those in the economy as a whole. They show that Taiwan's agriculture absorbs a disproportionate share of the older and the less educated workers. In 1980 only 26% of the male labour force in agriculture had education beyond the primary school, while this proportion in the total male labour force was 49%. Among women workers, only 10% of those in agriculture had education beyond the primary school, while the proportion in the total female labour force was 44%. In 1980, 60% of the male labour force in agriculture was over forty years of age as compared to 42% in the total labour force. Among female workers the age difference was even more pronounced. In 1980, 56% of the female labour force in agriculture was over 40 years of age as compared to only 25% in the total labour force. That it is the young, those between the ages of 20 and 44, who are most mobile, is comfirmed by the annual flow between occupations[43]. For example, in the mid 1970s, when the oil shock severely depressed industrial activities, there was a substantial net flow of workers in the age group 20-44 from non-agriculture to agriculture. It appears that agriculture is the residual employer and that workers move between it and the non-agricultural sectors according to economic conditions. However, labour mobility declines significantly once rural workers reach the age of 45.

That the young have a better chance of obtaining off-farm employment is also confirmed by the data in table 2.7. In 1975 the share of workers above the age of 45 was 30% for all workers supplied by farming households, 42% for full-time farm workers and 25% for part-time farm workers, and only 5% for workers engaged in other occupations (i.e. full-time in off-farm work). In other words, of those workers in farming households who did no work on the family farm but were fully engaged in other activities, 95% were under the age of 45. And of those farm family members who worked part on the farm and part off the farm, 64% were between the ages of 20 and 40.

In summary, four factors have influenced the development of part-time farming: a labour market that works well, the persistence of the extended family system, the development of a market for 'custom services' and rapid and decentralized industrial growth. They have combined to produce two types of part-time farm households in Taiwan. The first type is an extended family where some members (usually those over 45 years of age) work full-time on the family farm and some (the younger ones) have off-farm

Table 2.5: DISTRIBUTION OF WORKERS IN AGRICULTURE AND IN THE ECONOMY BY AGE

	+15	+20	+25	+30	+35	+40	+45	+50	+55	+60	+65	TOT
MALE						%						NUM
1975												
AG	11	7	8	11	13	15	12	9	8	5	1	949
EC	12	10	13	13	13	12	11	8	5	3	1	3473
1980												
AG	5	6	10	7	11	13	14	13	10	7	3	828
EC	8	9	19	12	11	10	10	10	7	3	2	4262
FEMALE						%						NUM
1975												
AG	12	11	9	13	15	15	13	8	4	1	0	544
EC	24	22	10	10	10	10	7	4	2	1	0	1705
1980												
AG	4	7	10	10	13	15	17	13	8	3	0	439
EC	17	23	16	10	9	8	8	5	3	1	0	2266

Table 2.6: DISTRIBUTION OF WORKERS IN ACRICULTURE AND IN THE ECONOMY BY LEVEL OF EDUCATION ATTAINED

	ILLIT	SELF	PRIMAR	JUNIOR	SENIOR	VOCAT	UNIV	TOT
MALE				%				NUM
1975								
AG	17	6	61	12	1	3	0	949
EC	8	4	51	16	5	9	6	3473
1980								
AG	11	7	63	12	2	4	1	828
EC	4	3	45	19	8	11	11	4262
FEMALE				%				NUM
1975								
AG	44	6	43	5	1	1	0	544
EC	22	3	46	13	4	9	4	949
1980								
AG	32	9	54	4	.02	.05		439
EC	12	3	40	16	5	15	8	2265

Source: DGBAS, Labour survey data

Note: EC: economy

AG: farm, forrestry, livestock, fishery, hunting (does not include agricultural experiment station, Farmers' Association and other services workers)

ILLIT: illiterate (no education)

SELF : Self educated (no education but literate)

PRIMAR: with primary education

JUNIOR: with junior high SENIOR: with senior high

VOCAT : with senior vocational UNIV: with university

Table 2.7: DISTRIBUTION OF FARM HOUSEHOLDS LABOUR BY EMPLOYMENT STATUS AND BY AGE (1975)

AGE	FULL FARM (1)	PART FARM (2)	FARM TOTAL (3)	OTHER OCCUP (4)	EMPLOY TOTAL (5)	LABOUR SUPPLY (6)
	NUMBER OF WORKERS(a)					
-14	52462	7056	59518	33595	93113	98108
15-	155085	95496	250581	198990	449571	467156
20-	654305	571440	1225745	303192	1528937	1647289
45-	400813	194239	595052	16176	611228	674594
60-	99542	17924	117466	3279	120745	144354
65-	118124	9393	127517	4888	132405	156451
TOT						
	AGE PERCENTAGES IN A WORKER CATEGORY (b)					
-15	4	1	3	6	3	3
15-	10	11	11	36	15	15
20-	44	64	52	54	52	52
45-	27	22	25	3	31	21
60-	7	2	5	1	4	5
65-	8	1	5	1	5	5
TOT	100	100	100	100	100	100

Source: Census data 1975

Notes:

a: Number of farm household members in the worker category and in the age bracket

b: percentage of the worker category in the age bracket

(1) Full farm: number of farm household members who work full-time on their farm

(2) Part farm: number of farm household members who work both on their farm and somewhere else

(3) Farm total: total number of farm household members who work on their farm

(4) Other occup: farm household members who do not work on their farm

(5) Employ total: Total number of farm household members who have employment

(6) labour supply: includes houseworkers

employment but all incomes are pooled and all live under the same roof. The second type is a household whose members have full-time off-farm employment but work on their farm after work or on weekends. These part-time households are likely to depend heavily on 'custom services' to do much of the farm work, especially during peak seasons and for activities which need special farming skills.

Part-time farming is not a temporary phenomenon. Indeed it is likely to become even more popular. Less certain are its consequences. The consequences for the farm sector are thought to be: (1) other things being equal, a net decrease in farm workers will mean slower agricultural growth, (2) the addition of off-farm income is likely to contribute to a more equal distribution of income in rural Taiwan, and (3) the increasing number of part-time farms may result in production inefficiency because of the residuality of the farming activity. The second purpose of this study is to shed light on the third consequence.

D. STATEMENT OF THE PROBLEM

The preceding examination of the historical development of the agricultural sector and of the agricultural policies and the detailed study of the forces in the land market and the labour market provide the setting for the policy question which is addressed in this study.

The agricultural development strategy adopted by Taiwan in the early 1950s was built upon two basic premises: (1) cultivators are more productive when they own their land, and (2) there exists surplus labour in agriculture. Accordingly, through land reform, the government created a large class of owner-cultivators. To protect the small owner-cultivators from losing control of their land, regulations were included in the land reform laws that made it extremely difficult to buy land or to increase the operational size of one's farm. Other agricultural development policies adopted in this period generally promoted the absorption of rural labour.

As conditions changed in Taiwan, the basic premises behind the agricultural development strategy became less valid. By the late 1960s, labour was no longer in surplus in rural Taiwan. In fact, the rural labour market was extremely tight in the 1970s as agriculture and the non-agricultural sector both competed for rural workers. With labour costs rising farmers were induced to adopt labour saving technology. Growth in off-farm employment opportunities also converted a large number of farm households into part-time farmers.

These developments, in turn, have encouraged policy makers to reconsider Taiwan's land policy. The land laws were designed to prevent the reemergence of large holdings. But such restrictions may no longer be useful.

Now the perception of the economic planners is that there may be too many small part-time farmers. Various arguments against small and small part-time farmers and in favour of large full-time farmers have been put forward[44].

(1) Small farms are believed to be inefficient since scale economies in the mechanized production technology cannot be achieved[45].

(2) Part-time farmers are believed to be less productive because of the residual aspect of their farming. Thus part-time farmers may be less attentive to their farm activity[46] (since it is now a secondary occupation and only a small fraction of their household income comes from farming), less able to adjust to sudden needs for labour (caused, for example by storms, diseases and pests), and more likely to divert the more able and productive family members into off-farm employment[47].

(3) Large full-time farmers are believed to be more responsive to changes in the economic environment. Thus for the 1970s, it is thought that the large farmers were the first to responded to the changes in agricultural demand brought about by the rapid growth of income per capita in Taiwan and that they adopted labour-saving technology more rapidly (unlike less developed countries, the concern of the Taiwanese agricultural planners is not directed towards the adoption speed of the green revolution; the green revolution took place in Taiwan in the 1930s).

These arguments in favour of a system of large full-time farms and in favour of the different land reform proposals are usually discussed and presented with relatively little empirical evidence[48], yet the underlying questions are largely empirical ones. Are small, and especially small part-time farmers less productive than large full-time farmers? Do economies of scale exist in Taiwanese agriculture? Did large full-time farmers respond earlier to the new trends in demand for agricultural products than small farms? Did they adopt the labour saving machines earlier, or the newly available herbicide? What would be the immediate consequences for the agricultural markets of amalgamating small and small part-time farms into large farms, each managed by one household who agreed to farm full-time? The following chapters attempt to provide empirically-based answers to these questions by estimating and comparing the productivity and performance of farms by size and by the degree that farm households participate in off-farm activities.

E. NOTES

1 In this chapter national data is used and the definitions of farms are those that are used in the national statistics (in chapter III, we will form our own definitions). Large farms are farms over 2 hectares, small farms are those with less than 1 hectare of cultivatable land (not corrected for land quality). Full-time farms are farm households where all the income is generated on the farm. Agricultural part-time farms are farms where the farming activity provides more than half the family income. The rest of the farms are non-agricultural part-time farmers. The definition of part-time farming is based on income shares. (This study will use a fertility corrected measure of size and a labour supply definition for part-time farming.)

2 A comprehensive study of the development of Taiwan until 1972, which was used extensively can be found in HO S. (1978).

3 For references see the bibliography section on land.

4 Various issues of PDAF, Agricultural yearbooks; see section C.1 on the land market.

5 Chen, Wang (1980).

6 Annual Report on Farm Record Keeping Families.

7 PDAF, Agricultural yearbooks and table B.1 in appendix B.

8 Chen, Wang (1980).

9 Shen T.H. (1974).

10 The rest of this paragraph and the next are based on statements from various annual reports of the JCRR (Joint Commission for Rural Reconstruction, the major agricultural authority during the 1950-1978 period), PDAF-agricultural yearbooks; Peng (1980) for mechanization questions; Shen (1974) and JCRR (1978) for policy questions.

11 Rice Review Magazine (1980).

12 Peng (1980) for the whole section on mechanization.

13 Custom contract: rental contract for an agricultural service usually hired on the basis of area serviced (machine + operators) or per day (animal + operator; skilled labour service).

14 Table B.4 in appendix B.

15 JCRR, annual reports (1968-1976).

16 PDAF, agricultural yearbook, and table B.1 in appendix B.

17 PDAF, agricultural yearbook, and table B.2. Note the difference in the domestic rice price (supported as part of the farm income policy) and the export price (concessionary as part of the international aid policy).

18 Chen, Wang (1980).

19 See also Ho S. (1983).

20 For references see the bibliography section on land

21 Rent-Reduction-Act art.2, art.4. Dr. Mao said that these rents apply to contracts registered in 1949-53. Since then no more tenancy contracts have been registered (see note 30).

22 RRA, art.6.

23 RRA, art.5.

24 RRA, art.19, art.20.

25 Land Act 1930, 1936, art.33.

26 Land-to-Tiller Act, art.10.

27 LTT, art.12.

28 LTT, art.30.

29 Mao (1978), p135-6.

30 personal talks with Dr. Mao (Chief of the Land Reform Institute and Chief of the Economic Planning division at the Council for Agricultural Planning (JCRR).

31 There is a constraint on the length of time that land can lay fallow, at most one season (3 months) is allowed, otherwise a penalty tax is imposed (and there is risk of forced selling). (Taxation and Tariff Commission (1974); Regional Planning Act 1974).

32 It is hard to tell what the legal status is of the contract farming agreements but they are mentioned in Mao (1978), p141 and Wu, Yu (1980), p15.

33 All sales have to be government approved and owner cultivators can not morgage their previously owned land beyond a limit (Mao (1978), p136). The mortgage terms are the Land-to-Tiller Act terms until 1981 (10 years maximum) but have been raised since (15 years).

34 Yu, Wu (1980), p3; Chen (1980), p2. Large farms especially are disappearing when the patriarch of the family dies and the farming sons each claim their share and become separate households. On smaller farms, usually only one son continues to farm and the other non-farming brothers do not sell their land share but rent it informally to the farming brother.

35 Some provisions of the Regional Planning Act (1978) also deal with the issue of conversion of farm land into non-farm land and with issue of land speculation. The act prevents sale of agricultural lands of certain grades to non-farmers (inheritance is not covered however). The act is primarily designed to control the conversion of land to non-agricultural uses and has not yet been enforced.

36 See previous note.

37 An extensive survey of the extend of off-farm employment, the sources of this off-farm employment and the effects on farming can be found in Ho S. (1983).

38 Gallin, Gallin (1982) report that the number of nuclear families had declined by nearly half while the number of joint families had risen 3-fold between 1958-9 and 1978-9 in the village which they studied. They state that the joint family is the ideal (p208). They also comment that mobility of men towards urban areas has declined (p212).

39 This section is based on the observations of Peng (1980) for the custom work market of machines services and on inference from my personal investigation of farm production activity and the hiring practices of 60 farmers in South Taiwan for the year 1979.

40 With the increasing awareness by the farmers of the harmfull effects of some of the insecticides on humans, there will probably be a greater development of this custom work market as protective equipment will be considered necessary. Additionally, new selfpowered sprayers have been introduced.

41 Ho S. (1979).

42 DGBAS, Labour survey data and table B.5.

43 See table B.6. where a more detailed commentary is given on the immigration flows.

44 The one argument that has been put forward in favour of small part-time farming is that their existence may have a favourable impact on the rural income distribution. The off-farm income distribution tends to inversely mirror the farm income distribution so that the total household income distribution is more equal. See also Koo (1982).

45 Yu, Wu (1980), p8, p15, p26; Chen (1980), p23.

46 Yu, Wu (1980), p8.

47 Chen (1978), p98; Chen (1980), p5.

48 An empirical investigation of part-time farming can be found in Yu (1970).

CHAPTER III

DATA AND HOUSEHOLD CHARACTERISTICS

A. INTRODUCTION

The empirical analysis in chapters four and five is based on data drawn from the 'Annual Report of Farm Record Keeping Families'. The purpose of this chapter is to describe this data set[1]. The information as originally collected, and subsequently processed into machine readable form, is described in sections B-C.

The data is organized by size, degree of off-farm activity, agricultural region and time. The size of the farm is measured in paddy land equivalent hectares. The degree of importance of farming to the household is measured as the share of the family's labour supply that goes to the farming activity and is called 'participation'. To make the study managable, only four of the eight agronomic regions of the Farm Record Keeping Families survey will be used (the North, Mid- and South Rice regions and the Sugar regions). There are nine annual samples (1972-1980). The various characteristics of the farmers are discussed in section D.

B. THE ANNUAL REPORT OF FARM RECORD KEEPING FAMILIES

Taiwan has had a long history of farm record keeping. It began in 1953 when a small number of farm households kept farm records as a part of an educational programme conducted by ten agricultural schools[2]. In 1960 the responsibility of the record keeping project was transferred from the schools to interested Farmers Associations. Since not all Farmers Associations participated in the project farm households from some important agricultural districts were not represented. In 1964 the Taiwan Provincial Department of Agriculture and Forestry joined the project and enlarged the sample of farm record keeping families to include households from eight agricultural districts. Since 1972, the project has been under the direct supervision of the township offices.

The data used in this study is drawn from the records kept between 1972 and 1980. During this period, about 450 farm households from 60 selected townships from all 8 major agricultural regions participated annually in the farm record keeping project. Because farm households participated on a voluntary basis, there is no reason to suspect the validity of the information recorded[3]. Since all transactions (cash and in-kind) were recorded daily, the accuracy is also high, certainly higher than the accuracy of data from periodic surveys where the responses depend on memory. However, because the participating farmers are self-selected, the sample is likely to be biased. It is likely that there are too many large farms and too few part-time farmers in the sample. Some of the bias can be corrected, but not all, as will be discussed in section D.5. Despite this problem, the journals kept by the farm record keeping families are the most complete and reliable farm household records available in Taiwan. Indeed, outside of Taiwan, few countries can boast of data of this high quality.

C. DATA FROM THE FARM RECORD KEEPING FAMILIES

Farm record keeping families recorded detailed stock and flow information on nearly all aspects of their activities. Unfortunately, some of the information recorded was lost through aggregation when the data was processed into machine readable form. Both the information that was recorded by the households and what is available in machine readable form is described in what follows[4].

Stock data

At the beginning and end of each calendar year, each Farm Record Keeping Family reported a detailed accounting of all their real and financial assets and liabilities. This account includes information on land holdings, buildings, machines, tools, fruit trees, draft animals, livestock, crops growing on the field, stored produce, stored farm supplies, financial assets, liabilities (short and long) and cash. The recorded information was aggregated into 15 categories when it was processed and converted into machine readable form. (A list of categories is provided in appendix C.) Unfortunately, the processed data does not distinguish between assets for farm production use and for consumption use. Consequently, farm buildings[5] could not be included in farm assets[6] and no attempt was made to estimate the labour input from draft animals[7] used in farming.

Flow data

Each Farm Record Keeping Family kept daily records of each cash[8] and 'in-kind[9]' transaction for the family, for the farm and for the off-farm activities. The information was then processed into 17 consumption expenses, 17 farm expenses, 16 farm receipt (organized by crops), 2 off-farm cost and 4 off-farm receipt categories, most with a cash and 'in-kind' subdivision. (See appendix C for a list of these categories.) Unfortunately, the processed data cannot be used to allocate costs to each farm output, and off-farm labour activities have been retained with very little detail.

Farm Record Keeping Families kept extremely detailed information on the labour allocation in their farming activity. The amount of labour used on each crop was recorded daily for each member of the family, for the hired workers, for the machines and for the animals (the latter two separately for self-owned and hired), with a description of the activity (hoeing, land preparation, weeding, fertilizing etc...). But most details were lost when the information was processed and converted to machine readable form. All information was converted into 3 labour categories: annual male family labour, female family labour[10] and hired labour[11]. It is particularly unfortunate that the information on the use of the self-owned machines and animals was lost[12] (the hired amounts can be retrieved from the relevant cost category). Also, labour cannot be allocated to the different farm receipt categories. But the quality of this labour data is still exceptional because there is no need to estimate the labour flow from the family members.

Each Farm Record Keeping Family also kept information on the amount and quality of land used in its farm operation, and the amount of land allocated to each crop. Subsequently, when the data was processed, the land information was aggregated into 3 categories of quality[13] (paddy, dry and other, without regard for the quality grade) and 4 categories of crop area[14] (first rice, second rice, other crops and permanent crops).

Family characteristics

Much information on the characteristics of each family was collected. Each Farm Record Keeping Family reported the age, education, occupation and health of each family member. But most of this information was lost when the data was processed. Family members were classified as adult male, female, old and young. The lack of information on the family members' characteristics, together with the fact that off-farm income flows were not retained in much detail, makes it impossible to conduct an in-depth analysis of the off-farm activity. But a farm activity study which does not concentrate on managerial skill effects is still possible with all the other data available in this survey.

In summary, the data used in this study is based on the daily records kept by Taiwanese farm families. A wealth of information was gathered but much detail was lost when the data was aggregated and converted into machine readable form. Thus, neither production costs nor labour input can be allocated to the output categories. Secondly, the amount of labour input from self-owned draft animals and machines is not available. Thirdly, agricultural buildings could not be included in farm assets. Fourthly, the information on off-farm activity which was retained, was insufficient to do an in-depth analysis of the off-farm activity. But since this study is focussed on the consequences of the size and the degree of off-farm activity on farming, the data that is available is more than sufficient and indeed of very high quality.

D. DATA BASE AND CHARACTERISTICS OF THE FARMS

The main aim of this study is to test the hypothesis that large full-time farms are more efficient that the other farm types, and this section describes the definition of each farmer characteristic. To make the study managable the decision was made to restrict the analysis to four of Taiwan's eight agricultural regions, so that the annual data base is limited to only 250 of the 450 Farm Record Keeping Families and the whole sample contains 2274 observations. To compare the farm performance of the households, the households were classified according to four characteristics: farm size, participation, region and year of production. The arguments which are used to defend the preference for the large full-time farm type are the base for the definitions of these characteristics chosen in this study.

D.1 Size of the farm (s)

In the literature on the efficiency of different sizes of farms, farm size is measured in a variety of ways. The most frequently used measure is the amount of cultivatable land held by the farm household[15]. This measure approximates the scale of farm operation if land is of uniform quality and if all farms are engaged in the same type of farming activities.

If the land is not of uniform quality then a comparison of farm performance by size, measured by the amount of cultivated land, may be quite misleading. If all large farms have poor land, while small farms have fertile land, then efficiency comparisons do not reflect the effect of size only, but also that of land quality. To correct for the land quality in this study, an equivalent-paddy-land size measure is computed.

Also, if the type of farming activity is very different between farmers then land size is a misleading indicator of the scale of operation. The operation scale of a specialized livestock (or fish pond) producer is not reflected by the land size. Fortunately, the farmers in the sample are crop farmers who have some livestock or add some fishery (forestry or processing) as a minor activity.

To take account of the differences in land quality[16], this study measures farm size in terms of paddy land equivalent hectares. The dry land[17] was converted into paddy land equivalent hectares by multiplying its area by .87 (the average of the conversion rates between equal graded paddy and dry land), and 'other' land[18] was converted by using .187 (the conversion rate of the lowest quality of dry land against grade 10 paddy land). The conversion rates were calculated from the land tax assessment schedules used in Taiwan to tax land of different grade and type[19].

In summary, the land size (s) is calculated as:

$$s = 1 \times P + .87 \times D + .189 \times O$$

where P = Paddy land hectare
D = Dry land hectare
O = Other land hectare

Our sample farms are classified according to the amount of equivalent land they use in their operation. There are three categories:

small (S)		$s \leq 1$ ha
medium (M)	1 ha <	$s \leq 2$ ha
large (L)	2 ha <	s

where s is the equivalent cultivatable land in hectares[20].

D.2 <u>Participation (p): the degree of importance of farming to the farm household</u>

The degree to which the farming activity is part of the family activities (called participation) can be measured in several ways. But the definition should relate to the mechanism by which part-time farming is assumed to influence farm production efficiency (similar to 'size' being related to the economies of scale assumption). In the published discussions on the effect of part-time farming in Taiwan[21], there is no agreement on the main reason why efficiency losses are incurred. But the arguments are usually variations around three main themes: (1) inattentive farming because farm income is not important for family income, (2) the labour quantity for farming is residual when the main labour supply is for off-farm work, and (3) the labour quality for farming is residual when the best labour supply is for off-farm work.

We define 'participation' as the share of the family labour supply going to the farm activity in the total labour supply of the family. With this definition we try to capture the effect for the farm activity of the residuality of the family farm labour. A second and less important reason for this labour definition of participation is that the alternative farm income share definition is too sensitive to the variability of the farm income as it is influenced by natural conditions. Although the farm income definition seems to be closer to the 'attention share' reason against part-time farming, in practical calculations it will not capture the more stable characteristic of part-time farming[22]. The labour supply amounts which go to the off-farm and the farm activity are more stable from year to year and closer to the inherent family characteristic. So our labour supply definition of participation captures both the labour residuality arguments and the 'attention share for farming' argument.

Farm Record Keeping Families kept detailed records of the amount of labour spent on farm work but did not report the off-farm labour time. However, the farmers did report the incomes from (1) temporary or occasional labour and from (2) full-time labour or other business activity. To estimate the amount of off-farm labour we assume that the first type of off-farm labour commands a wage which is comparable to the agricultural daily wage and that the second off-farm work category is supplied at wages which are comparable to the manufacturing wage[23]. The off-farm labour supply is the sum of the temporary labour (calculated from the temporary income by dividing this income by the agricultural daily wage) and the full time labour (calculated from the full-time income by dividing by the manufacturing daily wage). Total family labour supply is the sum of the family labour used on the farm (measured in male equivalent[24]) and the estimated family labour used in off-farm work.

Farm households are classified according to the degree of on-farm participation into four categories:

low participation	(LP)	$.25 \geq p$
part-time 1	(PT1)	$.50 \geq p > .25$
part-time 2	(PT2)	$.75 \geq p > .50$
full-time	(FT)	$p > .75$

where p is the share of family labour allocated to farm work (p = family farm labour/total family labour).

D.3 <u>Agricultural regions</u> (r)

The 250 farms in our annual samples are from four major agricultural regions of Taiwan: North Rice, Mid Rice, South Rice and Sugar. These regions differ in their climate, in their agronomic environment and in their opportunities for non-agricultural activity.

The North Rice region (NR) is in the north of Taiwan where rice can be grown in the valleys, in the Taipei plain and in the North Eastern plain. Citrus fruits can be grown on the slope land. The region is cool in the winter and receives most of its rain in the fall. This is the most industrialized and urbanized region in Taiwan. Both Taipei, the capital, and Keelung, the northern port city, are in this region. The opportunity for off-farm employment in industrial and commercial activities appears to be good throughout the rural area of this region.

Below the North Rice region is the Mid-Rice region (MR). It is less mountainous and more rural. However industrial activity is rapidly spreading into this region from the North. The climate is subtropical and substantially warmer than that of the North-Rice region.

The South Rice (SR) region is the major agricultural area in Taiwan. It is located near the southern tip of the island. The land is flat, fertile and irrigated. Some of the land in this region was consolidated in 1978[25]. The region has one major industrial centre, the port city of Kaohsiung, but most of the region is still primarily rural. This region has some of the best land in Taiwan for growing rice and beans. Since the climate is tropical, the area is also suitable for tropical crops and crops mature rapidly. It should be noted that some of the farms in our sample are located in the hills bordering this region and consequently have a higher share of dry land area.

The Sugar region (SUG) lies on the south-western side of the mountain range that runs from the north to the south of Taiwan. The land is hilly and less irrigated, and the climate is tropical. This region is largely rural without much opportunity for employment outside the agricultural sector.

It should be noted that the classification of farm households by region which is used in this study, is slightly different from the classification in the published report on farm record keeping families. After an investigation of the crop patterns, some villages in bordering areas were moved into another crop region for our study so as to ensure that farms in each region have a similar output mix. This was done so that our data would better comply with the assumption of a common production technology within a region. This reclassification of villages did not change the characteristic economic conditions of the sample regions as the reclassified villages were geographically close to each other.

D.4 Time

To test the hypothesis that small farms are less responsive to changing conditions (e.g. shift in demand pattern and changes in the labour market) than large farms, response patterns and time trends are needed. In this study, the hypothesis will be tested with nine annual samples (1972-1980) of 250 Farm Record Keeping Families.

D.5 <u>The distribution of farm households</u>

The 2274 farms of our sample have been classified into three farm size categories (small, medium, large), four participation categories (LP, PT1, PT2, FT), four regional categories (NR, MR, SR, SUG) and nine time periods (1972-1980). We can now discuss the issue of selection bias. Table 3.1 presents the distribution of our sample farms and that of all Taiwanese farms by size and by participation. However, comparisons of the two distributions must be done with care because the national data measures size by hectares (instead of paddy land equivalent hectares) and participation by income share (instead of labour share).

A comparison of the two distributions in Table 3.1 suggests that our sample contains too few small farms and somewhat too few part-time farms. Total sample averages are therefore distorted, but in this study we are not particularly interested in total sample averages. Rather our interest is in the differences between the various categories of farms, thus what is of importance is that cell averages are unbiased. They will be unbiased if the farmers in each cell are truly representative for that cell. This last requirement we assume fullfilled in this study because

Table 3.1 FARM TYPE DISTRIBUTION (PERCENTAGES)

	SAMPLE(a)				NATIONAL(b)		
	PT	FT	TOT		PT	FT	TOT
S	18	33	51	S	32	40	72
M	21	13	34	M	16	4	20
L	12	3	15	L	7	1	8
TOT	51	49	100	TOT	55	45	100

Source a: average share of each farm category, calculated from the total number of sample households (2274)
b: average share of each farm category, calculated by adding the numbers of 1975 and 1980 farm households together (1975, 1980 agricultural census)
note: FT: sample: household with over 50% farm share in family labour supply
census: Household with over 50% farm share in family income
L : sample: household with more than 2 hectare paddy equivalent land
census: household with more than 2 hectare land
M : sample: with between 1 and 2 hectare paddy equivalent land
census: with between 1 and 2 hectare land

there are a sufficient number of classification criteria (=characteristics) and categories within each criteria to insure that the households in each cell are homogeneous. The distributions of the sample farms by the four characteristics (size, participation, region, time) are presented in appendix C, table C.1[26].

In summary, the information of the Farm Record Keeping Families is of exceptional quality for investigating the consequences for farming of the size and the degree of family labour effort towards their farming. Because of the daily recording of the activities by the households, the farm production data for each household is very accurate, and even after processing, sufficiently extensive for the purpose of this study. Indeed, few data samples on agriculture exist of this quality and extend.

E. NOTES

1 This chapter is partially based on my personal experience with the Daily Farm Record Keeping Survey and with the various organizations that handle the Survey. I visited Taiwan from October 1979 to September 1980, where I had the opportunity of working at the Council of Agricultural Planning and Development (Taipei). Numerous visits were made to the Provincial Department of Agriculture and Forestry (Taichung), especially to the department which processes the Farm Record Keeping Families survey (but also the departments responsible for extension, international cooperation and technical reseach). I investigated the original records (the daily sheets) of 60 Farm Record Keeping Families of the South Rice region in order to understand the farming methods, the household behaviour, and the relationship of the original records to the processed data. I was able to visit the South Rice region (Pingtung) during December 1979 when the winter crops were on the field. I visited the Mid-Rice region (Chinzu) during the first-rice harvest season and also during the second-rice planting season of 1980. As a result I had the opportunity to talk to the different types of farmers (crop, pig, fish) in the different seasons. I also visited a Farmers Association and an Agricultural research station, and could ask questions about the behaviour of the farmers, and the organizations' roles.

2 Farm Record Keeping was started in 1953 and the literacy requirement was distortive at that time. Farms whose farm income share was less that 50% were also excluded in these early surveys. The representativeness problem was thus more severe than in the surveys since 1972.

3 Farmers do not fear that the information will be used for income tax purposes because there is only a land tax on the farming households. There may be some bias towards higher profit in the sample, because the act of reporting may increase the farmer's awareness of his actions. Farm households do not have to keep account of their farm business, neither for tax nor other reasons, but the categorized statements of each household produced by the PDAF can be used as accounting statements. Some farmers have indeed asked for these statements. They were used to ask farming advice from the extension officers in the Farmer's Association and to get loans from the FA credit department. However most farmers just write down the information and never look at it again.

4 Processing for storage was done at the Provincial Department for Agriculture and Forestry (PDAF). All recorded information was reduced to one sheet of data per farmer. The data from these sheets was put on computer tape at the Council for Agricultural Planning and Development (CAPD), and these data tapes will be used in this study.

5 Fortunately, the house has by far the largest share in the building wealth. Equipment barns are usually only shacks of low value. Only if there is a substantial amount of livestock production (pigs) is there investment in barns. But this type of small scale pig production on crop farms has been dying out since the late sixties because it is a labour intensive activity.

6 Income from financial wealth was classified by the PDAF as off-farm income. This indicates that financial wealth is not considered a farm asset by the PDAF, and we follow this practice too.

7 Draft animals are used as a labour input for land preparation, but they are rapidly being replaced by tillers.

8 The farmers were also asked to write down the unit price and the quantity of each transaction.

9 The farmers were asked to write down the imputed value of the transaction, if they had not, then the PDAF used the market price.

10 All female labour in this study is measured in male equivalent units. The conversion rate is .8, so ten hours worked by a women were counted as eight hours of input.

11 For hired labour no distinction was made for male or female, but the female labour was counted in male equivalents. The human labour content of custom work is counted in the hired labour category . Similarly, the human labour cost (evaluated at the market wage) was subtracted from the custom work cost and the residual classified in the machine cost (before 1977 in the rental cost).

12 The Farm Record Keeping Families reported the hours that a draft animal or a machine which they owned had been used by a family member. In fact the Annual Report of Farm Record Keeping Families reports the number of days per month that the self-owned and hired animal or machines were used. But this data was not retained for each farmer on the machine readable records.

13 The inventory of land and the land use data together made it possible to calculate the cultivatable land that the farmer had at his disposal. The cultivatable land includes the rented land but excluded the land rented out.

14 The amount of cropped land when the land was used to grow vegetables is the hardest to calculate correctly. Farmers subdivide the land in strips and several types of vegetables are grown side by side. They also usually are planted at different time intervals. Only if the whole field is plowed (usually if the farmer reported a land preparation activity with animal or machine use) can one determine that the vegetable crop was entirely harvested. Thus for vegetable farmers, sometimes the amount of cropped land is underestimated because harvesting and replanting of vegetables is continuous (this can produce very high vegetable yields)

15 Sen 1962.

16 The different land types (paddy, dry, other) are usually treated separately in the agricultural policies.

17 Dry land is rainfed land as compared to paddy land which is irrigated.

18 'Other' land is riverbed land, forest land and fish ponds.

19 PDAF, tax assesment records

20 Two more land size definitions could be used. Rao (1967) excludes fallow land while Rudra (1968) counts land twice if it is cropped twice. Both authors argue that their land measure is closer to a measure of scale of operation, the latter being a measure that includes all the factors of production. But we consider the choice of fallow land and the levels of non-land inputs as part of the production decision. The differently sized farms should choose in an equally efficient way.

21 See chapter II, section D.

22 Farm income can vary dramatically from year to year depending on the weather, disease and pest conditions. As a result, farm income shares will change randomly and do not represent an inherent family characteristic.

23 The manufacturing wage was calculated from the monthly income in the manufacturing sector and divided by the average monthly number of work days in this sector. This is similar to the treatment in table B.3. The data for these calculations came from annual labour survey data collected by the Department of Government Budgeting and statistics (DGBAS).

24 In this calculation female labour was counted in male equivalent time, so that it would be comparable to the labour from off-farm activity by females (the use of the daily agricultural wage and the daily manufacturing wage to calculate labour days from the off-farm income of females transforms this female labour into male equivalent labour).

25 This consolidation was not an ownership consolidation. The fields, irrigation and road network were redesigned into a more rational pattern. Farmers recieved 95-97% of their land back after the consolidation (according to my interviews of farmers in 1980. The farmers also indicated that they were very satisfied with the results of the consolidation, although they had only reluctantly accepted it in 1978).

26 Another consequence of the selection procedure of the sample is that the question of how and why farm households decide on their farm size and level of participation cannot be addressed directly. Even if the information on the quality of the household members and on the land rentals had been retained, this question could not be answered because of the selection method. If the sample had only been farmers who responded for all nine years, then the farm household's changes of farm size and participation levels could be traced and investigated over these nine years. In this case, the decision could be traced in terms of the household's economic conditions and personal characteristics. If on the other hand, every year a fully random sample was drawn then again the above question could be addressed. In this case the sample would reflect the nation's change in proportions of small and part-time farms so that these changes could be related to the agricultural sector's conditions. But the Farm Record Keeping Family sample is a mix of both selection methods. Size and participation are thus household characteristics whose consequences for farming productivity are the subject of this study. This approach is the standard one in the studies where only the effect of farm size is investigated. In these studies, even though a working land rent market exists, the land size is taken as a given characteristic of the farm and its consequences are then investigated. See the literature overview in chapter four.

CHAPTER IV

PRODUCTION PATTERNS AND SIMPLE PRODUCTIVITY MEASURES

A. INTRODUCTION

In this chapter, an investigation of the production structure of the small full-time, small part-time and large full-time farms will provide the answers to the following questions about the superiority of the large full-time farms: 1) Do large full-time farms make the better use of the available land (higher production and yields per land unit) than small full-time and small part-time farms? 2) Are large full-time farms more responsive to new circumstances, so did they produce the newly demanded agricultural products of the 1970s earlier and also adopt the new production methods earlier? 3) Do large full-time farms save and invest more per hectare than small farms? Additionally, this investigation can be used to identify the markets which would be seriously disturbed if a land reform policy were implemented in which all small farms were amalgamated into large farms each owned (or operated) by one household who agreed to farm full-time.

In section B, the literature is reviewed on the efficiency of the different farm sizes in the Asian region as measured by land productivity measures. In particular, the development of the discussion in the Indian context is reviewed because that debate brought out the strength and the weaknesses of the land productivity measures and is thus relevant to this chapter.

In section C, the multi-characteristic dummy variable regression approach to the comparison of the production structure between farm types is explained. This dummy variable model uses all of the farm type data available while keeping the interpretation sufficiently clear to be useful. Thus in the text we concentrate on the small full-time, small part-time and large full-time farms but the regression equations given in appendix D also provide information about the behaviour of medium (M) farms, the farms which are not so extreme in their levels of participation (PT2,PT1) and the time effects. (A slightly modified form of this dummy variable model will be used in chapter V.)

The production structure is investigated in sections D-G, with a discussion of the labour and machine use and the family endowment structure in section D, the output structure in section E, and the intermediate input structure in section F. Simple measures of yield and land use, together with the saving-investment behaviour are discussed in section G.

The discussions in sections D to G are organized such that the differences between farm types are pointed out first. These differences indicate what would happen to the agricultural markets in the very short run if all small full-time and small part-time farms were amalgamated into large farms, each owned (or operated) by one farm household who agreed to farm full-time. Long term adjustments to the new market situations cannot be ascertained, since this would require information about the demand for agricultural products and the supply of inputs to the agricultural sector. However, those markets where major immediate adjustments would occur from this reorganization of the farming sector can be identified.

Secondly, the timing of the adoption of machine use, of non-traditional crops (such as vegetable, fruits) and of new intermediate inputs (such as insecticides, herbicides) are discussed in the cases where there is a difference between the small and large farms. These activities were the relevant response to the new production circumstances of the 1970s in Taiwan[1]. This discussion is thus a test of the assumption of superior receptivity of large full-time farms to new circumstances. If large full-time farms are faster at adopting new activities then they should show larger values in 1972 for the activities which were introduced before 1972, and there should be evidence of a catching up by small farms in the 1970s. For activities which were introduced after 1972 (where starting values are similar), there should be significantly higher adoption in the early part of the 1970s on large rather than on small farms.

Thirdly, an attempt is made to describe the production choice behaviour of the different farm groups by linking the differences in the supply of family inputs (=endowments) to the differences of the output, the intermediate input, the bought labour inputs structure and to the yield and land use measures. These links show the adjustment strategies of the farm households to their input endowments and to the characteristics of their farm activity. On the one hand, adjustments to the different family input endowments is possible by compensation with substitute inputs. Thus the evidence of substitutability between family labour and hired labour, hired animal and machine services and owned machines is of interest. On the other hand, adjustment to the different family endowments is also possible through the choice of outputs. In this case, farms behave in a way that is analogous to countries in international trade, choosing output patterns suited to their (immobile) input endowment ratios[2]. Thus the lack of markets for immobile family factors need not lead to efficiency losses for the system if there are instead sufficient crop choices so that farmers can choose their crops according to their factor endowment structure.

Section H is the conclusion and provides the answers to the questions of this chapter. (The estimated dummy variable regressions which were the base for the tables in this chapter are reported in appendix D. More detail on the construction of the yield and land use variables can be found in appendix A.)

B. LITERATURE

The discussion on the efficiency of farms of different sizes in Asia started in 1962 with an article by Sen (1962) in which he made the following observations on Indian farm data for 1954-5, (repeated in Sen 1975, p147):

"Observation I: When family labour employed in agriculture is given an 'imputed value' in terms of the ruling wage rate much of Indian agriculture seems unrenumerative.

II: By and large, the 'profitability' of agriculture increases with the size of holding, 'profitability' being measured by the surplus (or deficit) of output over costs including the imputed value of labour.

III: By and large, productivity per acre decreases with the size of holding."

These observations started a heated discussion which raged between 1962 and 1973 and which was mostly concerned with the land productivity of the farms (the third observation). Sen (1962) explained his results by maintaining that family labour does not command the market wage on small farms so that more labour per acre is used. Since all other factors of production are proportional to the labour input there will be more output per acre on small farms. He also uses the argument that bullock labour is indivisible if no service market exists so that the bullock per acre input is higher on small farms and, since the other variable factors are in a complementary relationship with it, more output per acre will be produced.

A second set of arguments concentrated on the correct definition of land area which should be used in the calculation of land productivity. The use of cultivatable land could give misleading results. Sen (1964) argued that small farms had more fertile land because population pressure forced the break-up of fertile land (also Khusro 1964). Bhagwati-Chakravarty (1969) argued that less fertile land is sold first in distress sales and so this is the only land available for collection into bigger estates. Also larger farmers have non-pecuniary (prestige) benefits from large but relatively infertile estates (also Bardhan 1973). These arguments related fertility of land to size and thus to output per acre. A.P. Rao (1967) argued too that land area should be corrected for fallow and for irrigation levels. Rudra (1968) argued for the use of gross acres especially if there was heavy multiple cropping. In this study, we correct for the fertility of the land in the calculation of the farm size (see chapter III).

A third set of potential explanations of observation III concentrated on the statistical aggregation bias of the different measurement studies. Sen based his conclusions on size-class average data[3] for seven Indian regions (1962). In 1975 Sen noted that this could create a statistical illusion because he was both aggregating over villages and over households. The aggregation over villages strengthened the effect of both the labour market imperfections (which made labour immobile between villages, but less so within the village) and the non-homogeneity of land quality across villages. Thus it was possible that the productivities per acre did not vary within a village but varied considerably between villages. Empirical evidence was less than clear on this issue (Rao A.P. 1967, Rudra 1968, Saini-Bhattacharya 1972) because the definitions of acreage changed across the studies. Observation III was not reversed in studies which used household data instead of size-class data (Saini 1971, Bardhan 1973). In this chapter, the comparison between farm types uses class average data because the measures of the farm characteristics only approximate the underlying potential source of inefficiency (see chapter III).

Sen's observations I and II were essentially ignored during this period. Only Khusro (1964) paid some attention to the relationship between the net profit (after imputation of value to family supplied non-land inputs) and size. Saini (1969) saw that the productivity of different farm sizes was a special case of a total factor productivity investigation and thus should not solely concentrate on land productivity. Bardhan's study in 1973 essentially introduced the next stage of the debate on farm size efficiency by pointing out that the real issue of size is whether the technology showed increasing returns to scale[4]. He proceeded to estimate production functions of all factors and found that decreasing or constant returns to scale was the rule in rice regions (but increasing returns to scale in wheat regions in India). Bardhan did indicate that large farms might contribute to growth even if they were statically inefficient because they could save more and so invest more.

Thus the optimal farm size debate in the Indian context essentially brought out both the usefulness and the limitations of the land productivity measures. These measures continue to be very popular. As Census data usually provides sufficient information for their calculation, they can be used for cross country evaluations of the farm size issue. Thus Barry and Cline (1979) found that land productivity consistently falls with size in the Phillipines, West Pakistan and Malaysia[5]. The scant evidence on farm size efficiency in Taiwan also uses these measures (Chen 1980).

C. EMPIRICAL METHOD: THE DUMMY VARIABLE MODEL

This study concentrates on the differences in production patterns and production efficiency between small full-time, small part-time and large full-time farms, but data is also available on other farm types. Also the timing of some production variables is of interest in this study because of the interest in differential adoption rates, and so is the agronomic region. A method of data analysis had to be found which made interpretation simple but also incorporated all the available data.

The dummy variable model was choosen as the simplest approximation to the method of comparing the significance of the differences in the mean variables for all the different groups of observations. Four classification characteristics, size (s), participation (p), region (r), and time (t), are considered in this study, producing a total of 432 cells (s=3, p=4, r=4, t=9) where each cell should have at least 20 observations for reliable estimation. The comparison of all the group averages would produce 432!/[2!(432-2)!] computations per efficiency measure. This is too many to estimate and yet no data should be discarded[6].

We propose the following dummy variable model on all the observations for each efficiency measure:

$$a_{sprt} = a_0 + \sum_{s=1}^{2} a_s d_s + \sum_{p=1}^{3} a_p d_p + \sum_{t=1}^{8} a_t d_t + \sum_{r=1}^{3} a_r d_r + \epsilon_{sprt}$$

where: s: size
p: participation
r: region
t: time

so that each characteristic $i=s,p,t,r$ has its own dummy variable d_i. The dependent variable (a_{sptr}) is the observation on an efficiency measure or a production variable for the farmer. The focus of this study is thus the average (or expected) efficiency level of the farmers who belong to the different groups. For example, the average (or expected) efficiency level of the farmers who belong to the small, low participant, 1979, North Rice region group (s=S, p=LP, t=1979, r=NR) is:

$$E(a_{S,LP,1979,NR}) = a_{S,LP,1979,NR} = a_0 + a_S + a_{LP} + a_{1979} + a_{NR}$$

As can be seen, it is easy to identify shifts in the average efficiency level from group to group. The coefficient (a_i) of each dummy variable (d_i) indicates the value of the shift and the t-test on the coefficient shows whether this shift is statistically significant.

The disadvantage of the dummy model is that some regularity is imposed on the pattern of cell means if more than one characteristic is considered. One solution would be to add interaction dummy terms ($d_s d_p$), but this expands the number of coefficients to estimate[7]. Therefore, the disadvantage of the simple model without interaction terms must be weighted against the advantages of the clarity of interpretation of a few coefficients and the constraints of the number of observations.

It could be argued that a better model would be the simple regression model of the efficiency measure as a linear function of size, participation level and time, since each was a numerical measure before intervals were defined. This also imposes a regularity on the data and there is no a priori reason for assuming that the relationships are linear in the characteristics.

The second reason why we prefer the dummy model (against the linear regression model) is that each of the measures of the characteristics is in fact an approximation for the true variable of influence (see discussion in chapter III). Thus the size is an approximation for scale of production, the participation level for the residual aspect of farming, the time period for the weather conditions and the technological trends, and the region for the homogeneous agronomic area. Because of the approximate quality of the measured characteristics we felt that it was more appropriate to study households as belonging to classes (measured by belonging to a value interval of their characteristics). Thus there will be two dummy variables (d_s) associated with farm size (s = S, M) and three associated (d_p) with participation level (p = PT2, PT1, LP), while the constant (α_0) of the regression is the value level for the large full-time farm (the base level from which the shifts α_s, α_p are calculated).

We decided to estimate a dummy model for each region because the four regions are very dissimilar. The division of the total sample into four regional samples also allows an investigation of the robustness of the shifts that size, participation and time impose on the variables. For each efficiency measure (or production variable) four regressions are thus estimated, so that it may be shown whether shifts occur in the same direction for all regions. The conclusion about the influence of the farm characteristic will then be stronger.

The estimation of the time trend with the time dummy variables (d_t) gives an average of the trend in all farm sizes. But the assumption that large farms adopted new technology and crops faster (in the early 1970s while small farms did not yet adopt them) must be tested. We test this assumption by adding two interaction terms ($d_s d_b$) between the size (s = M, S) and the first five years of the sample; they are the 'break' dummy variables (d_b = 1 if t = 1972, 1973,1974,1975,1976, otherwise d_b = 0)[8]. Thus whenever this break coefficient is insignificant, one can conclude that small and large farms shared the same adoption trend throughout the 1970s.

So for each region, the model estimated is:

$$a = \alpha_0 + \sum_{s=1}^{2} \alpha_s d_s + \sum_{p=1}^{3} \alpha_p d_p + \sum_{t=1}^{8} \alpha_t d_t + \sum_{s=1}^{2} \alpha_{bs} d_b d_s + \epsilon$$

We assume that the ordinary least square assumptions hold

$$E[\epsilon] = 0 \qquad E[\epsilon'\epsilon] = \sigma^2 \qquad E[\epsilon d] = 0$$

The discussions in the text will be based on these estimated regressions by calculating the estimated value for each variable in 1980:

-for small full-time farms:

$$a_{SFT} = a_0 + a_S$$

-for small part-time farms:

$$a_{SPT} = a_0 + a_S + a_{LP}$$

-for large full-time farms:

$$a_{LFT} = a_0$$

D. FAMILY ENDOWMENT, LABOUR AND MACHINE USE PATTERN

Family endowments are the family labour, male and female, and the farm assets taken per hectare equivalent land. Family labour was reported in actual days used. Farm asset values are the sum of farm inventory[9], farm tools and machines, trees, and livestock as reported at the beginning of the production year and deflated with a constructed asset price index[10].

The main feature of the family endowment pattern as reported in table 4.1 is that large full-time farms have significantly less family labour per cultivated hectare (a

Table 4.1: LABOUR USE, MACHINE USE and FAMILY ENDOWMENTS per HECTARE in 1980 in four regions for SMALL FULL-TIME (SFT), LARGE FULL-TIME (LFT) and SMALL PART-TIME (SPT) FARMS

Region	North Rice			Mid rice			South Rice			Sugar		
Farm group	SFT	LFT	SPT	SFT	LFT	SPT	SFT	LFT	SPT	SFT	LFT	SPT
TOT HUM	705*	258"	303	568*	301"	271	501*	201"	318*	625*	281"	314
MALE FAM LAB	464*	160"	208	330*	201"	126*	288*	113"	162*	318*	134"	128
FEM FAM LAB	142*	48"	59	185*	76"	85	173*	30	99*	271*	109"	141
HIRED HUM	99	50	36	54	24	60	40**	58"	57	34	37	43
ANIMAL LAB	1.54	.11	.62	.35	-.19+	2.27	2.91	.57	6.66*	4.09	2.08	4.53
MACHINE HIR	1.99*	1.02"	2.65*	1.99	1.79"	2.97*	2.42	2.03"	2.78*	1.21	1.24"	1.05
MACHINE OWN	60788*	28802"	62467*	56719	65823"	47663	55520	49206"	67175	44062*	26968"	32706
ENDOWMENT												
T FAM LAB	506*	208"	267	515*	277"	211	461*	143"	261*	589*	244"	269
T FARM ASS	123158	104515"	112168	133113	143222"	134242	107393	94001"	133601	98217*	63497"	69966
%DRY LAND	.16*	.30"	.04*	.12	.09	.03	.29	.22"	.15	.30	.21"	.28

Source: based on tables D.1-4

Notes:

a: quantities per hectare paddy equivalent cultivatable land area

b: type of labour above:	Male (family)	Female (family)	Hired Human	Hired Animal	hired machine	owned machine	T farm asset
c: price in 1980 :	-----	-----	383.24	345.93	4592.64	1	1
d: units reported above:	man-days	man-days	man-days	day	ha serviced	stock value	stock value

e: Tot hum: family labour + hired human labour
f: T fam lab: male + female family labour (man-days)
g: T farm ass: machine owned + trees + livestock + tools + miscaleneous farm durables (deflated with an asset deflator, 1980$)
h: %dry land: dry land as share in the paddy equivalent cultivatable land available

": significantly different from zero (significance level .05)
+: usually means that the base value was considerably larger in the early 1970s than in 1980
*: significantly different from large full-time farms

minimum of 250 days less) than small full-time farms, and less or equal amounts than small part-time farms. Secondly, land quality is equally distributed over all farm types in all regions, except in the NR region where there is significantly more dry land on large full-time farms than on other farm types. And thirdly, farm asset endowments are equal on the farm types in the rice regions, but in the SUG region small full-time farms have significantly more farm assets per hectare.

An amalgamation of small farms would dramatically alter family labour application per hectare, but not the amounts of farm assets per hectare. Amalgamation would mean a loss of employment of at least 250 (NR) days per year for every hectare consolidated if occupied by small full-time farms. Alternative employment would have to be found for the farm household members thus dispossessed.

The labour and machine inputs consist of family labour, hired human, hired animal, hired machine services and owned machine services. The hired human labour was reported in days employed[11]. The hired machine services were calculated from the machine cost with the use of the machine service price[12]. The hired animal services[13] were calculated similarly. The owned machine services are assumed to be proportional to the owned machine stock and the latter was deflated with the machine and tool index[14].

The investigation of the use of non-family labour and services, be they human, animal or hired machine or owned machine, as reported in table 4.1, shows that large full-time farms tend to use least of these per hectare, although the differences are not significant between full-time farms. Small part-time farms do use significantly more hired machine services per hectare than large full-time farms in the rice regions and more animal labour per hectare too in the SR region. (The NR significant difference between large full-time and small farm for machine input per hectare is tied to the significantly higher dry land quality on large full-time farms, making rice machine use different.)

An amalgamation would not significantly change the hiring of human labour per hectare. The dispossessed family labour would not be hired by the newly formed large farms. This would mean that total agricultural labour employment would fall heavily. It should also be noted that hired labour amounts have not been very responsive to the rapid wage increases of the seventies (trends in tables D.1-4 are insignificant), so that it is not likely that even dramatic decreases in agricultural wages would increase hiring sufficiently to employ the dispossessed family labour. Generally less machine services and animal services would be employed on the land, creating a disturbance in these markets.

Looking for the evidence of substitution behaviour between family labour, hired human labour, and machine services in response to the rising relative wage[15] or across farms, three observations can be made. Firstly, the break coefficients were all insignificant which means that small and large farms shared the same trends and that the adoption speed of the new mechanized methods is similar. Secondly, all farms responded to the declining relative capital cost with an increase in machine use per hectare, hired and owned (trend up), and with a nonsignificant decrease in hired labour per hectare (trend down) but family labour amounts per hectare did not alter (the trends are reported in tables D.1-4). Thirdly, across farm types, within a year and per hectare, labour of all kinds is uniformly less on large full-time than on small full-time farms and almost uniformly less than on small part-time farms. Evidence of substitution behaviour only appears between small full-time and small part-time farms where family labour is replaced by hired machine labour.

The conclusion on the substitution strategies that can be drawn from the family endowment, labour use and machine use data is that two strategies have been used by the households with respect to machine use in Taiwan in response to the relative machine cost decrease (and the relative human labour cost increase).

Households show that the strategy of adjustment to the machine cost decrease was intensification if they were constrained to stay of the same size and level of participation. By construction, the data presented is such that we are comparing households 'as if' they did not have the option of changing their characteristics during the nine sample years[16]. Through time, the response of these households to the growing relative cheapness of machines has been to add machines to an unchanging level of human labour amounts per hectare. Thus land has gradually become more intensively cultivated and this strategy can only have been efficient if output values per hectare followed the same pattern of intensification. This will be investigated in the next section. Thus, the consequence for the sector of the relative capital cost decrease has been that the total application of labour and machinery per hectare has risen on all the farms where neither the farm size nor the participation level changed (or could change).

On the other hand, the households whose participation level declined[17], were using the strategy of substituting human (family) labour with (hired) machine services. The data in our sample shows that small full-time farms use more family labour per hectare than small part-time farms but less hired machine services. Thus, whenever the participation level of a small full-time farm changed there was a replacement of family labour with machine services. In this way, there was a substitution of labour by machine services for the sector through the rapid expansion of part-time farming which the sector as a whole experienced. Thus, the consequences for the sector of the relative capital cost decrease (and the labour wage increase) has been a substitution out of family labour use into machine use on all the farms where the households did decrease the participation level.

Thirdly, intensification is also the strategy of small farms compared to large farms if there is no possibility to change the participation level on small farms[18]. The data shows that small full-time farms use more family labour per hectare than large full-time farms, but neither the machine inputs not the hired labour per hectare are significantly different (if anything, slightly larger too). Alternatively stated, there is no evidence that large full-time farms attempt to add hired labour or machine services to compensate for their relative lack of family labour. And the question is then whether the output values per hectare on small full-time farms are sufficiently above the output values per hectare on large full-time farms to warrant the intensification on the small full-time farms.

For the investigation of the output pattern, three main observations with respect to family endowments and labour use can be retained. One, there is a pattern of increased intensity of labour application to land when going from large full-time to small part-time to small full-time farms. Secondly, the family labour content of total labour use is highest on small full-time farms. Thirdly, in the NR region land quality is significantly different on large farms as their land has a higher dry land content than small farms. The investigation of the output pattern will indicate if there are output responses to these labour and land conditions.

E. OUTPUT PATTERN per HECTARE

The output pattern shows the crop choice of the '(group) average farmer' who had one hectare available. This 'average farmer' produced eighteen crops, of which 10 are reported in table 4.2. (The other eight crops were together only a small fraction of the output value and did not show a significant difference between farm types.) The total output values was deflated by an index of net returns[19]. Crop quantities were calculated from reported crop receipts using the annual prices[20].

The crop choice pattern, as reported in table 4.2, is mainly different between farm types for vegetable, rice and fruit-orange production. The most consistent pattern relates to vegetable production per hectare. Small full-time farms produce significantly more vegetables per hectare (minimum 6800 kg more) than large full-time farms in all regions, and in the SUG region small part-time farms also produce more vegetables than large full-time farms. The rice production pattern is also consistent (if land quality it taken into account). Thus small full-time farms choose rice production[21] less often than large full-time farms and choose other crops instead. In the MR region it is the small full-time farms which produce significantly less rice but more fruit-sugar than large full-time farms, while small part-time farms produce less fruit-sweet potato but significantly more sugar. In the SR region small full-time farms also produce significantly less rice, fruit and beans but significantly more cereal than large full-time farms while small part-time farms produce similar crops as large full-time farms. In the SUG region it is the small part-time farms which produce significantly less rice but more sweet potato-orange while small full-time farms produce less rice but significantly more orange. However, in the NR region small full-time farms produce significantly more rice but significantly less fruit than large farms, because of the larger dry land content on large full-time farms. The effect of these crop patterns is that total output value per hectare is significantly higher on small full-time farms than on both large full-time and small part-time farms, the latter two producing similar amounts.

The immediate consequences of an amalgamation would primarily be felt in the vegetables and rice markets[22].

Table 4.2: SELECTED OUTPUT AMOUNTS per HECTARE (kg/ha) in 1980 in four regions for SMALL FULL-TIME (SFT), LARGE FULL-TIME (LFT) and SMALL PART-TIME (SPT) FARMS

Region	North Rice			Mid Rice			South Rice			Sugar		
Farm group	SFT	LFT	SPT	SFT	LFT	SPT	SFT	LFT	SPT	SFT	LFT	SPT
RICE	5827*	4272"	7303*	5906*	9047"	8644	5039*	6270"	5923	2315	3289"	1097*
SWEET POT	490	230	-197+	-122+	92	-120+	-477+	-96+	668	630	32	1562
SUGAR	131	207	-30+	1439	-961+	4318*	13882	5594	11516	27698	28692"	20987
VEGETABLES	33650*	11404"	11408	14409*	7572"	4651	14705*	3044	2736	12927*	5691"	10535*
ORANGE	99	279"	71	-37	-56+	86	67	20	-28+	996*	-883	503
FRUIT	261*	1058"	-6+	5560	2612	926	2673*	4723"	2938	4406	3358"	3061
CEREAL	74	41	17	91	-19+	170	314*	-12+	87	619	886"	677
SPECIAL CROP	210	500	243	69	-31+	30	1	-84+	39	540	334"	147
HOG	578	121	-382	1810	1105	828	713	800	837	215	257	-96
POULTRY(an)	89	38	69	91	15	103	100	54	96	76	4	-21+
BEANS							706*	1272"	633*			
DRY LAND%	.16*	.30"	.04*	.12	.09	.03	.29	.22"	.15	.30	.21"	.28
OUTPUT ($)	355874*	184372"	170814	375749*	271765"	241289	295176	237641"	227826	240165*	165290"	134475
RICE 1972	4831	4372	6207*	6239	6978"	8961*						
SW POT 1972							2174*	880	3319*			
VEGET 1972										5970*	3431	3578
FRUIT 1972	460	789	193*									
HOG 1972										1060	638	759
DRY L 1972				.18	.23	.09						

Source: based on tables D.5-8

Notes:a: per hectare paddy equivalent cultivatable land area

b: Prices 1980: Rice: 14.32 NT$/kg; Sweet Potato: 3.668 NT$/kg; Sugar: .795 NT$/kg; Vegetables: 6.531 NT$/kg; Orange: 9.066 NT$/kg; Fruit: 9.022 NT$/kg; Cereal: 9.664 NT$/kg; Special Crop: 11.83 NT$/kg; Hog: 48.258 NT$/kg; Poultry: 129 NT$ per animal

": significantly different from zero (significance level .05)

+: usually means that the base value was considerably larger in the early 1970s than in 1980

*: significantly different from large full-time farms

There would be a significant fall (minimum 6837 kg per hectare) in the production of vegetables, in proportion to the existing area occupied by small full-time farms in the rice regions and in proportion to the total area occupied by small farms in the SUG region. The ownership consolidation would also produce a rice production increase[23]. Generally, consolidation of small farms would decrease the amount of output produced per hectare especially because of the consolidation of the more productive small full-time farms.

That large full-time farms are more desirable because they switch faster (earlier) to the newly preferred crops while switching earlier out of traditional crops is not supported by the evidence. Modern crops are vegetables and fruits and traditional crops are rice, sugar, sweet potato. Only in the NR region have small farms increased rice production and decreased fruit production while large full-time farms did not alter their production. In the early 1970s, in the MR region large full-time farms increased their rice production significantly more than small farms, and in the SR region they did not decrease the sweet potato production as drastically as small farms. In the SUG region vegetable production rose significantly less and hog production declined significantly less on large farms than on small farms. We conclude that, if there are significantly different time trends in crop production, they are generally not in favour of large farms.

The output pattern shows clearly that households are choosing crop combinations which are related to their family endowments and to the labour use pattern. Both the total quantity of output per hectare and the crop combinations are influenced.

Firstly, land quality matters for the production choice as can be seen by comparing farm types in the NR region. In the NR region, the dry land proportion is significantly higher on large than on small farms. The consequence is a significant reduction of rice (paddy land crop) but a significant increase in fruit production (dry land crop) and a tendency on large farms towards more dry land crops such as 'special' crops, orange, sugar. It should be noted that the machine use (hired, owned) per hectare was also significantly lower on large farms because existing machines are mostly rice related. In the MR and SR region there is no significant land quality difference and so there was no paddy-dry crop switching between farm types[24].

Secondly, the amount of labour input per hectare influences the total output per hectare and the family labour content influences the crop output combinations when comparing small full-time and large full-time farms. But small part-time and large full-time farms show nearly the same output structure.

a) Considering the production pattern per cultivated hectare, the major difference between small full-time and large full-time farms is that family labour amounts are nearly 300 days higher on small full-time than on large full-time farms (see table 4.1). The other labour inputs are similar between the two farm types. The result (as seen in table 4.2) is that the total output value is significantly higher, a minimum of 75000 NT$, on the small full-time farm (insignificantly so in the SR region). But the higher family labour content on small full-time farms does not uniformly expand all crops: the supervision sensitive vegetable crop expands more than any other crop by a minimum of 6800 kg, while the mechanized rice crop declines as can be seen in the MR, SR, and SUG region.
b) The difference between large full-time and small part-time farms is not strong in terms of labour inputs, but still, large full-time farms have a tendency to use less labour input (significantly so in SR region). The output value on the other hand, has a tendency to be higher on large full-time farms. The crop output combinations do not differ between farm types (except in the SUG region where the small part-time farm produces more vegetables but less rice).

The conclusion that can be drawn from the output pattern is that the output choices of the households are sensitive to the family endowments. Thus households with significantly more family labour - the small full-time farms - will produce a higher proportion of supervision sensitive crops in the output mix. Also the value of total output per hectare is highest for these farms (insignificantly so in SR). Total output per hectare is lower and about equal on large full-time and small part-time farms (except in the SR region). It is possible, however, that overall efficiency is lower for small part-time farms.

In order to draw conclusions about production efficiency, one more set of variables is needed, so the next section discusses the intermediate input pattern.

F. INTERMEDIATE INPUTS per HECTARE

The intermediate inputs discussed are the eight major intermediate inputs out of thirteen cost categories[25]. Each cost was deflated using the national price index[26] for the category. The variable cost includes the hired human, animal and machine cost and is deflated with the profit price index[27].

The intermediate input use pattern, as reported in table 4.3, differs mainly between farm types for seed, fertilizer, herbicide and insecticide. Variable cost per hectare, which includes the bought labour, has a tendency to be highest on small full-time farms, lowest on small part-time farms (nonsignificant differences), but the

Table 4.3: SELECTED INTERMEDIATE INPUTS per HECTARE (NT$/HA) in 1980 in four regions for SMALL FULL-TIME (SFT), LARGE FULL-TIME (LFT) and SMALL PART-TIME (SPT) FARMS

Region	North Rice			Mid Rice			South Rice			Sugar		
farm group	SFT	LFT	SPT	SFT	LFT	SPT	SFT	LPT	SPT	SFT	LFT	SPT
SEED	9155*	3635"	8166*	4270	2142	3091	8915*	4428"	5426	8761*	5459"	5664
FERT	14013*	8569"	9280	16483	14902"	11241*	16805*	10949"	10448	15744*	11606"	11877
REQUISITES	5213	4176"	9280	6338	4621"	4902	10217	8214"	6760	6980	5146"	3647
HERBICIDES	1743	1717"	1691	1377	1371"	1572*	1633	1838"	1543	739*	948"	697*
INSECTIC	4997	3758"	2507	10644	11785"	6816*	11920	12746"	8428*	7408*	5455"	4877
WATER(ha)	2.09*	1.31"	2.35*	2.12	2.13"	2.42	1.57	1.33"	1.60	1.71	1.43"	1.52
LIVESTOCK	4199	-1233$^+$	-7379$^+$	5134	-414$^+$	1027	17217	24635	18039	449	154	-2673$^+$
FEED(kg)	97	62	-33$^+$	322	220	159	182	172	185	83	49	-42$^+$
VAR COST	103913	58494"	40832	143133	104941"	103264	144280	132857"	133002	84332	60067"	37183
VC/OUTPUT	33.93	38.27"	41.34	34.34	38.41"	41.91	41.40*	49.01"	54.75	35.68	37.95"	38.53
SEED 1972										6299	5444	3202
INSECT 1972				7112	4765	3284						
LIVEST 1972										11902	6863	8720

Source: based on tables D.9-12

Notes:

a: per hectare paddy equivalent cultivatable land area

b: all values expressed in 1980 constant NT$, except feed in kg at 189.48 NT$/kg and the water in ha at 1898.19 NT$/ha

c: Herbicides were reported in the requisites before 1978

d: the variable costs include the costs of hired labour services (human, animal, machine) reported in Table 4.1

": significantly different from zero (significance level .05),

$^+$: usually means that the base value was considerably larger in the early 1970s than in 1980

*: significantly different from large full-time farms

proportion of variable costs in output value follows a reverse pattern. The intermediate input conbinations do not change significantly between farm types. Amalgamation would generally decrease the demand for seed and fertilizer, mostly because of the small full-time farms, while not changing the situation in the other markets.

There is no evidence that large full-time farms are faster at using new intermediate inputs such as herbicide and insecticides. In the early seventies, the MR small full-time farms were using much more insecticide than other farms; since then, large full-time farms have caught up. The situation in the SUG region is related to the very fast expansion of vegetable production (and thus seed) and the more rapid decline of hog production (and thus livestock input) on small full-time farms.

We can conclude that the intermediate input use is closely related to the output pattern. Both seed and fertilizer use are mainly inputs for rice and vegetable production, so that these inputs change according to the relative strengths of the vegetable-rice pattern of production between farm types. The water use rises with the paddy land content of the land, being used twice a year on paddy land (so that water use differs on large full-time farm in the NR region). Herbicide use does not seem to be a clear substitute for weeding (labour use), except possibly on the MR small part-time farms and on the large SUG region farms. Insecticide use tends to be lowest on small part-time farms, possibly related to the lower production of both vegetables and fruits.

G. SIMPLE PRODUCTIVITY MEASURES AND INVESTMENT per HA

The simple productivity measures studied in this section are essentially the commonly used land productivity measures, such as the multiple cropping index, the crop yields, the output per hectare and the profit per hectare[28]. (A detailed definition of each measure can be found in appendix A.) Because Bardhan (1973) pointed out that large farms might be needed in agriculture because they invest and save more, the investment and saving per hectare are discussed too.

Differences in land utilization can be measured with a multiple cropping index if all available crops have the same length of maturity. As reported in table 4.4, in general, small full-time farms have the highest or an equal multiple crop index to large full-time and small part-time farms, however the index does not indicate production intensity on these farms. It is instead highly determined by the crop maturity schedules. The multiple crop index increases as vegetable production rises but decreases as the production of fruit, orange or sugar rises since these crops occupy the land for the year. Thus in the SR region, there is a cumulative effect on the multiple crop index of small full-time farms because of significantly higher vegetable and lower fruit production, while in the MR region, there is instead a neutralizing effect of the higher fruit production. In the NR region, there is a cummulative effect on the multiple crop index of small farms because of significantly higher vegetable and lower fruit production, while in the SUG region, there is instead a neutralizing effect of the higher fruit production. We can conclude that the multiple crop index does not indicate the degree of land utilization by the farm types, but primarily reflects the crop maturity pattern instead.

Rice yields are closely studied in Taiwan because rice is the main staple food and the main target of the national food self-sufficiency policy. Referring to table 4.4, in general rice yields do not differ significantly between farm types, except in the MR second rice yields. In this MR case, large full-time farms' second rice yields have shot ahead of small farm yields in the second half of the seventies since the break coefficient is significant. But overall rice yields are not significantly influenced by the farm type. Thus, the advantage that Sen and other investigators found for the small farms does not obtain in Taiwanese rice production. However, there is also no evidence of a disadvantage on small and part-time farms for this mechanizable crop. This is probably the consequence of a rice technology which is neutral to scale[29]

Table 4.4: SIMPLE PRODUCTIVITY MEASURES and INVESTMENT per HA in 1980 in four regions for SMALL FULL-TIME (SFT), LARGE FULL-TIME (LFT) and SMALL PART-TIME (SPT) FARMS

Region	North Rice			Mid Rice			South Rice			Sugar		
Farm group	SFT	LFT	SPT	SFT	LFT	SPT	SFT	LFT	SPT	SFT	LFT	SPT
MULT CROP	227*	178"	198*	198	195"	206	244*	217"	204	179	170"	153
RICE YIELD1	4427	4202"	4373	5756	6233"	5851*	6006	5538"	5882	6186	6469"	6310
RICE YIELD2	3519	3241"	3666	4943*	5461"	4951	4027	4179"	3991	4751	4937"	4961
OTH YIELD	171429*	99654"	157808*	167282	150795"	102575	84416	84250"	66329	96315*	74561"	103622*
OUTPUT/HA	255874*	184372"	170814	375749*	271765"	241289	295176	237641"	227826	240165*	165290"	134475
PROFIT/HA	251960*	125878"	129980	232616*	166824"	138028	150896	104784"	94824	155834*	105224"	97298
F INV/HA	38453	23738	32024	51822	40696	35677	34034	26967	25991	23911	36141"	18047*
SAV/HA	99893*	42357"	134547*	129309	82023"	198745*	71832	52033"	179766*	32761	27485"	66640*
RICE Y2 1972				5015	5100"	5023						
OTH Y 1972	63551	34974"	49930	80491	39715"	15784	43493*	19120"	25405	35198	24521"	42505*

Source: based on tables D.13-16

Notes:

a: multiple crop index: cropped area per cultivatable area
b: rice yields: first or second season rice harvest per area planted to rice (kg)
c: other yield: non-rice crop value per area planted to non-rice crops (undeflated value)(does not include mushroom)
d: output/ha: output value per equivalent cultivatable hectare (deflated with a profit deflator)
e: profit/ha: profit value per equivalent cultivatable hectare (deflated with a profit deflator)
f: investment/hectare: investment in farming per equivalent cultivatable hectare (deflated with the consumer price index)
g: saving/hectare: family savings per equivalent cultivatable hectare (deflated with the consumer price index)

": significantly different from zero (significance level .05)
*: significantly different formm large full-time farms

and to supervision[30], and also because very good machine service markets exist[31].

The non-rice crop value yield is the total income from non-rice crops per non-rice cropped area (sugar, the most characteristic crop of the Sugar region is part of this yield measure). The non-rice yield is highest on small full-time farms while in the NR and SUG regions the large full-time farm yield is lowest and in the MR and SR regions the small part-time farm yield is lowest. Break coefficients are such that the relative positions of the farm types were the same in the early years as they are in the recent years. However, the yield differences were much larger between the farm types in 1972 in the MR and SR regions with small full-time farm yields nearly double the large full-time farm yields, but this advantage has fallen dramatically. On the other hand, in the NR and SUG regions, the yield differences have grown larger in 1980 because for all farm types yields nearly tripled since 1972. The yield patterns of the rice and non-rice crops suggests that non-rice crops receive the differential family labour amounts between farm types.

The output per hectare and the profit per hectare measures of land productivity show the same pattern, with small full-time farms producing significantly more per hectare (insignificantly so in the SR region) than large full-time farms which, in turn, produce slightly more than small part-time farms. Break coefficients are insignificant so this pattern has been stable over the sample period. The pattern of output per hectare and profit per hectare matches the pattern of the family labour per hectare. Thus per hectare, the significantly higher cultivation intensity on small full-time farms produces significantly more output and significantly more returns to the family than on large full-time farms (with the exception of the SR region farms). However, the slightly higher intensity of cultivation on small part-time farms does not produce higher output and returns than on large full-time farms, and may indicate a problem with total factor productivity.

Turning to the investment behaviour, in the rice regions, small full-time farms invest more per hectare (but insignificantly) than large full-time farms and large full-time and small part-time farms have similar investment amounts. In the SUG region large full-time farms invest more than small full-time farms and significantly more than small part-time farms, which is related to the reduction of livestock activity on small farms. There is thus generally no large variation in annual farm investment per hectare.

On the other hand, saving per hectare varies considerably, with small part-time farms saving significantly more than small full-time farms and these saving more than large full-time farms. These savings per hectare variations are of course partially a reflection of the fact that household incomes per hectare on small full-time farms are larger than on large full-time farms and that small part-time farms have income sources which do not relate to their farm size.

Thus the allocation of savings per hectare to farm investment is noticably higher (half of the savings) on large full-time farms and small full-time farms than on small part-time farms (only one quarter), indicating the relative importance that the farm households give to the farming activity in their dynamic household decisions. For the farming activity itself however, there are no large dynamic consequences resulting from the farm types because investment levels are not very different per hectare. This conclusion is confirmed by the fact that the amounts of farm asset available per hectare also do not show much influence from the farm types.

H. CONCLUSION

There is no evidence that large full-time farms are more 'productive' than small farms, as non-rice yields, output per hectare and profit per hectare generally are highest on small full-time farms. Large full-time farms are in the middle but not significantly different from the small-part time farms. Rice yields are similar on all farm types, so that small and part-time farming does not lead to yield losses for this mechanizable crop.

That large full-time farms are needed because they respond faster to new trends in agricultural consumption or to new technologies is not confirmed by the data for the 1970s. Generally there were no differential time effects (break coefficients were insignificant), neither for vegetable or fruit production, nor for the machine, herbicide or insecticide use. Thus small and large farms shared the same annual quantity increase (or decrease) throughout the 1970s.

In a dynamic context, farm investments per hectare are not significantly different between farm types in the rice regions. In the SUG region, small farms show significantly less investment than large full-time farms which relates to their substantial reduction of livestock production. The comparison of savings per hectare and farm investment per hectare does show that the importance of the farm as an investment area is highest on large full-time and lowest on small part-time farms. But the farm activity itself does not suffer because the farm investment levels per hectare are not different across farm types. This conclusion is also comfirmed by the fact that farm asset levels per hectare are similar on all farm types.

The effect of the policy proposal to amalgamate small farms into large farms, where one household would farm full-time, would immediately have serious consequences in several agricultural markets. Especially because of the amalgamation of full-time small farms, there would be a large amount of dispossessed family labour. This labour would not be hired by the newly formed large farms since they already use even less hired labour than do small farms. The surprising unresponsiveness of the hired human labour inputs to the extremely fast wage increase between 1972 and 1980, gives little hope that hiring of large farms would eventually repond sufficiently to wage decreases. Instead, agricultural employment would fall dramatically (by a minimum of 250 days per hectare amalgamated). The vegetable market would experience a dramatic reduction in supply (a minimum reduction of 6800 kg per hectare), while the rice market a large increase in supply. Generally, total production would fall and with it the intermediate input demand. Because of the amalgamation of small part-time farms, the machine and animal service market would experience a fall in demand and less machines would be used on the land.

Overall, the evidence of the production data suggests that farm households behave rationally, but do so by adjusting their output pattern to their fixed endowment of family labour and land instead of adjusting hired services. Adjustment to the family labour per land ratios does not generally take place through a replacement of family labour by machine services or hired labour. Instead cultivation is intensified on the small full-time farm (whose family labour per land ratio is highest of the farm types), so that output per hectare is significantly higher than on the other farms. Additionally, the farms adjust the crop combinations to the family labour proportion in the total labour use, so that the proportion of supervision-sensitive crops in total output is highest on small full-time farms. Crop combinations also responded to the land quality endowments.

The data also suggests that this strategy of adjusting production to the family endowments may be equally successful in efficiency terms on small full-time farms as on large full-time farms in the NR, MR and SUG regions but that there may be problems in the SR region and on the small part-time farms. Compared with large full-time farms, the family labour-land ratios are significantly higher on small full-time (at least 250 days per hectare higher) and output values per hectare are correspondingly significantly higher (minimum 74875 NT$ more per hectare) while variable costs are a slightly lower proportion of output (at 37%). (The only exception is the SR region where the output value is not significantly higher.) Compared with large full-time farms, the labour-land ratios are higher, but not significantly so, on small part-time farms and output values per hectare are slightly lower while variable cost proportions are slightly higher. This pattern may indicate inefficiency on small part-time farms relative to large full-time farms.

In order to further test the question of the total production efficiency of the different farm types under this situation of very dissimilar family input ratios, total factor productivity will be investigated. This is the subject of the next chapter.

I. NOTES

1 The issue of technical change over the different farm types in Taiwan is not as great an issue as in most developing countries, because it is not a question of such a major change as the green revolution. The green revolution, and the question of its adoption were issues of the 1930s and 1950s in Taiwan. There is no mention in the Taiwan literature, where concern is expressed about small or part-time farming, about adoption rates of bio-technical innovations (Wu, Yu (1980); Chen 1980)). If anything there is some concern that new varieties in Taiwan do not get a sufficient testing period any more because farmers take up the new varieties and methods too fast (CAPD, talks with the technical research division members).

2 Adaptation of the Heckshér-Ohlin theorem which says that a country (farm) has a comparative advantage in those goods (crops) whose thechology is most intensive in the relative abundant factor of the country (farm) and so exports this good (produces and sells it to the agricultural market) (Woodland (1982), Ohlin (1933)).

3 The data used is the average value, taken over the farmers in a size group. This average value is then compared with the farm size.

4 In the Latin American context Cline (1970) had already estimated Cobb-Douglas production functions for Brazil, finding constant returns to scale.

5 For these measures: gross income, value added, per ha cultivated, or cultivatable.

6 The extremely large number of comparisons could be avoided by limiting the comparisons to the small full-time, the small part-time and the large full-time farms. However, the information on the medium farms and those which are not so extreme in their participation level also gives additional insight. Spurious differences between small and large farms can be identified if medium farm values are not somewhere between them. Similarly, PT2 and PT1 farm values should be in between the values of the full-time and the low participant farms reported in the text.

7 Too many interaction terms of the type $d_s d_p$ would make the correlation matrix of the independent variables singular and so make the regression estimation impossible.

8 We choose the period 1972-76 versus the period 1977-80 because the growth rate of the agricultural production was significantly higher in the period 1972-76 than in the four years before it and after it. The availability and adoption of the new mechanized methods was the reason for this higher growth rate which later slacked off. It is thus interesting to investigate if small (and medium) farms showed a significantly different growth path than the average large farm growth path. For econometric reasons we can only test the difference for the first 5 years of the sample. An example can show the effect of the break term. E.g., it is of interest to measure whether the small farms lagged significantly behind the large farms in the adoption of machinery. There are two possibilities. 1) Since machine use became attractive from 1968 on (especially in rice production), by 1972 large farms may already have adopted them faster than small farms. This would be indicated in the regression for the machine stock (see table D.1-4 where $a=\Delta$) by $\Delta SB+\Delta S<0$. Catching up in the early 1970s by the small farms would then be indicated by $\Delta SB<0$ (given the general upward trend for large farms of $\Delta 72<\Delta 73<..<0$). Alternatively, a further speeding ahead by the large farms would be indicated by $\Delta SB>0$. An insignificant break coefficient ($\Delta SB=0$) would mean that small and large farms share the same annual adoption volume in the 1970s. 2) If however no machines were yet available before 1972, so that large and small farms started off equally in 1972 ($\Delta S+\Delta SB=0$), then earlier adoption by large farms would be indicated by $\Delta SB>0$ (in a situation of growth or $\Delta 72<\Delta 73<..<0$).

9 Farm inventory was included because generally this value is an approximation for the average amount of products that the farmer has continuously around on the farm (fertilizer, herbicides are bought three times a year and stocked until used, some products are also stored for a while).

10 An index for the farm asset stock was constructed. The index is a Fisher Ideal index, based on sample shares of the farm assets in the total farm asset stock value, and using national price indices. The farms assets are: livestock, tools, machines, trees, and farm inventory. The fruit price index was used as a reasonable approximation for the value changes through the years of trees and for each of the other assets there was a national price index (DGBAS) (see appendix A).

11 The amounts of hired human days reported corresponds closely to the amount that can be calculated from the human labour cost using the agricultural wage rate. This suggests that hired labour is indeed usually hired at the agricultural wage rates as reported in the price statistics (DGBAS, Prices paid and recieved by farmers). Female labour was counted at a conversion rate of .8 (10 hours worked counted as 8 hours input). The male wages for the period were:

1972	78	1975	195	1978	254
1973	101	1976	193	1979	289 NT$
1974	171	1977	213	1980	383 per day

12 DGBAS, Prices paid and recieved by farmers from 1976 on, earlier service prices were calculated from prices reported in JCRR (annual reports) in some of the articles on cost situations of the farmers (thus on the bases of surveys), but not all years were available. Where a year was lacking, an average was calculated between the available observations. The resultant machine service prices used are:

1972	1150	1975	2230	1978	3293
1973	1510	1976	2590	1979	3527 NT$
1974	1870	1977	2627	1980	4592 per ha.

13 See previous note, the animal service prices used are:

1972	88	1975	198	1978	202
1973	107	1976	196	1979	274 NT$
1974	175	1977	206	1980	346 per day

14 DGBAS, Prices paid and recieved by farmers, indices.

15 The relative cost changes can be captured by comparing the index of each cost category. For the 1972-80 period, they are:

year	male wage	interest cost	machine service	animal service	tool equip	profit
1972	20	90	25	25	52	39
1973	26	93	33	31	57	51
1974	45	105	41	51	82	70
1975	51	101	49	57	89	84
1976	51	97	56	57	82	76
1977	56	93	57	60	82	71
1978	66	92	72	58	83	78
1979	78	95	77	79	89	89
1980	100	100	100	100	100	100

16 From the method of analysis and farm classification in this study, one cannot investigate whether farms became smaller or changed their level of participation in

response to the changing economic circumstances, through time. As discussed in chapter III, the sample selection method itself also prevents this investigation.

17 See previous note. The choice of participation level is a choice which can not be analysed in this study. As discussed in chapter II, the phenomenon of part-time farming depends strongly on the farm family labour characteristics, and this information is not available.

18 Family labour endowment on the farms is not proportional to the land size, so that small farms automatically have more family labour endowment per hectare. In the MR and SR regions, the endowments are similar on all farms (6 equivalent workers). In the NR and SUG regions small farms have 1.5 equivalent workers less than large farms, the latter having 8 workers.

19 An index of net profit was constructed and used on the total output value, the total variable cost and on the profit, so that profit can be calculated from the other two. The index for the net profit, or net returns to the index is a Fisher Ideal Index and is based on the profit shares of outputs and variable inputs calculated from the total sample (2274 observations: around 250 observations per year), and the prices of these commodity groups (DGBAS, price paid and received by the farmers). (See appendix A.)
We used this profit index on both output and variable cost so that output minus variable cost would be the profit as reported in table 4.4.

20 The national price index information did not fully correspond with the categories of this survey so that indices for several commodity groups had to be constructed. If the national price data did correspond to the sample category then the national price index was used.

The price indices were calculated from national commodity price information (DGBAS) and the shares of the commodities in the national agricultural production (PDAF) of the subgroup, using the Fisher Ideal price index. Price indices were calculated for:
- cereals: sorghum, corn, Kaohliang, wheat
- special crops: tea, peanut, sesame, cassava
- fruit: all fruits except the citrus fruits (26 types)
- orange: all citrus fruits (5 types)
- vegetables: all vegetables (38 types)
- beans: all bean types (5 types)
- poultry: chicken, duck, turkey and other.

(See also appendex A.)

21 This is not a rice yield measure. Instead it indicates how frequently rice is chosen as a crop by the farm groups. The rice yield measure is reported in table 4.4.

22 The information in this study gives an indication of the supply function shift. Longer term adjustments because of changes in the relative product prices cannot be investigated within the scope of this study. Knowledge of the market demand structure would be required. However it is likely that the relative price would rise of those crops where the supply curve would shift in (vegetable, an increasingly desired food in Taiwan).

23 The rice effects in the NR region are related to the land quality. A consolidation of small farms would produce large full-time farms with significantly higher proportions of paddy land than the present large farms. Rice production effects would probably be the same as what can be observed in the MR region, where land qualities are similar on the large farms as on the small farms, and as on the small NR farms. Thus there would also be an increase in rice production from the amalgamation.

24 The same pattern of output adjustments to land quality differentials can be observed between the MR and SR region. The farms in the SR region have more dry land than those in the MR region, and there is more production of dry land crops in the SR region in consequence.

25 Throughout this study, farm costs do not include farm taxes, farm interest payments and land rental payments. These costs are related to the reported family endowments and not to the use of intermediate inputs. The information on the family endowments is insufficient to relate the tax and land rent cost to the owned and rented land, or the interest cost to the farm assets.

26 DGBAS, price paid and received by farmers, indices

27 see note 17.

28 Since these land production measures are fairly easy to calculate, they tend to be used almost exclusively in the Taiwan agricultural literature.

29 Rice fields cannot are extremely large because they have to be level. Thus economies of scale with respect to field size do not exist.

30 The machine technology imposes its own quality standard on the activity. Also the rice technology has become very streamlined and standardized with respect to fertilizer applications, herbicide use etc.., thereby diminishing the gains from family supervision.

31 The existence of the machine service markets means that the machine services become divisible, thereby diminishing the economies of scale associated with indivisibilities. Also the growing market for human labour which specializes its activities diminishes the gain from family supervision. (There are already markets for males who only do the fertilizing activity, the insecticide spraying, pruning, etc.).

CHAPTER V

TOTAL FACTOR PRODUCTIVITY

A. INTRODUCTION

Three question are addressed in this chapter by estimating value-added production functions of the family supplied production factors. Is there evidence of increasing returns to scale? Are part-time farmers technically less efficient than full-time farmers? Can a redistribution of land improve the allocative efficiency of the agricultural sector by improving the deployment of land and labour? The latter question is investigated in terms of adjustments of land sizes to households (rather than the reverse) because a change in the land legislation is an instrument that the government can use. The labour market is already free of legislative constraints and it may be very hard to find, and undesirable to use, policy instruments or legislation to make households adjust their labour allocation to the farm land[1].

To investigate the above questions a special value-added model is developed, where net farm income is assumed to be a function of the family supplied factors: land (paddy, dry), labour (male, female) and farm asset stock. As shown in the previous chapter, the factor application on the land (especially the family labour application) is very different across farm types, so that single (average) land productivities measure only approximately the social efficiency level of each farm type. Thus a special form of the total factor productivity approach is attempted in this chapter by concentrating on the family supplied inputs and the net return they produce. This approach is necessary because of data limitations, but is sufficient, given that the main interest of the agricultural authorities is in the efficient use of the land resource of the agricultural sector, as held now by households, and in the efficient use of the farm assets as owned. Also, although not recognized by the authorities, efficient use of the economy's resources means that there should be full use of immobile farm family labour. That is, farming should not use family members who could work somewhere else, when there is unemployment on some farms of family members who could not work except in the self-employed farm situation.

The literature overview in section B shows the development of methods for total factor productivity comparisons between farms of various sizes in the Asian developing countries. In section C, the three forms of production inefficiency are defined and related to the size and participation characteristics of the farmers in Taiwan. This study's value-added production function approach is explained in section D and three functions (the linear function, a linear function with slope dummy variables and the Generalized Linear function) are proposed for estimation in section E. The statistical assumptions and the data for the estimations are described in section F-G. The empirical results are presented in section H and the conclusions in section I. For clarity of presentation, most tables of the estimation results are collected in appendix E.

B. LITERATURE

As indicated in the previous chapter, concern for the efficiency of production in the farms of various sizes originally tended to be concentrated on the efficiency of land use. However, Sen's (1962) observations I and II went beyond the land productivity question by relating the output to all the inputs, including the farmer-supplied human and bullock labour.

Khusro (1964) stressed the point that the efficiency question not only concerns land productivity but should encompass total cost of production including the value of non-land family supplied inputs. He indicated that there is a problem of finding appropriate prices for these non-marketed factors. He then tried to correlate net profit (inclusive of all revenues and costs) to the land size of the farms. This was thus an extension of Sen's study since it included family supplied factors other than labour, and the net return to land was better approximated. Khusro found that net profit per hectare was positively correlated to the farm size, but not significantly so, for size-class data from 7 regions in India[2].

It was Saini (1969) who clearly stated that the size-efficiency issue was a question about the returns to scale in farming. He estimated a Cobb-Douglas production function with land, human man-days, bullock pair-days, fertilizer-manure cost and irrigation costs as arguments. Constant returns to scale could not be rejected in his four samples of individual farm data from India[3]. Saini also found that the production functions of the farms (classified into 3 size classes) were the same[4] and that the ratio of marginal value products[5] over wages for labour were greater or close to one, while very much less than one for bullock labour on the small farms.

Bardhan (1973) estimated Cobb-Douglas production functions for several regions in India and he concluded that generally the returns to scale were constant or decreasing except in wheat regions. In the same study he tested for differences of the Cobb-Douglas function for the different farm sizes[6]. Although the ratios of farm inputs to land were not constant, he found that the marginal value products of labour were higher than the wage rates[7].

Although Farrell (1957) formalized the analysis of efficiency difference into its components, it was a study by Yotopoulos and Lau[8] (1971,1972) which provided a model for testing the effects of:

a: returns to scale (a property of the production function)

b: technical inefficiency (failure to operate on the technically inefficient production function)

c: price efficiency (failure to maximize profits)

in the context of the agricultural production on small farms in a developing country. The latter two efficiencies together define economic efficiency. Note that both Saini (1969) and Bardhan (1973) were already testing for both technical efficiency (equality of the Cobb-Douglas production function constants) and price efficiency (equality of the marginal product with the market price). Yotopoulos-Lau (1973), on the basis of Indian data, concluded that the technology exhibited constant returns to scale, that the technical efficiency difference was in favour of small farms and that both sizes of farms were equally efficient and had chosen labour according to profit maximization. (Labour was a variable factor in the model.) The above empirical studies used estimations of average production functions based on actual production data.

The problem of measuring efficiency (especially technical efficiency) has also been studied in the context of comparing actual farmer efficiency with technically (experimental) optimal farming efficiency levels. The measurement of the technical difference is then expressed by an index number. This was the approach taken by Timmer (1970), Shapiro and Muller (1977) and Herdt-Mandoc (1981). This method presupposes an initial estimation of a frontier production function (either on the basis of a linear programming method on experimental data or under the econometric constraints of one-sided disturbances[9] in the production function estimation). Once a frontier production function is constructed, an index of relative technical and allocative efficiency is calculated for each farmer. These indices are then related to personal and environmental characteristics of the farmers. The Herdt-Mandoc (1981) study tried to investigate fertilizer use efficiency of Philipino farmers by comparing the farmers' technical efficiency with the technical efficiency of International Rice Institute experts, both farmers and experts producing on plots at the actual farms. Herdt and Mandoc concluded that both technical and allocative efficiency declined with increases of the farm size and with a decrease in the amount of off-farm work days by the farmer.

A further development of the measurement of relative efficiency with the use of index numbers is to bypass the estimation of the production technology altogether. Our problem is then a special case of measuring productivity differences based on the index number theory (Diewert 1982). (This approach was used by Allen (1982) to compare technical efficiency differences between enclosed and unenclosed farms in 18th Century England.)

In this second part of the overview of the literature on the empirical measurement of efficiency differences between farmers in development countries, we could see a growing concern for a measurement of the efficient use of all factors of production which goes beyond the land productivity measures. There was, on the one hand, the identification of three sources of production inefficiency (discussed in the next section) and there was, on the other hand, a growing use of two measurement approaches (the production function estimation, frontier or average, and the index number approach).

C. SOURCES OF INEFFICIENCY

Generally three sources of inefficiency are distinguished in production. The first is "the returns to scale" source of efficiency which follows from the characteristic of the production technology to exhibit an optimal production scale. The scale of production refers to a proportional expansion of all inputs which, in the case of increasing returns to scale[10], leads to a more than proportional expansion of the output.

The claim by economic planners that small farms are inefficient follows from the 'increasing returns to scale' assumption in the mechanized farm technology (Wu, Yu, 1980; Chen, 1980). If there are no rental markets for machines and farmers do not share the use of the machines or own them jointly, then only large farms can use machines to their full capacity. Thus small farms, who own and use machines would have a higher machine cost per unit of output and an agricultural system of small farms would be less efficient than a system of large farms. Even if sharing of machines is practiced, large farms could be more efficient if the machines could be used on larger fields, thus diminishing the time loss (and transaction cost) from going from one small farmer's field to another's.

However, these conditions for increasing returns to scale may not hold given the Taiwanese situation. Firstly, great care was made to develop locally made small machines (similar to the imported Japanese farm machinery) and a 'machine custom service' market has developed. Secondly, in the rice regions, the land is irrigated from an irrigation network (not from private wells), which imposes limitations on the field structure. Thirdly, the 'custom service' system quotes contracts per hectare serviced, not the time used. Where large machines are unavoidable, for the sugar harvesting, the refineries own the machines and do the harvesting for all the farmers. Thus, although the planners for theoretical reasons believe in increasing returns to scale, the actual structuring of the activity in Taiwan may well allow constant returns to scale[11], so that the returns to scale must be empirically measured.

The second source of inefficiency is technical inefficiency (Farrell 1957, Yotopoulos-Lau 1971) which is a failure to operate on the technically efficient production function[12]. Thus, technically inefficient farmers use more inputs for a same level of output as technically efficient farmers.

The claim that part-time farmers are inefficient is based on the assumption of residuality of farm labour on part-time farms. The first argument about the residual labour is directly a technical inefficiency argument. The assumptions are (a) that non-farm activities of the family put time and effort constraints on the labour which is available for farming and (b) that farm production is very sensitive to timing of the activities and to speedy reaction to unexpected weather, disease and pest conditions. As a result, part-time farmers, who must be at their off-farm work, will not be available at these crucial moments and there will be less production from the inputs than on full-time farms.

The second type argument about the residual labour, which claims that off-farm activities absorb the higher quality labour of the family, is a technical inefficiency argument only if more assumptions are added. These assumptions are (a) that the lower quality family members make the decisions on part-time farms, (b) that the higher quality members make the decisions on full-time farms, and (c) that lower quality family members are worse managers than higher quality members and so will generally use more inputs for a same level of output. The low quality members are the physically weak, the old, the uneducated and the women, thus the family members who did not find off-farm employment. That low education leads to bad management is possibly true[13], but that the other characteristics[14] influence management ability is debatable. Also that management must be done by the farming members of the family does not follow. If none of the latter assumptions holds, then this second argument about the residual labour is not part of the technical efficiency issue but instead is part of the allocative efficiency issue.

The third source of inefficiency is allocative inefficiency (Farrell 1957, Yotopoulos-Lau 1971) and is normally defined as a failure to maximize profits when the farmers fail to equate the marginal value product of each input to its price and the marginal cost of each output to its price. The profit maximizing behaviour of each farmer thus ensures that the marginal productivity of each factor and the marginal cost of each output is equalized across farmers. And this equality of factor productivities and marginal crop costs across farmers is the condition for the maximal total production of outputs from the agricultural resources.

However, note that the allocative efficiency issue is closely tied to the existence of markets which provide the farmers with the opportunity prices of the production variables for their allocative decisions. Part of the question in this thesis is whether the land market is working, and, if it doesn't, whether the farmers have full choice on the allocation of the other production variables. The latter depends on the existence of markets for all non-land production variables. But this brings us to the issue of the family supplied labour. Farm household members may be of two types:

1) the mobile members for whom the disutility of off-farm work is equal to the disutility of self-employed farm work. These members will compare the market wage with the marginal value product in farming and thus the labour supply for farming from these members is a choice variable. Here one can expect an adjustment of labour to the land allocation.
2) the immobile members for whom the disutility of off-farm work is much greater than the disutility of self-employed

farm work. These are the family members who do not want to work away from the home (mothers with small children, older women) or who do not want to be tied to contracted time periods (older farmers, weaker people, those who do want to set their own work pace). The labour supply for farming from these family members is thus a fixed factor in the farming activity (determined by the family structure) if we assume the leisure-labour choice to be solved. In this situation, the question of a flexible system of allocating land to the households becomes important for the full employment of this agricultural resource.

Thus where the labour is not fully mobile, there can be underemployment of immobile labour on certain farms (maybe on small full-time), underemployment of the land on others (maybe on small part-time) and use of mobile labour for farming on yet other farms (maybe on large full-time). If land could be transferred without constraints, there would be more agricultural output (using the underemployed immobile labour of some households on the underemployed land of other households, or replacing mobile with immobile labour) and also more output in the other sectors (using the mobile labour shifted out of agriculture). This gain in agricultural production from a land reallocation would be the larger, the less the land and the immobile labour are substitutable in the agricultural production technology, since marginal value products would then vary considerably with the different labour/land ratios on the farm types. Note that this substitution possibility depends on the number of possible crops (each having a very different technology) and on the substitutability of the immobile labour with other inputs.

Ultimately, the concern of this thesis is the proper allocation of land and labour across farm households so that the agricultural sector has an optimal output from its labour and land resources. This is a test of the hypothesis that the distribution of land to the households (and thus to the labour endowment of the family) is not optimal because the present land legislation is effectively blocking the working of the land market[15]. The alternative to the distribution of land to the households would be to have households adjust the labour to the land endowment. This is an option if a well working labour market exists, and indeed the mobile family members can and have adjusted to the land endowment by the expansion of part-time farming. But households have an endowment of immobile family members too, and the economy is not making optimal use of its resources if the agricultural sector does not use this labour.

The choice of the optimal size-participation combination for the sector must ultimately be determined by the optimal use of the land, the mobile family household members and the immobile members, all within the context of the need of the non-agricultural sectors for the mobile family members and the food needs of the increasingly rich population[16].

D. TREATMENT OF THE VARIABLE INPUTS-OUTPUT MIX

The value-added functions estimated are special forms of a variable profit function in which real net farm income is assumed to be a function of the quantities of family supplied inputs. This specification allows (1) an estimation of the returns to scale in family supplied inputs, (2) a comparison of the marginal products of the family supplied inputs across farm types, and (3) a comparison of the net incomes of full- and part-time farms relative to their quantities of family supplied factors. These results bear directly on the issues of returns to scale, allocative efficiency and technical efficiency respectively.

We start from a model which expresses the general concern of the agricultural authorities. The authorities want an optimal use of agricultural resources, but the system uses H private farmers as the decision makers. So the aim of the authorities can be formalized as:

$$(1) \qquad \text{Max } p\sum_h^H y^h - w\sum_h^H x^h \quad \text{s.t.} \quad g(y^h, x^h, v^h) \geq 0 \text{ and } \sum_h^H v^h - V = 0$$

where y (outputs) and x (inputs) are marketed at respectively p and w, but v are family supplied factors who are not traded. The sector has a total number V of the latter resources. The optimization requires:

(2) $p - \partial g(y^h, x^h, v^h)/\partial y^h = 0$ ∀h households

(3) $-w - \partial g(y^h, x^h, v^h)/\partial x^h = 0$ ∀h

(4) $g(y^h, x^h, v^h) \geq 0$ ∀h

(5) $\lambda - \partial g(y^h, x^h, v^h)/\partial v^h = 0$ ∀h

These conditions except the last one, are also satisfied if each farmer h maximizes the value-added on his farm:

(6) $\max_{y,x} \; py^h - wx^h \quad \text{s.t.} \quad g(y^h, x^h, v^h) \geq 0$

and the resource allocation in the sector is then optimal if the distribution of the family supplied factors is such that the condition (5) is satisfied. We develop the special value-added approach for this latter investigation.

The special value-added approach used in this study is a blend of the index number approach and the production function approach. The pure index number approach would be the most simple approach to the measurement of total factor productivity on the different farm types[17]. However, it requires the a priori assumptions that the technology is constant returns to scale, that there is no technical inefficiency, and that all markets exist except one: land, in this study. Under these assumptions, if prices are the same for all farmers, net profit per unit of land is the marginal value product of land, and for allocative efficiency it should be equal across all farmers. If prices differ between farmers, a deflator method can be used on the net return so that the allocative efficiency can be measured by the value of k in the following relationships between actual real net return and the optimal possible real net return from the land input:

for farmer 1:

where p: output price
w: input price

(7) $(p^1y^1 - w^1x^1)/[\Pi(p^1,w^1)/\Pi(p^0,w^0)] = k^1\ \Pi(p^0,w^0)V^1$

and for farmer 0:

y: output
x: bought input
V: land input

(8) $(p^0y^0 - w^0x^0)/[\Pi(p^0,w^0)/\Pi(p^0,w^0)] = k^0\ \Pi(p^0,w^0)V^0$

Where $\Pi(p^0,w^0)$ is the solution to (6) for the prices (p^0,w^0) and $V=1$ unit of land. Allocative efficiency means that $k=1$, (less efficient farmers have $k<1$). Thus in this method, overall allocative inefficiency of land shows in k variations, and no information is given on the sources of the allocative inefficiency, only that there is allocative inefficiency. There are several problems with this index number approach. It is vitally dependent on the assumption than (p,w) are the correct opportunity prices, so that a full set of markets must exist. As argued the previous section, some family labour may not be marketable, and assuming agricultural wage rates as the opportunity cost may be distortive. Inversely, the family labour could be taken instead of land as the factor of evaluation, but since land markets may not have been very active and correct land opportunity costs are hard to find, this may well be equally distortive. Additionally, the issue of constant returns to scale and technical inefficiency must be measured, not assumed a priori. Thus we decided that the index number approach was not usefull in its entirety.

The alternative was to use the transformation or profit function approach. To avoid the simultaneous equation bias in a transformation function estimation, it is better to estimate profit functions, by estimating the derived supply-demand system of the variables for which markets exist. This would mean the estimation of the profit function from the actual profit, as in Yotopoulos and Nugent (1976), p97-8:

$$(9) \qquad (qk/A) \;.\; z = \Pi(qk/A;v)$$

where: q=p : output price
=w : input price
z=y : output
=-x : input
v : fixed factor

with the estimation of a system:

$$(10) \qquad z_i = \partial\Pi/\partial(k_i q_i/A) = f(qk/A;v) \;.\; A/k_i$$

The allocative inefficiency in the use of marketed variables (z_i) can be measured by the value of k associated with each farm type. The technical inefficiency can be measured by the variation in A associated with each farm type. Returns to scale can be determined from the function $\Pi()$. If there is more than one fixed factor v, then the variations in the marginal value products ($\partial\Pi/\partial v$) across farm types can indicate that there may be a gain for the sector from organizing markets for these factors. Thus this approach is complete, but we cannot use it because we do not have enough price observations in our sample to estimate $\Pi(qk/A;v)$ for the parameters of q.

We estimate a value-added model that has features of both approaches: a) the index approach is used to deal with the output and bought inputs, and b) the production function approach is used to deal with the family factors.

We start from the assumption that the farmer attempts to choose the output mix and the bought input mix to maximize the net profit available as a return to the family supplied factors, given the technology. Thus the choice for a farmer facing the prices $(p,w)>>0$ with a transformation function $g(y,x,v)$ is to:

(11) $$\max_{y,x} \{py - wx \mid g(y,x,v) \geq 0\}$$

where:
- y: output quantities
- x: bought inputs
- v: family inputs
- p: output price
- w: input price

and the solution is $\Pi(p,w,v)$. (Note that this is also the the solution to equation (6) and thus implies conditions (2)-(4) to be satisfied.)

As the sample contains only nine observation years[18], there are not enough observations on prices (p,w) to estimate the parameters of $\Pi(p,w,v)$ in (p,w). So we assume that p and w are separable from v:

$$(12) \quad \Pi(p,w,v) = \Pi[f(p,w),v]$$

We assume in fact that the relationship is:

$$(13) \quad \Pi[f(p,w),v] = f(p,w)\ G(v)$$

so that the observation for each farmer is:

$$(14) \quad py - wx = f(p,w)\ G(v)$$

The left hand side is the observed net profit or value-added. On the right hand side we have f(p,w) which is a function of the prices and is thus a value-added price. The second part G(v) is a value-added function of self-supplied factors and thus a form of output quantity produced by the family factors. So the self-supplied factors produce an output G(v) which is priced at f(p,w) and this is equal to the observed farm income for the family.

This form of separability assumption is equivalent to imposing constraints on the technology, such that the Hicks-Allen substitution elasticities between the self-supplied factors (v) and the variable commodities are:

$$(15) \quad \Psi = (\Pi \ \partial^2\Pi/\partial q\partial v)/[(\partial\Pi/\partial v)(\partial\Pi/\partial q)]$$

$$= \frac{g(q)\cdot G(v) \ \cdot \ (\partial g/\partial q)\cdot(\partial G/\partial v)}{g(q)\cdot(\partial G/\partial v) \ \cdot \ G(v)\cdot(\partial g/\partial q)} = 1 \qquad q = p,w$$

where $\Pi = g(q)\ G(v)$ is the net revenue function. The interpretation is that there are no outputs nor bought inputs that have a special link to any self-supplied factor.

If we now compare two farmers facing different market prices:

$$(16) \quad \text{farmer 1:} \quad p^1y^1 - w^1x^1 = f(p^1,w^1)\ G(v^1)$$

$$(17) \quad \text{farmer 0:} \quad p^0y^0 - w^0x^0 = f(p^0,w^0)\ G(v^0)$$

or for farmer 1:

$$(18) \quad (p^1y^1 - w^1x^1)/[f(p^1,w^1)/f(p^0,w^0)] = f(p^0,w^0)\ G(v^1)$$

and for farmer 2:

$$(19) \quad (p^0y^0 - w^0x^0)/[f(p^0,w^0)/f(p^0,w^0)] = f(p^0,w^0)\ G(v^0)$$

Thus net income deflated by $[f(p^1,w^1)/f(p^0,w^0)]$ depends on v in the same way for all farmers. The link between the index number approach and this value-added approach can be seen in comparison of equations (7)-(8) and (18)-(19).

Note that $[f(p^1,w^1/f(p^0,w^0)]$ is a 'true' price index:

$$(20) \quad P^1 = P[p^1,y^1,p^0,y^0,w^1,x^1,w^0,x^0] = f(p^1,w^1)/f(p^0,w^0)$$

which we assume to be a Fisher ideal price index of q=(p,w)

$$(21) \quad P^1 = [\sum_i s_i^0(q_i^1/q_i^0)]^{1/2} \; [\sum_i s_i^1(q_i^0/q_i^1)]^{-1/2}$$

where $s^1 = q^1z^1/\Sigma q^1z^1$ the share of an output ($y^1 \geq 0$) or an input ($x^1 \geq 0$) since $z = (y,-x)$. The use of this index of prices essentially means that we are dssuming the following function for f(p,w) = g(q):

$$(22) \quad f(p,w) = g(q) = [\sum_i \sum_j a_{ij} q_i q_j]^{1/2}$$

This Fisher index is exact for a quadratic mean of order r=2 of output and variable input prices (Diewert 1978; Allen, Diewert 1981). It should be noted that the use of this deflator method is less restrictive than the usual double value-added deflator method[19]. No separability is imposed between the outputs and the variable factors in our study (Bruno 1975, Diewert 1975).

The Fisher index of prices (P) is calculated on the basis national price data (p_t, w_t) for the farm outputs and variable inputs using sample share information (s_t) , using the nine years of price observations (nine annual price observations for 26 outputs and inputs).

In summary, we derived a model which expresses the production situation of the farmers, so that we can examine the efficiency issues in their effect on the relationship between the actual deflated net revenue available to the family supplied factors and the levels of the family supplied factors:

$$(23) \quad (p^1y^1 - w^1x^1)/P^1 = f(p^0,w^0)\ G(v^1)$$

This model was choosen for two main reasons: 1) the
The five family supplied factors considered produce a value added for the sector which is from 51% to 63% of the farm output value (see table 4.3) and these factors are the variables whose distribution over the households is of such concern to the agricultural authorities. The five family factors are the land area (paddy, dry), the family labour used (male, female) and the total value of the farm assets. 2) There was not enough price data to investigate the inefficiencies in the crop choice and the bought input choice in detail. However, since the consequences of these choices are concentrated in the observed net revenue value, this method indirectly does measure the choice efficiency.

The problem studied is thus directed to answering the question whether the present agrarian structure with its land, family labour and farm asset distribution over the households is able to produce the maximal value-added for the sector from these resources. This will depend on:
1) whether value-added expands more, less or proportional to a proportional expansion of all the family farm factors (the returns to scale issue) as estimated by

$$(24) \quad G(\lambda v)=\lambda^k G(v) \qquad H_0 : k>0$$

2) Whether some households, particularly the part-time households, have less actual value-added (Π) from their family farm factors than similarly endowed full-time households can produce (the technical efficiency issue) as estimated by

$$(25) \quad G(v^{FT}) = \Pi^{FT} = \Pi^{PT} = G(v^{PT}) - E^{PT} \qquad H_0 : E^{PT} > 0$$

And 3) whether there could be a gain in the sector's total value added by changing the family supplied factor mix of the farmers (the allocative efficiency issue). This question can be answered by comparing the marginal value products of each family factor across the farmers since allocative optimality requires these to be equal across farmers, as the system (1)-(5) has now become:

$$(26) \quad \text{Max} \sum_{h}^{H} f(p^{o},w^{o})\, G(v^{h}) \qquad \text{s.t.} \quad \sum_{h}^{H} v^{h} - V = 0$$

with first order condition:

$$(27) \quad f(p^{o},w^{o})\, \partial G(v^{h})/\partial v^{h} - \lambda = 0 \qquad \forall h$$

$$(28) \quad \sum_{h}^{H} v^{h} - V = 0$$

This is equivalent to asking whether farmers are either able to allocate the outputs and bought inputs in such a way that the productivity levels of the (fixed) self-supplied factors are equalized across farms, or alternatively, whether they are able to choose the family factors because the markets work and thus the family factors are mobile (then $\lambda = w$). The farmers may even follow both strategies at the same time, depending on the family production factors. Thus for example, amounts of farm capital and male labour could have been chosen to equalize the productivities to the interest cost and the wage respectively (thereby indicating the mobility of these factors), while for land and female labour there might be an equalization of the marginal products across farmers because of correct choice of output mix (and its associated bought input mix).

E. FUNCTIONS

Our aim is to estimate functions of:

$$(29) \quad py - wx / P = f(p^0, w^0)G(v) = \Pi(v)$$

The left hand side is real net income and is directly computed from the data. To estimate the model, we must choose functional forms for $\Pi(v)$. These indicate the relationship of the family supplied factors to the real net income. As not all farms use male labour or female labour, some of the components of v can be zero, therefor we cannot use Cobb-Douglas or translog specifications. Instead, we use the linear function and two of its more flexible functional forms. Also, production is not possible without the land input so that the estimated function cannot have a constant[20]. In the next sections we describe the linear function with dummy variables (called 'linear dummy'), the 'generalized linear' function and the resticted approximation of both: the 'linear' function.

E.1 <u>The Linear Dummy model</u>

The first function that we propose as an approximation of Π(v) is a linear function in v where the coefficients of v are allowed to vary with the farm size and participation[21]. This is thus a linear function of v with slope dummy variables d :

$$(30) \quad \Pi(v) = \sum_k (\alpha_0^k + \sum_s \alpha_s^k d_s + \sum_p \alpha_p^k d_p) v^k$$

s : size class
p : participation
k = 1...5 inputs

For farmers with characteristics (s,p), the value marginal product (or shadow price) of the family factor v^k is:

$$(31) \quad VMP_{sp}^k = \alpha_0^k + \alpha_s^k + \alpha_p^k$$

s = S,M
p = LP,PT1,PT2
0 = L,FT (base)

This function allows us to explore some efficiency issues. Allocative efficiency can be tested directly for the farm types, because the magnitude of α_s and α_p shows whether the value marginal products of the factors vary with size and participation. If markets exist for the factor, then one can compare the value marginal products to the market prices. If markets do not exist, one can compare the value marginal products across farmers since this shows whether the factor is allocated correctly in the sector.

The linear dummy variable production function model automatically imposes constant returns to scale on the technology. But we can compare the efficiency of large and small farms, although we can not distinguish increasing returns to scale from technical efficiency that improves with size. Measurement of technological efficiency can be done by comparing the expected net returns from the factors as given in $\Pi(v)$[22] and the actual returns, and by investigating whether this difference is systematically associated with the participation characteristic or the size of the farm.

E.2 <u>The Linear model</u>

The simple linear function is a restricted form of the the 'linear dummy model' as the coefficients of the dummy variables are restricted to be zero:

$$(32) \qquad \Pi(v) = \sum_k a^k v_0^k$$

The simple linear function is also a restricted form of the generalized linear function, as presented next.

If the value-added function is linear, then the assumption that farmers have sufficient output and bought input choice to adjust perfectly to fixed endowments of the family factors can be accepted. In this case, lack of markets for some of the family factors does not create allocative inefficiency of resources in the sector. The linearity of the estimated function means that marginal products are constants, and thus equal for all farmers, so that there could not be a gain for the sector from a transfer of family resources from one farmer to another.

E.3 The Generalized Linear Model

An alternative to the previous production models is to choose a production technology where all farmers are assumed to have the same basic technology but this technology is more flexible in its structure of combining factors to produce net profit. This function does not impose constant returns to scale a priori and the marginal rates of substitution between factors can change within this technology.

We approximate the technological relationship between fixed factors and the net returns for fixed factors with the generalized linear function (Diewert, 1973, p. 295):

$$(33) \qquad \Pi(V) = 2\sum_i \alpha_i v_i^{1/2} + 2\sum_{i \neq j}\sum \alpha_{ij} v_i^{1/2} v_j^{1/2} + \sum_i \beta_i v_i$$

where symmetry is imposed. No constant is present because there is no possibility of net revenue without the use of land. Note, when α_i and α_{ij} are restricted to be zero, that the generalized linear function collapses into the linear function.

Of the three proposed functions, this function allows us to explore the efficiency issues in greatest detail. The technology is linearly homogeneous if $\alpha_i = 0 \;\; \forall i$, thus constant returns to scale is a hypothesis which can be tested. If the $\alpha_i \neq 0$ then the technology is not homothetic. (See interpretation of non-homotheticity in the comments to table E.9 in appendix E.)

The value marginal product (or shadow price) of a fixed factor v^k for a farmer h is:

$$(34) \qquad VMP^h_k = \alpha_k (1/v^h_k)^{1/2} + \Sigma_i \alpha_{ik} (v^h_i / v^h_k)^{1/2} + \beta_k$$

Thus the shadow price of the factor v is dependent on the endowments of all the factors when $\alpha_{ij} \neq 0$. The technology allows the farmers the possibility of combining their factors in such a way that equality of the shadow prices of these factors across farmers may result. We test for this possibility by calculating each farmer's shadow prices[23] and then testing their equality across the farm size and participation characteristic. Thus we estimate dummy variable regressions of the calculated shadow prices ($\hat{VMP}^k_{sp}$):

$$(35) \qquad \hat{VMP}^k_{sp} = \gamma^k_0 + \Sigma_s \gamma^k_s d_s + \Sigma_p \gamma^k_p d_p \qquad \begin{array}{l} k = 1...5 \text{ inputs} \\ h\text{: farmer} \\ s\text{: size} \\ p\text{: participation} \end{array}$$

where we calculated $\hat{VMP}^k_{sp}$ according to equation (34) and using estimated coefficients ($\hat{\alpha}_k$, $\hat{\alpha}_{kj}$, $\hat{\beta}_k$).

For the measurement of technical inefficiency we compare the expected net return of the factors as predicted by $\hat{\Pi}(v)$ with the actual net return. We then test if the difference is systematically influenced by the participation characteristic of the farmers, by using the dummy variable regression on the difference. This method is based on the fact that the estimated $\hat{\Pi}(v)$ is an average production function (not a frontier production function). The assertion that part-time farms are technically inefficient, thus systematically producing less output with their factors than full-time farms produce from their factors, should mean that the estimated net return $\hat{\Pi}(v)$ is systematically above the actual net return on part-time farms and systematically below the actual net return on full-time farms. The dummy variable approach tests whether the difference between actual and estimated net return $(\Pi-\hat{\Pi})$ is systematically much lower on part-time farms than on full-time farms of the same size[24]

F. DATA

The three specifications are estimated with the data described in chapter three. The model uses data on net revenue and five family supplied factors.

The five components of v are the family supplied factors:

1) Paddy land area (cultivatable in ha)

2) Dry land area (cultivatable in ha)
3) Family male labour days actually used. The families reported either the days (counted as 10 hours), half days, or hours that were spend on the farm production[25]. There was no further information that might have given us the possibility of distinguishing if the labour came from a mobile family member or an immobile family member. Questions about the contribution of male labour to value-added (the marginal product) in comparison to the opportunity cost can thus only broadly indicate that male labour is mobile (when marginal productivity is close to the wage), or that it is generally immobile.
4) Family female labour days. The families reported the actual amounts of work time, but in the processing a conversion rate of .8 was consistently applied to make female labour equivalent to male labour[26].
5) Deflated total farm asset stock value. The deflator used is a Fisher price index which uses national price data with asset shares calculated from the sample. The assets included are: tools and machines (37%), farm inventory (28%), livestock (21%) and trees (14%), all as reported on balance sheet at the beginning of the year[27]. An alternative to using stock values would be to use the service flow. However, there was insufficient information to attempt a reasonable calculation of the service flow for these Taiwanese assets[28]. Questions

about the contribution of capital to value-added in this study will thus not so much be about the technical contribution of farm assets to value-added, but about the contribution of the capital invested in the farm activity to the net farm return[29].

The dependent variable is the net revenue. It is the sum of all the crop and non-crop actual farm incomes from which all the paid costs are deducted[30]. This net profit is then deflated by a Fisher price index based on national price data and average shares of output and variable inputs in profit as calculated from the total sample of 2274 observations.

To distinguish the consequences of technology and farmer behaviour from the influences of variations in soil and climate, we subdivide the sample into groups of farms with similar environmental conditions. Thus all-paddy farms (designated a) are distinguished from mixed paddy-dry land farms (designated b) and pure dry-land farms (designated c). The sample is also subdivided according to the regions described in chapter three: North Rice (NR), Mid-Rice (MR), South Rice (SR) and Sugar (SUG) (thus MRb indicates the mixed paddy-dry farms of the Mid-rice region). Each region had sufficient observations for estimation in the all-paddy and the paddy-dry category, but only the Sugar region had sufficient all-dry farms.

G. THE STATISTICAL PROPERTIES OF THE MODELS

We estimate the linear, the linear dummy and the generalized linear model with the ordinary least squares method. The model is thus:

(36) $\Pi_h = \Pi(v_h) + \epsilon_h$ h: household h

With the usual ordinary least squares assumptions:

(a) $E(\epsilon) = 0$

(b) $E[\epsilon^2] = \sigma^2$

(c) $E[\epsilon_j \epsilon_h] = 0$ j,h : households

(d) the explanatory variables (v) are uniformly bound by a finite constant $|v| < M$

(e) they are also distributed independently of the error

(f) and the rank of V is full: r=5

Assumptions (b) generally mean that we assume that there is no systematic influence on the variance of the error terms, thus no heteroskedasticity, while (c) means that there is no influence from one farmer in the sample to the next. Assumption (d) is no problem since there are definite bounds on the factors that any family has available.

Assumption (e) is likely to be satisfied in this study, as it is a value-added function estimation of the family supplied factors of production. Using the argument of Hoch (1965) and Zellner, Kmenta, Dreze (1965), the error in the a posteriori (actual) value-added is independently distributed from the family inputs (explanatory variables), and is linked to random weather conditions and other agricultural conditions such as disease and insect influences. It should also be noted that in our model, the a posteriori value-added can be negative even though there is a positive use of family factors. These are cases where both paid and family supplied factors are misallocated given the a posteriori levels of output (or the lack of output) because of the random weather-disease influence. We cannot exclude these observations because this is a genuine part of the net revenue situation facing farmers in Taiwan.

This brings us to the discussion of the first assumption (a) that $E[\epsilon] = 0$, so that we are estimating average (expected) relationship between family factors and value-added, and not frontier relationships. The latter would require that all errors be of the same sign, since the estimated function should then give the maximal possible value-added from the amounts of family factors. In our estimation, we are maintaining the assumption that there are enough observations on extra good, extra bad and average weather-disease situations in the sample, and that there are enough farmers at all levels of technical efficiency. The actual estimated function is thus the relationship between family factors and the value-added they can produce given average weather-disease conditions and at average technical efficiency levels of production.

We can in fact investigate if there are any characteristics of the farmers which systematically pull the actual value-added above or below the expected one, given the family inputs and the estimated value-added functions. The year of production is a candidate for the investigation of the weather-disease influence to identify the extra good or extra bad production years. The degree of participation in farm production can be used for the investigation of systematic technical efficiency differences. Thus we also analyse the structure of the estimated error of production with a dummy variable model. (This is in fact our test for technical inefficiency.) A dummy variable model is estimated on the errors of the value added function estimations $(\Pi-\hat{\Pi})=\hat{\epsilon}$:

(37) $\hat{\epsilon}_i = a_0 + \Sigma a_i d_i + \eta_i$

d_1 = 1972...1980 dummy
or d_1 = participation group dummy
or d_1 = size dummy

We are thus maintaining the hypothesis that the weather-disease conditions and the technical efficiency levels of production are neutral to the allocative properties of the production situation with respect to the family supplied inputs (isoquants are shifted parallel to the position of the average isoquant). Note that this is a very heuristic approach to the technical inefficiency measurement since the statistical properties of this dummy regression on the estimated errors are unknown. The allocative efficiency is investigated via a dummy regression on the estimated marginal productivities according to equation (34) and (35); again the statistical properties of this dummy variable regression are unknown.

H. ESTIMATION RESULTS

H.1 Introduction

Before addressing the efficiency issues which are the main concern in this study, the salient econometric results are reviewed.

Coefficients for the 'linear dummy model' are shown in table E.15-18, test statistics in table E.5-6, and the resultant marginal products of the family supplied inputs for small full-time, small part-time and large full-time farms in table 5.7. Generally the statistical fit was good (R^2 at least .86). For the Mid-rice mixed paddy-dry farms (MRb) and the Sugar all-paddy (SUGa) farms the hypothesis that the size and participation dummy coefficients are zero is not rejected (significance .05). In these cases the linear function is appropriate and marginal productivities of the factors are constants (isoquants are linear). On the NRa, MRa and SUGc farms, size and participation dummy coefficients are significant, on the SRa and SRb farms there are only size effects while on the SUGb farms there are only participation effects (table E.15-18). Note that the statistical fit of the 'linear' function is high (R^2 at least .81) even though in most cases the 'linear dummy' function fits the data significantly better.

Coefficients of the 'generalized linear model' are shown in table E.8, test statistics in table E.1-2, the size-participation dummy variable regressions on the calculated marginal products in table E.19-22 and the resultant marginal products of family factors for small full-time, small part-time and large full-time farms in table 5.6. Generally the statistical fit was good (R^2 at least .83). As can be seen in table E.2, the hypothesis of the linear function is not rejected at significance levels of .05 for the NRa, MRb and SUGa farms. (The MRb, SUGa cases agree with the conclusion of the 'linear dummy' model.) For the other regions the constant returns to scale generalized linear model fits the data much better than the linear model. Only in the SRa farms is the non-homothetic generalized linear model significantly better than the constant returns to scale model.

There is one difficulty with the estimated generalized linear functions: they do not satisfy the regularity condition of neo-classical value-added functions. Returning to system (26)-(28), the second order conditions for maximization of the production from the agricultural resources, require the bordered Hessian to be negative definite or G(v) to be quasi-concave or concave. If we rewrite system (26) by incorporating the resource constraints:

$$(38) \qquad \text{Max} \sum_{h=1}^{H-1} G(v^h) + G(V - \sum_{h=1}^{H-1} v^h)$$

$$= \text{Max} \sum_{h=1}^{H-1} G(v^h) + G(z) \qquad \text{where: } z=V-\sum_{h=1}^{H-1} v^h$$

then the first order conditions are:

$$(39) \qquad \partial G(v^h_i)/\partial v^h_i - \partial G(z)/\partial z_i = 0 \qquad \forall\ i=1..5 \text{ factors}$$

$$\forall\ h,k=1..H-1 \text{ households}$$

$$\partial G(v^k_i)/\partial v^k_i - \partial G(z)/\partial z_i = 0 \qquad \forall\ i$$

and the second order conditions require the [5(H-1)x5(H-1)] Hessian associated with the vector $[dv^h_i, dv^h_j, dv^k_i, dv^k_j]$ $\forall h,k=1..H-1$ and $\forall i,j=1..5$, must be negative definite where (39) holds:

(40)

$$\begin{bmatrix} \partial G(v^h)/\partial v_i^h \partial v_j^h + \partial G(z)/\partial z_i \partial z_j & \partial G(z)/\partial z_i \partial z_j \\ \partial G(z)/\partial z_i \partial z_j & \partial G(v^k)/\partial v_i^k \partial v_j^k + \partial G(z)/\partial z_i \partial z_j \end{bmatrix}$$

which implies that the diagonal elements must not be positive:

(41) $$\partial G(v^h)/\partial v_i^h \partial v_i^h + \partial G(z)/\partial z_i \partial z_i \leq 0$$

This further implies that

(42) $$\partial G(v^h)/\partial v_i^h \partial v_i^h \leq 0$$

since (41) has to hold for any households chosen as the H-the household.

The evidence for all nine samples and for both the 'generalized linear' and 'linear dummy' functions on the values of the change in the marginal products of each factor with respect to an addition of that factor is that (42) does not hold for all factors. A sufficient condition for the 'generalized linear' function to satisfy (42) is that the matrix of coefficients, as reported in table E.8-9, would have all its off-diagonal elements ($\hat{a}_{ij}$) non-negative. This is not the case in our estimated functions. In all nine cases there is a strong negative coefficient for the female-paddy term (female-dry term in Sugc). Added to this is a negative coefficient for the paddy-asset term on the all-paddy (all-dry) farms (except in SRa) and a negative paddy-male term on the paddy-dry farms (and SRa case). These effects dominate the functions and the shadow price shifts. The result is that the Hessian matrices of second order derivatives of the estimated functions (when evaluated at the input levels which are used by the households) are not negative definite for most households and on average, since the diagonal elements are not all negative[31]. Thus $\partial G(v)/\partial v_i \partial v_j > 0$ for at least one factor for most households in the generalized linear model. However, the 'generalized linear' model produces patterns of shifts of the shadow prices which generally are not contradicted by the direction of the shifts of the shadow prices in the 'linear dummy' model, as can be seen by comparing the sign patterns in tables E.19-22 and tables E.15-18. The 'linear dummy' specification is very flexible and does not impose many a priori restrictions on the value added functions. This specification is the same as an estimation firstly, of a simple linear approximation of the value added function for each farm type, and then, a comparison of the relative positions of the resultant shadow prices of the production factors between the farm types. Both the 'generalized linear' and 'linear dummy' approaches confirm each other so that this suggests that the shadow price patterns are not a consequence of the choice of the flexible functional form (e.g. the generalized linear as against the translog or generalized leontief or another flexible function). It should be noted that the issue of returns to scale is neutral to the curvature problem of the estimated functions as all the factors are expanded proportionally when scale effects are considered. The issue of the regularity violation in the estimated functions will be considered further when allocative efficiency is discussed.

The next three sections are a discussion of the results of the 'generalized linear' and the 'linear' models as they bear on the issues of returns to scale, of allocative efficiency and of technical efficiency. The 'linear' model is a restricted version of the 'generalized linear' model where essentially equality across farms of the shadow prices is imposed (these restrictions are statistically acceptable in the NRa, MRb and SUGa cases). Alternatively interpreted, the fixed shadow prices as derived from the 'linear' model can be considered as an average of the 'linear dummy' model shadow prices which is then compared to the average as calculated in the 'generalized linear' model.

H.2 Returns to scale

The hypothesis of constant returns to scale can be tested directly in the 'generalized linear' model. The hypothesis can be accepted in all the cases, except the SRa case where the technology is non-homothetic[32]. (Test statistics are reported in table E.1.)

The hypothesis of constant returns to scale cannot be tested directly in the 'linear' model. In this case we have to build an approximative test, as outlined in section E.1. The hypothesis can be accepted in all cases, except the SRa case, as average error $(\Pi-\hat{\Pi})$ on small full-time farms is generally equal or even larger than on large full-time farms. Only in the SRa region is there a significant overestimation of the actual net return on small full-time farms with the estimated linear function.

Thus the direct test of constant returns to scale in the 'generalized linear' model produces the same conclusion as the approximate test in the 'linear' model. The assumption of increasing returns to scale can be rejected in all cases, except the SRa case. This means that the optimal size of the farm need not be large and a system of small farms is equally efficient from a returns to scale perspective.

H.3 Allocative efficiency

In this section allocative efficiency is first investigated against the opportunity costs and then across farm groups. The first supplies information on the overall allocative efficiency of the farms in each region and farm land type and the general working of the market system. The second investigates the factor productivities across the

Table 5.1: SHADOW PRICES (NT$) FOR LABOUR 1
(FARMS WITH GOOD OFF-FARM EMPOYMENT OPPORTUNITIES)

		NRa+	NRb	MRa	SRa‡
L	Male	270 (28)	214 (48)	292 (32)	347 (na)
L	Female	153 (54)	101 (109)	222 (40)	184 (na)
GL	Male	271 (4)	194 (29)	299 (22)	183 (66)
GL	Female	172 (39)	200 (54)	178 (50)	227 (84)

Notes
Calculated labour productivity which can be compared to the average national farm wage: Male 275, Female 249 NT$

L: Linear model — a: all paddy farms
GL: Generalized linear model — b: paddy-dry farms

+: Linear model cannot be rejected (significance .05)
‡: Non constant returns to scale GL model, and Linear size dummy model instead of L model
(standard deviations in brackets)

farm groups and requires an interpretation of the shape of the estimated functions and its possible cause.

First the results of the 'linear' model are compared with the average shadow prices derived from the 'generalized linear' model and with the market prices as reported in tables 5.1-5. The shadow prices of the family supplied factors are the coefficients of the 'linear' function. To find the shadow prices in the 'generalized linear' model, the first order derivatives of the function are calculated for each farmer's level of inputs and then averaged over the sample. The market prices are calculated as the averages, over 9 sample years, of the market prices which were deflated with the profit index[33]. The standard deviations reported are for the 'linear' model the standard deviation of the linear function coefficients and for the 'generalized linear' model, the standard deviations of the base coefficient in each dummy regression of the calculated shadowprice[34].

Comparisons of the shadow prices with the market prices are tests for allocative efficient behaviour by the farmers in the choice of the family factor and so indicate if the family factors are mobile. First labour is considered then farm assets, then land.

When farmers have good opportunities for off-farm employment, estimated marginal products of labour are similar to the national wages. Farms in the NRa and NRb regions are close to Taipei and Keelung; farms in SRa are close to Kaohsiung, and farms in MRa are in an area with much rural industry. Table 5.1 shows that marginal products are similar to the average national farm wage of 275 for men and 249 NT$ for women[35].

The other farms are further from industrial employment, usually because they are further in the hills. Table 5.2 shows their labour marginal products. The values are erratic and usually less than the national farm wage.

Table 5.2: SHADOW PRICES (NT$) FOR LABOUR 2
(FARMS WITH POOR OFF-FARM EMPLOYMENT OPPORTUNITIES)

		MRb⁺	SRb	SUGa⁺	SUGb	SUGc
L	Male	141 (41)	79 (51)	81 (50)	144 (43)	236 (83)
L	Female	31 (61)	181 (61)	2 (58)	85 (47)	-33 (79)
GL	Male	222 (54)	96 (25)	139 (83)	141 (14)	198 (57)
GL	Female	-20 (53)	146 (17)	-3 (28)	111 (32)	-129 (105)

Notes:
Calculated labour productivity which can be compared to the average national farm wage: Male 275, Female 249 NT$

L: Linear model
GL: Generalized linear model

a: all paddy farms
b: paddy dry farms
c: all dry farms

⁺: linear model cannot be rejected (significance .05)
(standard deviations in brackets)

The male shadow price is generally higher than the female shadow price. This result may indicate more mobility for males.

Table 5.3 shows the shadow prices for assets. Given the construction of the asset variable, the shadow price ought to equal the interest rate plus the depreciation rate if the farmer has chosen the profit maximizing quantity of capital. The official agricultural interest rate was 18.9%, the market rate 40.8%[36], and the shadow price of the assets should at least cover the capital cost (assuming that appreciation is not larger than depreciation[37]). The shadow

Table 5.3: SHADOW PRICES (%) FOR FARM ASSETS

Dominant farm for the region	NRa+	MRa	SRa‡	SUGb	
L	34.6 (3)	10.3 (3)	26.1 (na)	26.8 (5)	
GL	29.5 (3)	-1.5 (6)	35.6 (6)	28.5 (4)	
Non-dominant farm for the region	**NRb**	**MRb+**	**SRb**	**SUGa+**	**SUGc**
L	17.9 (4)	23.9 (5)	51.6 (6)	59.1 (4)	41.7 (10)
GL	40.0 (8)	44.5 (8)	44.9 (4)	61.9 (4)	74.7 (16)

Notes:
Calculated rate of return on farm assets which can be compared to the 18.9% average official agricultural interest rate or the 40.8% average national market interest rate if no depreciation is assumed

L: Linear model
GL: Generalize linear model

a: all Paddy farms
b: Paddy-dry farms
c: all-dry farms

+: Linear model cannot be rejected (significance .05)
‡: Non constant returns to scale GL model, and Linear size dummy model instead of L model
(standard deviations in brackets)

prices are halfway between the official and the market capital cost on the dominant land type farm for each region (all-paddy in the rice regions, mixed dry-paddy in the Sugar region). Presumably, the agricultural authorities devote most attention to these farms and there is some evidence that, as a result, these farms have better access to the official agricultural capital markets. The shadow prices on the non-dominant land type farms are at or above the market

Table 5.4: SHADOW PRICES (NT$) FOR PADDY LAND

	NRa⁺	MRa	SRa‡	SUGa⁺
L	14656 (5199)	41129 (5858)	17354 (na)	47866 (6747)
GL	13181 (3765)	44953 (9150)	35609 (9493)	46948 (3626)
	NRb	**MRb⁺**	**SRb**	**SUGb**
L	28183 (8702)	76407 (9441)	56758 (8379)	52257 (6315)
GL	5143 (7292)	46172 (11846)	36566 (10420)	54905 (2228)

Notes:
Calculated rental rate for land which can be compared to the average official rental rate for land of 16634 NT$

L: Linear model — a: all paddy farms
GL: Generalized linear model — b: paddy-dry farms

⁺: Linear model cannot be rejected (significance .05)
‡: Non constant returns to scale GL model, and Linear size dummy model instead of L model
(standard deviations in brackets)

capital cost indicating less access to the official capital markets.

Tables 5.4 and 5.5 show the shadow prices of paddy land and dry land. Except for dry land in the rice regions, and for the NR region, they exceed the official rental rate of NT$ 16634. For this reason renting does not occur. Within each region, paddy land shadow prices are equal on the two land type farms, showing the robustness of the paddy

Table 5.5: SHADOW PRICES (NT$) FOR DRY LAND

	NRb	MRb⁺	SRb	SUGb	SUGc
L	7096 (9199)	10241 (10332)	9297 (12844)	36942 (6179)	40936 (10125)
GL	-63652 (19571)	-3372 (8510)	-35978 (18445)	59760 (4214)	21785 (7820)

Notes:
no average official rental rate is available for dry land

L: Linear model b: paddy-dry farms
GL: Generalize linear model c: all dry farms

⁺: Linear model cannot be rejected (significance .05)
(standard deviations in brackets)

land shadow price in each region. Dry land is farmed in the rice regions, even though it has a negative return, since long fallow periods are limited by law and since the farmers hope to sell it eventually for non-agricultural uses. Only in the Sugar region does dry land have a high shadow price because it is devoted to a use for which it is well suited (dry land production methods are well established).

Having thus discussed the allocative efficiency issue against the market prices, we now discuss the issue of the differences that the size and participation characteristic may make for the shadow prices of the family factors. Thus tables 5.6-7 show the shadow prices of the family factors of the small full-time, large full-time and small part-time farms as calculated. For the 'generalized linear' model, table 5.6 is based on tables E.19-22, (standard deviations of the large full-time farm coefficient). (Table 5.8 contains the data for the all-dry farms of the Sugar region. Because there were not enough observation on large full-time farms in the sample, the base group is the farms with more than 1 hectare.) For the 'linear dummy' model[38], table 5.7 is based on the size-participation dummy case in tables E.15-18 (standard deviation of the large full-time farm coefficient). (The same information as in tables 5.1-7 can be found in an arrangement by region in the appendix tables E.23-26.)

In this investigation of the effects of the farmers' characteristics we have to come to an understanding of the implications of the curvature properties of the functions, which will be discussed after a general overview of the shadow price shifts. First the male labour, then the farm assets, the paddy land and finally the female labour shadow prices are presented for the farm groups.

Male shadow prices across farm types tend to be insignificantly different from each other (except in SRa). In fact a generalized linear model with the male shadow price held constant[39] usually does not mean a significant loss of fit against the unrestricted model and this restricted model produces almost no changes in the shadow prices of the other factors. Thus the male shadow price is constant across farm types[40].

There is a general tendency for asset shadow prices to be stable across the farm groups in the Sugar region (SUGa, SUGb). In the rice region, the asset price on small full-time farms are generally higher than on both other farms and at or above the market opportunity price for farm capital (40.8%) (except MRa, NRb) and at the official agricultural capital cost (18.9%) on small part-time farms.

In six cases, the paddy land shadow prices of large full-time and small part-time farms tend to be similar, equal on both all-paddy and paddy-dry farms of the same region, and, except for the NR region, far above the official rental rate. The equality of the shadow prices is the reason why there is no renting of land between small part-time and large full-time farms. It also shows, even if a rental market were opened, that land would not be transferred from small part-time to large full-time farms. In the two other cases (NRb, SRa) the shadow price of paddy land on small part-time and small full-time farms are equal. Again, small part-time farms do not have an incentive to rent out land to full-time farms. There is however a general tendency for paddy land shadow prices to be significantly lower on small full-time farms bringing the shadow price on small full-time farms close to the official land rental rate in the rice regions(except in NRb and MRb[41]).

Table 5.6: ESTIMATED SHADOW PRICES in the GENERALIZED LINEAR MODEL in four regions for SMALL FULL-TIME (SFT), LARGE FULL-TIME (LFT) and SMALL PART-TIME (SPT) FARMS

Region	North Rice			Mid rice			South Rice			Sugar		
Farm group	SFT	LFT	SPT	SFT	LFT	SPT	SFT	LFT	SPT	SFT	LFT	SPT
ALL-PADDY FARMS		NRa⁺			MRa			SRa‡			SUGa⁺	
PADDY LAND	5055*	22506" (3765)	19229	21546*	45503" (9150)	56443	13791*	51651" (9493)	55031	33551*	51332" (3626)	49004
MALE LAB	270*	281" (4)	272*	306	266" (22)	308*	326*	562" (66)	-77*	-5*	78 (83)	236*
FEM LAB	130	100" (39)	181*	263	182" (50)	77*	316*	-396" (84)	499*	168*	6" (28)	-79*
F ASSETS	41.1*	21.4" (3)	22.2	10.0	.4 (6)	-8.2	48.5	51.6" (6)	17.0*	60.9	58.0" (4)	60.4
PADDY-DRY FARMS		NRb			MRb⁺			SRb			SUGb	
PADDY LAND	-7986*	22622" (7292)	-9265*	-4860*	68131" (11846)	61207	23470*	69052" (10420)	19308*	43108*	53424" (2228)	61131*
DRY LAND	2836	-23319" (19571)	-117844*	-32706*	-1872 (8510)	9167	-70185	-47565" (18445)	11007*	77107*	59050" (4214)	59659
MALE LAB	283*	86" (29)	83	171	150" (54)	352*	35	70" (25)	97	189	107" (14)	129
FEM LAB	278	378" (54)	104*	169*	-112" (53)	-62	197*	85" (17)	156*	9*	116" (32)	132
F ASSETS	16.2	24.5" (8)	59.1*	75.6*	40.2" (8)	22.3*	60.6*	38.6" (4)	40.7	28.1	28.8" (4)	27.4

Source: table E.19-22

Notes: * : significantly different from the large farmer group   " : significantly different from zero

⁺ : Linear model cannot be rejected (significance .05)   ‡ : Non constant returns to scale model

(standard deviation of base coefficient in the dummy regression used for the confidence interval)

P : paddy land............official rental rate: 16634 NT$ D : dry land..............na

M : male labour...........average wage: 275 NT$ F : female labour.........average wage: 249 NT$

A : farm assets...........bank-market interest: 18.9-40.8%

Table 5.7: ESTIMATED SHADOW PRICES in the LINEAR SIZE-PARTICIPATION DUMMY MODEL in four regions for SMALL FULL-TIME (SFT), LARGE FULL-TIME (LFT) and SMALL PART-TIME (SPT) FARMS

Region	North Rice			Mid rice			South Rice			Sugar		
Farm group	SFT	LFT	SPT	SFT	LFT	SPT	SFT	LFT	SPT	SFT	LFT	SPT
ALL-PADDY FARMS		NRa			MRa			SRa			SUGa+	
PADDY LAND	-21697	-17450 (11887)	-10093	9064*	49224" (16290)	47691	6208	23506 (16581)	32246	56564	47015" (17311)	80992
MALE LAB	387	442" (88)	279	346	235 (82)	369	404*	833 (85)	318*	-69	134 (126)	-162
FEM LAB	116*	656" (200)	338	253*	40 (99)	108	185	-426 (226)	41	105	-122 (153)	-16
F ASSETS	65.4*	42.5" (5)	42.7	48.1*	24.0" (24)	.3*	21.5	37.3" (16)	32.7	101.1	76.0" (20)	44.0
PADDY-DRY FARMS		NRb			MRb+			SRb			SUGb	
PADDY LAND	39301	-9700 (19532)	88877*	33761	66065 (37037)	75887	66200	113052" (15742)	69129	53635	63533" (10280)	53878
DRY LAND	45595	14964 (18746)	91252*	-30157	-39107 (32284)	56715	-54443	7178 (24498)	-69545	67615	60356" (9228)	58900
MALE LAB	178	229 (125)	-439	194	276" (92)	-184*	351*	-73 (128)	414*	124	68 (98)	-329*
FEM LAB	212	613" (216)	834	117	99 (162)	76	16	-274 (222)	246	57	88 (79)	409*
F ASSETS	-45.1*	11.6 (5)	-12.1*	52.7	16.5 (24)	35.2	18.6	51.4 (16)	21.5	31.6	19.8" (8)	-12.7

Source: table E.15-18

Notes: * : significantly different from the large farmer group   " : significantly different from zero

+ : Linear model cannot be rejected (significance .05)

(standard deviation of the base coefficient, used for the confidence interval)

P : paddy land............official rental rate: 16634 NT$ D : dry land..............na

M : male labour...........average wage: 275 NT$ F : female labour.........average wage: 249 NT$

A : farm assets...........bank-market interest: 18.9-40.8%

Table 5.8: SHADOW PRICES for the SUGAR ALL-DRY FARMS in the GENERALIZED LINEAR and LINEAR DUMMY MODEL

MODEL:	GENERALIZED LINEAR			SIZE-PARTICIPATION DUMMY		
	SFT	M+LFT	SPT	SFT	M+LFT	SPT
DRY LAND	-25695*	9454 (7820)	54019*	57110	-7643 (na)	112245
MALE	432	305" (57)	-41*	-49	450" (na)	63
FEMALE	-76	-68 (105)	-203*	-89	-91" (na)	17
F ASSETS	99.4*	69.1" (16)	58.5	58.4	92.1" (na)	-44.2

Source: tables E.15-22
Notes: The base farm group is the farms over 1 hectare (instead the usual farms over 2 hectare) because there were not enough large full-time farms in the sample. Generally, the whole sample may be too small (91 observations) to give reasonable estimates of the shift coefficients)

There is also a general tendency for female shadow prices of small full-time farms to be around or above the female wage (249 NT$) (except SRa and SUGb), while the shadow prices on large full-time and small part-time farms are much lower and very erratic.

Dry land shadow prices are high and shared by large full-time and small part-time farms on the dominant land type farms in the Sugar region, while the small full-time shadow prices are even higher. In the rice regions, dry land shadow prices are erratic and generally negative.

The preceding discussion of the shadow prices for the farms with different characteristics suggests that all the farm groups in the all-paddy North rice region share the overall tendency to equate the family factor productivities to the national average market prices or official prices (although small full-time farms seem to have less access to the official asset market). Additionally, the small full-time farms of the all-paddy farms in the other rice regions also show this tendency (although in the SRa region with less access to the official asset market).

Additionally, all the farms in the Sugar region (SRa, SUGb[42]) work with a very different technology than the farms of the rice regions and the factor productivities suggest a much more rural structure of the economic environment. Thus labour productivities are generally lower than the national agricultural wage, while land productivities are nearly 2.5 times the official national rent and dry land shows productivities comparable to paddy land. Within the region, there is not a great variation in the factor productivities between the farm groups, so that the distribution of the family factors does not need to change.

The estimations for the paddy-dry mixed farms in the Rice regions, tend to produce shifts in the land shadow prices which suggest that the effect and interaction between the two land types is not captured very well in the model.

This may be a consequence of collecting the farms with very little dry land together with farms which are nearly totally dry land farms.

The curvature problem that we have already shown to exist in section H.1, is now further discussed because it is important for the interpretation of the movements in factor productivities when the family supplied factor mix changes. Since generally the land productivity pattern is influenced, it is necessary to investigate the possible causes of the difficulty in the estimated functions. The relationship which dominates the estimated functions and the resultant paddy land productivities of the farm groups is the relationship between female labour and land. As constant returns to scale was the norm and because of the separability assumption[43], the issue can be discussed around the estimated unit value isoquant between paddy land and female labour[44]. The movements in the paddy land and female labour productivities between the farm groups follows from the endowment structure and the shape of the estimated unit value isoquant. We know from chapter four that small full-time farms have a higher labour-land ratio than small part-time farms and that large full-time farms have the lowest labour-land ratio. However, the estimated influence of the female labour is such that the land productivity falls whenever there is an addition of female labour to the land. The paddy land shadow price is thus lowest on small full-time farms because more female labour is used per land area than on the other farms and the estimated isoquants are concave.

There could be several causes of this estimation result. The first cause could be a data problem, in the measurement of the amounts of family supplied factors, especially the female labour . The second cause could be the model specification, which relies on 1) the separability assumption between on the one hand the output and bought inputs and on the other hand the family supplied factors and 2) the optimization assumption of the choice of output and bought input mix.

The measurement of the family supplied factors had to stay at a level of aggregation which could be inappropriate for the actuality of the production situation in Taiwan. No differentiation was possible in the labour quality. The original data was very carefully collected so that the labour days were counted. This is indeed better than what is available for most agricultural studies where only the numbers of family members is known (so that usually labour days must be approximated). However, in the Taiwanese case, with the increase in education and off-farm opportunities (the latter selective in the choice of member's qualities), homogeneity of the farm labour quality on the different farms can no longer be assumed. Additionally, the variations of the disutility of farm work for the immobile family members have probably become bigger between farm types because of the off-farm income possibilities (combined with income sharing practices in the households). Thus counting only the labour days may introduce large statistical variation in the measurement of the relationship of labour to the value added and thus to the productivity of the other factors. In this context is is interesting that it is the female family labour which causes the problem and not the male labour, probably because male labour is both more homogeneous in quality and in evaluation of the disutility of working, and relates more to the market situation. The measurement of the farm asset variable was also very aggregated, so that variations in opportunity cost structure could result. E.g. machinery, because it provides an observable collateral, can more easily be bought with credit from the official banking system. Thus for the farm types with high proportions of farm machinery in the farm asset value, the opportunity cost will be close to the official bank interest cost, and estimated productivities of assets may reflect this.

The model specification relies on several assumption, so that the estimated relationship between value added and the family supplied factors may systematically be disturbed if these assumptions do not hold. Thus if there exist several sets of crops, each set distinguishable by major differences in their technologies and factor intensities (which rely in fact on specific family supplied factors), then the separability assumption as stated in (13)-(14) does not hold. We know from chapter four that the set of available crops from which the farmers can choose is very large, and the crops have distinctive technologies. Some need a lot of family labour per land (e.g. vegetables) because production is sensitive to carefull labour application, thus requiring the self-supervised family labour. Other crops need little family labour per land (e.g. rice, sugar) because the production can be mechanized. This situation can be drawn as in figure 5.1, where there is a 1\$-isoquant FF of the female family labour-intensive crop and a 1\$-isoquant LL of the land-intensive crop. If the

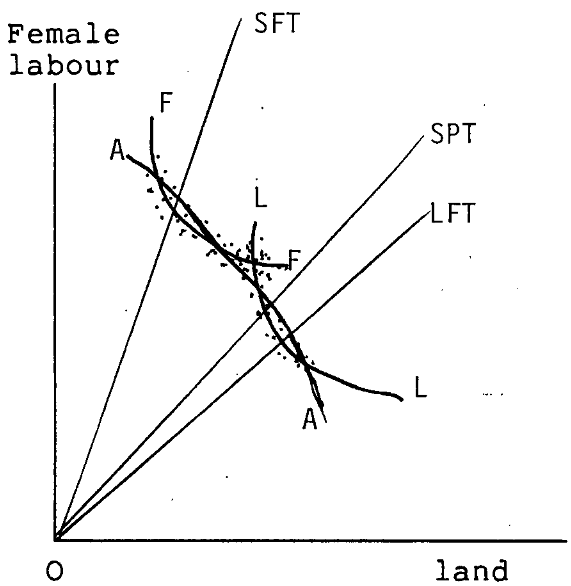

figure 5.1

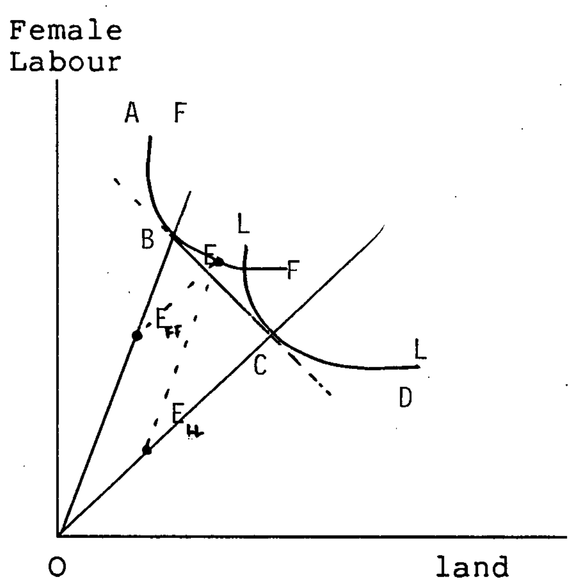

figure 5.2

assumption that farmers are choosing the optimal crop choice mix perfectly is also violated, then the relationships of value added to family supplied factors could very well produce the concave isoquant in estimations. Thus, if most observations are distributed around these crop value isoquants then the estimations will produce an envelope function AA. The issue becomes thus a question of whether farmers[45] are are not maximizing their value-added by allocating their family factors across the crops such that the value marginal products of each factor are equalized in each crop production ($VMP^k_{FF} = VMP^k_{LL}$ $\forall k$=inputs). This would mean a production along ABCD in figure 5.2, with a simultaneous production of the labour and land-intensive crop for farmers on endowment rays between OB and OC. Thus a farmer with an endowment at E would produce OE_{FF} of the labour-intensive crop and OE_{LL} of the land-intensive crop and have more than 1$ total value-added, instead of 1$ from only the labour-intensive crop, or less than 1$ from only the land-intensive crop. Thus the curvature property of the estimated value-added functions tends to suggest that farmers have difficulty in optimally choosing the crop mixes, and the difficulty of the choice becomes especially difficult for the farmers whose endowment ratios are far from the endowment ratios OB or OC where specialization is optimal. Correct crop diversification requires a large amount of versatility, accuracy and a good knowledge of both the labour and land-intensive crops. This accuracy may be lacking on the farms (especially since the part-time farm groups fall in the category with endowment ratios between OB and OC).

Further research into the production process will be needed to resolve this issue. The research should be directed towards the choice mechanism of the production mix and the structure of the separate crop technologies. The data in this sample is not appropriate for the estimation of separate crop production functions as inputs cannot be allocated to the different crops. However, the original reported farm information could be the basis of such a detailed study. The data from the crop production estimations could then be used in a detailed analysis of the annual crop mix choice and the relationship of this choice to the availability of the family endowments in each farm group.

We conclude from the investigation of allocative efficiency, that the investigation of the total factor productivity at the level of aggregation of this chapter has to be interpreted as preliminary. The production situation on the farms has become very complex, so that simple model specifications become less appropriate. However, the patterns of the estimated land productivity differences between farm types, together with the shape of the estimated value added functions, do seem to suggest that land and female family labour are not very mobile, so that there is no activity of adjusting the land to the family labour endowments or the reverse. Thus, each farming household is bound by the family labour and land endowments and should correctly adjust the output mix accordingly. The shapes of the estimated functions suggest that this output mix choice may be particularly unsuccesfull for the farmers whose factor endowments are such that they should carefully diversify. This means that there could be a gain for the sector if more attention was given to teaching farmers accuracy in the choice of crop diversification.

H.4 Technical efficiency

Technical efficiency cannot be tested directly in the context of the 'linear' and 'generalized linear' specifications of the value-added functions. It is also very difficult to separate technical inefficiency (less value-added from a given set of inputs on an inefficient farm than on an efficient farm) from allocative efficiency when the different categories of farmers are known to be producing on different endowment rays and have a choice of several outputs. The reason for technical inefficiency when observing the total output or the total value-added from the inputs could be the inappropriate choice of the output mix, which is an allocative issue. Thus technical inefficiency is only clearly defined in the situation where only one output is produced. However, it is still valuable to investigate if part-time farmers' actual value-added is systematically below the amount that the estimated function would predict from their factor inputs ($\Pi-\hat{\Pi}<0$), while there is a systematic underestimation on full-time farms ($\Pi-\hat{\Pi}>0$). Dummy variable regressions on ($\Pi-\hat{\Pi}$) were estimated and the results are presented in table E.12-14.

Given the 'generalized linear' model, participation effects are significant and in favour of full-time farms only on the dominant farm type for each region (the all-paddy farms in the rice regions, the mixed farm in the sugar region). The non-dominant land type farms show no participation effect. So comparing dominant land type farms, small full-time farms have systematically more value-added than would be predicted from their factors and small part-time farmers have less value-added than would be predicted from their factors.

The same conclusion can be drawn in the 'linear' model. On the dominant farm land types of the region (on NRa, MRa and SUGb) the difference between the actual and the estimated net returns is significantly smaller (more negative) on part-time farms than on full-time farms. In the other cases there is no effect from participation.

We can conclude for the dominant land type farms, that generally more value-added is generated from the family factors on the full-time farms than on the part-time farms.

This is probably the consequence of the fact that the development of exact farming methods is usually concentrated on the methods for prime land farms of each region. Thus, there will be a significant effect from carefull farm choices (as main family activity), which is lost on part-time farms.

I. SUMMARY AND CONCLUSION

The investigation in this chapter indicates that there are no gains from a system of large farms. The evidence also points to problems with the marketing of both land and female family labour in the present context of the land legislation and the character of family labour. There is also some evidence for a loss of efficiency on part-time farms of the dominant land type in each region, but there are no effects on the other land type farms.

The approach was to estimate a value-added production function which is a special case of the variable profit function. Because of price data limitations, the entire variable profit function could not be estimated but only the relationship between the family supplied factors and the real net return from farming.

For the estimations, we specified a linear function, a linear function with slope dummy variables for the farm characteristics, and a generalized linear function between real net return and the five family factors: paddy and dry land, male and female labour and farm assets. We controlled for soil and climate by separately estimating all-paddy, paddy-dry mixed and all-dry farm land households for the four regions. This gave us nine cases as only the Sugar region had sufficient all-dry observations. The statistical fit was generally very good with R^2 at least .81. Also, the conclusions that can be drawn from the linear dummy model generally confirm those of the generalized linear model (and where meaningful, those of the linear function).

We can conclude that the assumption of increasing returns to scale can be rejected in all cases except the South Rice all-paddy case where the technology is non-homothetic. Constant returns to scale prevail, so net value-added is proportional to the scale of family farm operation. There is no gain from having only large scale farms in the sector.

Our findings mean that the mechanization of agricultural production has not introduced increasing returns to scale. The machine service market is thus sufficiently well organized that there are no indivisibilities in machine use. Increasing returns to scale because of field size advantages also do not play a role, possibly because of the requirement of level fields in rice production (the most mechanizable crop) and because of the field size limitations in an irrigated system. Machine service contracts where prices are quoted per hectare and not per time period, also diminish the advantage for farmers with large and unfragmented fields.

The issue of allocative efficiency can be discussed generally by comparing the average factor opportunity cost with the average factor productivities as generated by the generalized linear model. Average labour productivities are close to market wages where good industrial employment opportunities exist. Everywhere else the labour shadow prices are erratic and below the wage rates, with female labour shadow prices below the male shadow price. Thus shadow prices of labour reflect differential existence of employment opportunities in the regions. Farm asset productivities tend to be at, or slightly above, the bank capital cost (18.9%) on the dominant land type farm and at or above the market capital cost (40.8%) on the other land type farms. This suggests differential access to the capital markets where the dominant land type farmers are more incorporated into the official capital market as part of the general official attention that these farmers receive. The average paddy land productivities are at least two times the official rental rate, except in the North Rice region where they are at or below the rental cost. This is why legalized rental agreements are no longer a vehicle of land reallocation. Dry land productivities are also very high in the Sugar region but negative in the rice regions. Thus, in the Sugar region dry land is an agricultural asset of equal value as paddy land, whereas in the rice regions it is held for speculative purposes because conversion to commercial use is expected in the future.

The pattern of the marginal productivities of the family factors on small full-time, small part-time and large full-time farms suggest that both land and female labour are fixed endowments, while male labour seems to respond to the local employment opportunity situation. Farm assets also seem to be used in accord with the existence of an active market, although access to capital markets may not be uniform for all farm types (but this may in part be a consequence of the composition of the farm assets).

However, the estimation results do tend to point to the fact that the production situation in Taiwan is no longer appropriately captured in simple model specifications where a large degree of aggregation is imposed (based on profit maximizing and separability assumptions between subsets of the production variables). The estimation results of the aggregated model used tends to suggest that both land and female labour are immobile (with as consequence that labour quality and work disutility differences start to influence the farm production situation), and this, combined with the existence of a large variety of crops with different requirements for these factors, tends to make the accuracy of the annual crop choice decision crucial for the optimal use of the family resources. In this context, the shapes of the estimated functions seem to suggest that not all farmers are equally successful at adjusting their production pattern to their resource endowments. Especially the farmers without endowment mixes that give them a readily identifiable compartative advantage towards a specialization in the production of certain crops seem to make the mistakes. Thus small full-time farms with their high labour-land endowment ratio and large full-time farmers with their low labour-land endowment ratio tend to correctly choose the output mix because their endowments very obviously point to the optimal crop choices: supervision-sensitive and labour-intensive crops on the small full-time farms and land-intensive and supervision-neutral crops on large full-time farms. However, the small part-time farms fall between these two with their endowment ratio and should choose a crop mix which is a combination of the two extremes. This choice requires much more versatility, knowledge and flexibility, which the shapes of the estimated value-added functions suggest as lacking. Thus attention by the agricultural extension establishment to the issue of accurate crop diversification might produce a gain for the sector. However, further investigation of this issue is necessary and would require data which was not available, but which could be available if the original data could be used.

On the all-paddy farms for the North and Mid Rice region and the dry-paddy mixed farms of the Sugar region, there is also some evidence for an added efficiency loss beyond the consequences of the endowment ratios which is specifically connected to the part-time character of the farms. This is probably linked to the existence of very detailed production methods for these land types, as research tends to concentrate on these farms. Full-time farmers can take advantage of these methods, but part-time farmers cannot as their farm time is residual. On the non-dominant farms, farming methods are more generally specified so that so that full-time farmers do not have an advantage over part-time farmers.

J. NOTES

1 This is the problem of the immobile family members who are productive as farmers but not otherwise.

2 The sample data was devided into size categories. For each size class the average net profit was calculated and then graphed against the farm size-class.

3 Two regions were sampled for two years

4 Three production functions were estimated and their parameters were not very different from each other.

5 For each farm size, the marginal value products was calculated at the geometric mean of the farm inputs of the size-class.

6 This was tested by using slope dummy variables for the size-class on the coefficients of the Cobb-Douglas function and an additive dummy variable on the intercept. The dummy variable coefficients were not significantly different from zero, so that the production function was the same for all farm size-classes.

7 Although it is difficult to ascertain from the article, Bardhan seems to have calculated the marginal value product of labour for each farmer, using the estimated labour elasticity and the farmer's average labour productivity. The difference between the farmer's wage rate and his MVP was calculated. The average difference over all farmers was significantly higher than zero. However, this calculation of Bardhan does not tell us whether the difference was also larger than zero for small farms.

8 A very good exposition of the problems of measuring efficiency of farms of various sizes in developing countries (India, Greece) is presented in Yotopoulos, Nugent (1976), ch4-6

9 see Forsund et al. (1980)

10 The technology would eventually have to turn into a decreasing return to scale technology or the optimal size of the farm would be the total cultivatable size of the country. In the Taiwan case our interest is directed to a size interval of .25 to 7 hectares, the presently

existing farm size range, which might be expanded to 10 hectares.

11 Empirical studies in other developing countries consistently find constant returns to scale to be the norm, except in wheat production, see e.g. Barry (1970), Cline (1973), Bardhan (1973).

12 Technical efficiency, strictly speaking, can only be defined for each output technology. If there is a multi-product situation, then the assumption of similar production mix must be added in the technical efficiency argument, otherwise there is a confusion between technical efficiency and allocative (mix choice) efficiency.

13 As distribution of farm technology is increasingly done via farm magazines and labeling on the packages of the fertilizer, insecticides and herbicides, functional literacy is a necessity for absorption of the new technologies.

14 Unless being a woman or old is exactly correlated with low level of education.

15 Land market regulations may drive a large transaction cost (or risk cost) wedge between land rent received and paid, or between land value received and paid in a sale, to the point where no transactions take place and land is a fixed quantity for the household.

16 The growth of income per capita is shifting the food demand out of staple crops (rice) into higher quality food (vegetables, fruits).

17 This approach was used by Allen (1982).

18 Even if regional prices were available, this would not help the estimations, because the regions are estimated separately.

19 The usual value-added approach assumes separability between the set of outputs, the set of intermediate inputs and the primary factors. On the other hand, a production function approach assumes separability between the set of outputs and the set of all the inputs, thus being less restictive, but it is better to estimate profit functions (see below). The least restrictive approach is the transformation function approach, but it would also be better to estimate profit functions (based on the assumption that for the crops and the inputs which came on the market that there was an attempt at profit

maximazing with respect to the prices, which introduces a violation of the regression estimation assumptions in the transformation function estimation or the production function estimation). But the variable profit function approach can not be used because we do not have enough price data points (also in the derived output supply functions estimations, the problem of the large number of zero observations would be a problem). As we have to impose separability, we decided to impose it between the set of all outputs + bought inputs and the family inputs, thereby leaving the relationship between the outputs and the bought inputs unrestricted.

20 The sample does not include pure animal farms, all are crop farms, with some livestock as a sideline (chickens, ducks and at most 10 pigs). Thus land is an essential factor

21 This is similar to Bardhan's method of allowing slope dummy variables in the Cobb-Douglas function. The interpretation for the variation in the marginal products is however very different in our GL model versus Bardhan's CD model.

22 This method is described in more detail in section E.3.

23 This is similar to Bardhan who also calculated the farmers' shadow prices to compare them to the wages.

24 This is similar to Bardhan's method of allowing intercept dummy variables on the constant of the Cobb-Douglas production function. Both methods were designed to test technical efficiency.

25 The hours spent on farm business by going to the market or the Farmers' Association, or doing the books, were not always reported, so that male labour is somewhat underreported.

26 This is the conversion rate usually used on all female labour input in Taiwan agricultural production information.

27 The shares of the different assets did change over the nine years:

Year	1972	1980	AVER
Livestock	31	13	21
Machines+tools	30	48	37
Trees	13	14	14
Farm inventory	26	25	28

28 We found no studies that could help us to assume reasonable depreciation-appreciation rates for the Taiwanese farm assets. Studies from developed countries do not apply. Possibly for machinery, Japanese rates might apply. But for the tropical fruit trees, the rates are as yet unknown. For livestock neither the Western studies (too hot) nor the peasant Asian systems (too commercialized) apply.

29 The meaningful opportunity cost is thus the interest rate. Since allowance should be made for depreciation-appreciation, and given the farm asset shares, net depreciation is probably positive, the interest rate will be the minimum value that the shadow price of assets should be for allocative efficiency.

30 Tax, interest cost and land rent costs were not deducted. We are thus assuming that the net profit (before taxes, land rent and interest costs are deducted) must pay for the total amount of land cultivated (regardless of ownership) and farm assets (regardless of its financing) and the other family inputs. Our definition of net return is thus not entirely the same as farm income going to the family. The latter is calculated after taxes and land rents are paid and after interest is paid on loans.

31 Usually if the diagonal elements are positive for the whole sample, they are also positive in the subsamples where the farms are grouped according to size and participation.

32 See comments to table E.9 for the non-homothetic case for an interpretation in terms of scale economies.

33 The official land rent, the average male and female (converted) wage and the official and market interest rates. See appendix A and table A.1.

34 Thus for the 'linear' model $\Pi = v\alpha$, the marginal productivity of the factor ($\partial\Pi/\partial V = \hat{\alpha}$) is reported, and the standard deviations are the square roots of the diagonal elements of $(V'V)^{-1}\sigma^2 = \text{var}(\alpha)$.

For the 'generalized Linear' model of equation (33), the marginal productivity (VMP) for each farmer is given as in equation (34), where we report the average over the H-number of households: $\Sigma \hat{VMP}^h/H$ and the standard deviation of the base coefficient (γ_0) in the dummy regressions on the $\hat{VMP}$ as in equation (35): $\hat{VMP} = \gamma_0 + \Sigma\gamma_s d_s + \Sigma\gamma_p d_p$, so the standard deviation is the square root of the element of the variance-covariance matrix $(D'D)^{-1}\sigma^2$ that is associated with γ_0. This base γ_0 is the VMP for the large full-time farm.

35 The average female wage was 199 NT$, but after conversion is 249 NT$: the female wage for the equivalent labour from women.

36 The most common form of a private market credit system is the savingspool system. The official credit system is collected under the Unified Agricultural Credit Program and the interest rates quoted in this study are for unsecured loans.

37 If we were to assume depreciation-appreciation rates as in Canada (livestock, trees: appreciation 4%, machinery: depreciation 13%, inventory: depreciation 0%) and use the sample weigths of the assets, the net depreciation rate would be 3.41%.

38 Although it is obvious that the generalized linear function does impose somewhat more regularity on the marginal productivities. This results from the requirements that all observations have to be included in the form of the generalized linear function. The linear dummy variable function does not impose as much similarity in technology on all farm groups.

39 This is the model where the generalized linear function is estimated with the restrictions : $a_{PM} = a_{DM} = a_{MF} = a_{Mh} = 0$ The test statistics for this assumption are reported in table E.3.

40 This is troubling as the male wage has been rising from 200 NT$ in 1972 to 383 NT$ in 1980, thus indicating that male shadow prices are progressively more out of line. This may be a consequence of an increasing incidence of immobility of the agricultural male labour force as the male agricultural family workers become older, without mobile young members entering the farm activity.

41 The MRb case where the shadow price of land on small farms is negative could be linear however, so that all farm groups share the same positive shadow price.

42 The SUGc estimations of the VMP dummy regressions are erratic probably because there are too few observations in each farm group cell, as the total number of observation in the sample is only 91.

43 This is the consequence of the separability assumption in section D., as separability means:

$$\frac{\partial}{\partial q}\left[\frac{\partial \Pi / \partial v_1}{\partial \Pi / \partial v_k}\right] = 0$$

where v is a family input and q is a price, either of output or bought inputs. Thus price changes do not change the shape of the value-added isoquants in the family input space.

44 Generally evidence points to mobility of male labour and farm assets, so that the main factor which changes the land productivity is the female labour amounts.

45 This is very similar to international trade theory, where countries (farmers) are unable to trade their factors across their borders (farms). Instead they trade products (crops) at the prices set in the world market (agricultural product markets). The decision is to maximize the country's (farm's) value-added by finding the product (crop) mix which is optimal for the country (farm), namely where the productivities of the immobile production factors are equalized across industries (crops). In the country case this means trading of these factors of production between the industries inside the country and thus intra-country market prices for the factors because separate agents decide the production output of each industry. However in the case of the farmer, since he is the same agent who produces the several crops, there is no need for an intra-farm factor market. The necessity of equalizing the value marginal products of the factors across the products is however still there on the farm for the optimization of the value-added (Hechsher-Ohlin and Stolper-Samuelson theorems). Note too that, where in the international trade situation it is dubious that the assumptions of these theorems are fulfilled, they are almost automatically fulfilled in the farmer case.

CHAPTER VI

CONCLUSION

The question that this study has attempted to answer is: 'Is there empirical justification for the claims made by the policy makers in Taiwan that the present stagnation in agriculture is largely attributable to the smallness and the part-time operation of an increasing number of farms?' Since the late 1960s, agricultural growth has been slow, despite the adoption of a labour-saving development strategy in response to the competition for labour from the non-agricultural sectors. The continued slow growth has prompted the agricultural authorities to reconsider the 1949-53 land reform laws in their concern about the decline in the number of large full-time farms. In chapter II, we identified three factors which have contributed to the decline in farm size: the land reform laws, the inheritance custom and the increasing demand for land for non-agricultural uses. Four factors were identified as having influenced the growth of part-time farming: a labour market that works well, the extended family system, the expansion of the specialized 'custom services' market into more farm activities, and the rapid decentralized industrial growth. Part of the stagnation in the agricultural growth is thus immediately attributable to the loss of labour and land resources in agriculture. This loss of resources, however, expresses itself in Taiwan by an increase in the number of small and part-time farms. The agricultural authorities, in their wish to promote the large full-time farms with the methods proposed under the second land reform debate, have indicated that they believe that a system of large full-time farms would revive the sector's growth. These farms are assumed to be the most productive farms in the sector and this hypothesis is tested in this study.

Fortunately, we located an exceptional data set: the annual Farm Record Keeping Families survey. The data from nine recent (1972-80) surveys for four major agricultural sectors of Taiwan (the North, Mid-, South rice and Sugar regions) were used. The quality of this data is better than data from most other sources which rely on the memory of the farmers. In this survey, farmers daily recorded all the household's transactions (in kind and cash) and activities, be they for farming, for non-farming or consumption. Thus an analysis of this data could provide a reliable test of the superiority of the large full-time farms and also measure the likely consequences of some of the second land reform proposals.

A system of large full-time farms is considered to be superior to a system of small and especially of small part-time farms for many reasons. First, large full-time farms are considered to be more responsive than small farms to changes in the composition of the demand for agricultural products and the supply of new inputs. The analysis in chapter IV shows no evidence of this greater responsiveness. The output composition of small farms responded much more readily to the decline in the demand share of staples (rice and sweet potato) than the output composition of large full-time farms, except in the North Rice region where the significantly higher paddy land endowment on small farms promoted a rice production strategy on small farms. Also, mechanized production and new intermediate inputs, such as herbicides and insecticides were adopted just as readily by the small and small part-time as the large full-time farms.

Large full-time farms are also assumed to be more 'productive' than small and small part-time farms. The analysis in chapter IV indicates otherwise. The average land productivity, measured by the output and profit per hectare, is substantially higher on small full-time farms than on large full-time farms. On small part-time farms both output and profit per hectare are slightly lower than on large full-time farms. Interestingly, the difference is not a matter of cropping intensity differences as the multiple cropping index reflects only the crop maturity lengths. Instead, the productivity difference is mainly manifested through yield differences in non-rice crop production, while rice yields are similar on all farms. So the evidence on family supplied factor use indicates that small full-time farms use the land most intensively of all the farm groups, by using their substantially higher family labour to land endowment in the production of labour and supervision intensive crops such as vegetables. Large full-time farms do not respond to their relative lack of family labour by hiring more services or using more machines per hectare, and therefor production per hectare is less. Small part-time farms do respond to their relative lack of family labour by hiring more machine services per hectare than small full-time farms, but then produce similar outputs as large full-time farms.

That large full-time farms are needed because they save and then invest more than small farms is not supported by the evidence either. The investment per hectare, as well as the farm asset level per hectare and the owned machine stock per hectare, are similar for all farms. There are only two exceptions: farm investment per hectare on the small farms of the Sugar region is lower because livestock production is falling on these farms, and the owned machine stock per hectare in the North Rice region is lower on large full-time farms because they have a higher share of dry land, so that less rice related machines are needed (but more is invested in trees).

The main reason cited by Taiwanese policy makers in favour of large farms is the presence of economies of scale which are associated with the mechanization of agriculture.

The analysis of chapter V refutes this hypothesis of increasing economies of scale (except in the South Rice region); the production technology exhibits constant returns to scale. The scale economies, usually related to indivisibility associated with machines, have been avoided by the organization of the 'custom service' market so that small farms can use the mechanized methods as efficiently as large farms.

The total factor productivity analysis of chapter V provides some evidence that part-time farming leads to an inefficient use of the family factors in some cases. These cases are characterized by farms whose land quality is dominant in the region (the all-paddy farms of North Rice and Mid-Rice and the paddy-dry mixed farms of the Sugar region). This efficiency loss is probably the consequence of the development of exact farming methods by the agricultural research establishment for these farms. Full-time farmers can reap this gain from optimal timing and effort, while part-time farmers, whose farm labour time and effort is residual, cannot. However, there is no such loss on the farms with the other land qualities since production techniques are defined less exactly, and thus there is less gain from having more flexibility in the labour application.

The policy proposals which impose a minimum size on the farm are easily shown to be counterproductive, using the analysis in chapter IV and V. An amalgamation of small farms into large farms, each operated full-time by one household, would have substantial undesirable market effects. Because of the amalgamation of small full-time farms, there would be a large loss of agricultural employment (probably mostly in the category of agricultural workers who are unemployable on the market). This loss of the labour resource would create a substantial loss of production, especially of vegetable production (an increasingly desired food) and an increase in rice production (a staple). There is little hope that the large full-time farms would respond to a possible collapse of the agricultural wages by hiring more (and thus producing more), as there has been a surprising unresponsiveness of hired labour to the rapid increases of the agricultural wage rate between 1972 and 1980. Because of the amalgamation of small part-time farms, there would be less demand for machine and animal services in these 'custom service' markets. Generally, less machine and intermediate inputs would be used in agriculture. Thus policies which artificially increase the number of large full-time farms, by imposing land thresholds, would greatly reduce land productivity because of a general decline of labour (and other input) application. There would only be a slight compensating improvement in the total factor productivity of the still employed resources as there are no gains from economies of scale to be expected and only modest efficiency gains from the reduction of small part-time farming.

The investigation of the allocative efficiency in chapter V, and of the production patterns in chapter IV, revealed the great complexity of the production decision in the Taiwanese agricultural sector. The patterns of the average shadow prices do indicate that the farmers try to efficiently allocate the resources for which markets exist. Both the investigations of the average shadow prices in each farm land type and between farm groups point to the relative mobility of male labour. Thus average male labour shadow prices are high where industrial employment opportunities exist and the shadow prices do not differ significantly between farm groups. Also average farm asset shadow prices indicate that the dominant land type farm may have more access to the official financial markets, probably as part of the general attention that these farmers receive from the authorities. However, there is also some suggestion that both land and female are immobile. This would then mean that accurate crop mix decisions become important for the efficiency of the allocation of land over the households. Generally, it is not entirely clear that taking the restrictions off the land market will induce more land transactions. The low dry land shadow prices in the rice regions indicate that dry land is held for speculative purposes. Also the official land rent is much lower than the land shadow price except the North Rice region, which is why there is no official tenancy. But shadow prices are similar on large full-time and small part-time farms in six cases, and similar on small full-time and small part-time farms in the other cases. This means that a relaxation of the land market restrictions may not induce land transfers from small part-time farmers to full-time farmers, despite the evidence of some overall (technical) efficiency loss on part-time farms of the dominant land type. However, the land shadow prices were significantly lower on small full-time than on large full-time farms. These land shadow price patters were intimately linked to the differences in female family labour per land endowments and to the estimated relationships between land and female labour. Female family labour seems to require the farm employment (whether because it is unemployable off-farm, or because the disutility of off-farm work is far above the disutility of self-employment) and contains self-supervision which is important for some of the crops. Thus when a small full-time farmer considers renting or selling his land, the asking-price will be higher than the land shadow price because both the land and the female employment returns must be covered. As there are no economies of scale, it is doubtful that large full-time farms can produce a higher land return than this asking-price. Thus no trade will result between small full-time and large full-time farms. These may be part of the reasons why the new rental arrangements such as 'contract farming' seem to have such a disappointing rate of adoption.

To conclude, Taiwanese agriculture has benefitted substantially from the undistorted functioning of the markets for labour and other inputs. The empirical evidence suggests that there should be no departure from the policies which facilitate the market processes. Thus policies which reduce the restrictions on the land market are recommended. The promotion of the new rental arrangements (with assurance that those who rent will not be forced to sell) and the relaxation of the mortgage market restrictions should continue. Policies which would impose different restrictions on the land market, such as a lower limit on farm operation or land holding and an enforced amalgamation, are counterproductive. There is no reason why small full-time farms should disappear as no economies of scale exist. Indeed their average land productivity is much higher than on large full-time farms and they disproportionally produce the non-staple crops which the population more and more demands. The relaxation of the constraints on the transfer of farm land between farmers should provide the economic environment in which the decision is left to the full-time farmers to induce the part-time farmers to let go of the land when the gap between the returns to the two forms of farming widens and when rural part-time farmers become more certain of continued non-agricultural employment. This process could possibly also be facilitated if the mortgage market would be organized via the Farmers Association credit departments, which could provide long term financial assets for rural investors (those selling their land). There is an additional reason for promoting the growth of a more modern land market organization (and a long term rural credit market). This study established that the organization of farming is not to blame for the recent slower agricultural growth. The main reason is the steady decline of both land and labour resources in agriculture due to the demand increase in the non-agricultural sectors. This is a process which will continue to express itself in an increase of the number of small and part-time farms in the immediate future and a loss of young agricultural workers. However, starting in five - ten years, the resource loss may become acute when the present generation of older immobile full-time farming workers starts to disappear too. The adjustment of agriculture and its farm organization to this situation will be much facilitated if a well established and functioning modern land and rural long term credit market exists by that time. If the initiative towards a new land market organization is taken now, there is time to experiment and to find the structures which work best in Taiwan.

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APPENDIX A

PRICES AND LAND PRODUCTIVITY MEASURES

A. INTRODUCTION

In this appendix a more detailed explanation of some of the variables which were used in this study is provided. In section B, the prices as used in this study are explained, and in section C, the simple productivity measures which were discussed in chapter IV are defined in detail.

B. PRICES, PRICE DEFLATORS

We use several price deflators in this study. Some of the deflators are taken from the national price information and some have been constructed.

B.1 Individual commodity group prices

The national price index information did not fully correspond with the categories of the household daily report data, so that we constructed indices for several commodity groups. If the national price data did correspond to our sample category then we used the national price index.

The price indices were calculated from national commodity price information and the shares of the commodities in the national agricultural production of the subgroup, using the Fisher Ideal price index. We had to calculate a price index for:

- cereals: sorghum, corn, Kaohliang, wheat
- special crops: tea, peanut, sesame, cassava
- fruit: all fruits except the citrus fruits (26 types)
- orange: all citrus fruits (5 types)
- vegetables: all vegetables (38 types)
- beans: all bean types (5 types)
- poultry: chicken, duck, turkey and other.

We used these calculated price deflators and the national price indices to construct a net profit index (used in chapters four and five) so that we could calculate real profit and also quantity indices for the above commodity groups (used in chapter four).

B.2 The index of Net Profit (Value added to the family supplied factors)

We constructed an index for the net profit, or net returns to the family supplied factors of production (see chapter five).

The index is a Fisher Ideal Index and is based on the profit shares of outputs and variable inputs calculated from the total sample (2274 observations: around 250 observations per year), and the prices of these commodity groups.

This index is used in chapters four and five, to deflate the net profit (or value added) the variable costs and the output value and is reported in table A.1.

B.3 The index of Farm Asset Prices

We constructed an index for the farm asset stock. The index is a Fisher Ideal index, based on sample shares of the farm assets in the total farm asset stock value, and using national price indices. The farms assets are: livestock, tools, machines, trees, stored produce and farm supplies. We used the fruit price index as a reasonable approximation for the value changes, through the years, of trees; for each of the other assets there was a national price index. The calculated farm asset price is reported in table A.1.

B.4 Miscaleneous prices

The interest rates were calculated as a weighted average of the official agricultural interest rates [JCRR, annual reported interest rates for agricultural loans (weight 75%)] and market (private) interest rates [DGBAS, prices received and paid (weight 25%)]. The calculated interest rate is reported in table A.1.

The price which gave us the most problems was the land rental price because of the virtual non-existence of a land rental market (see chapter two). Because of this we had to construct a vector of possible official rental prices. There is an official rental price quoted since 1976, and we also found one observation for the land rent in 1969 (JCRR 1970). We assumed for 1969 to 1972 that the same 1969-amount of rice per hectare (59.2 kg/ha) was paid for rent, while for the period 1973 to 1976, that the rent was the 1976 amount of 47.36 kg/ha. (The government changed its agricultural policies in 1973, when the sector experienced stress). The official rice prices were then used to calculate the rental value. The resultant official land rental prices are reported in table A.1.

The labour wages were available in the national statistics (DGBAS, prices paid and received by farmers). The wages as paid to the hired labour in the sample could be calculated from the labour cost reported and the amounts of hired labour. These wages in the sample corresponded closely to the male agricultural wage rate. This suggest that labour in the sample was indeed hired at the agricultural wage rates. The agricultural wage rate is reported in table A.1.

The machine service cost and the animal service cost were not available before 1976. After 1976 they could be found in DGBAS, Prices paid and recieved by farmers. Thus

Table A.1: SELECTED PRICES USED IN THIS STUDY

year	LAND RENT per HA (1)	MALE WAGE per DAY (2)	FEM WAGE per DAY (3)	CAP COST per $ (4)	MACH SERV per HA (5)	ANIM SERV per DAY (6)	PROFIT INDEX (7)	ASSET INDEX (8)
	NT$	NT$	NT$	%	NT$	NT$		
1972	8466	78	54	15	1150	88	39	48
1973	10332	101	73	16	1510	107	51	48
1974	13712	171	119	20	1870	175	70	71
1975	15332	195	139	19	2230	198	84	89
1976	16098	213	155	17	2590	197	76	78
1977	13050	213	155	16	2627	207	71	80
1978	10370	256	178	15	3293	202	78	87
1979	10370	298	217	16	3527	274	89	89
1979	10370	383	280	18	4593	346	100	100

Notes: (1) constructed annual land rent per ha
(2) source: DGBAS, prices paid and received
(3) source: " " " " " by farmers
(4) constructed interest cost per NT$
(5) constructed machine service cost per ha
(6) constructed animal service cost per day
(7) constructed profit index
(8) constructed farm asset index

the earlier service prices were calculated from prices reported in JCRR (annual reports) in some of the articles on cost situations of the farmers (thus on the bases of surveys), but not all years were available. Where a year was lacking, an average was calculated between the available observations. The resultant machine and animal service prices are reported in table A.1. The machine service cost per ha refers to the cost of one service (such as transplanting, or harvesting) delivered on one hectare land.

C. LAND PRODUCTIVITY MEASURES

C.1 The multiple crop index

The multiple crop index is the amount of land cropped (gross) per cultivatable hectare and approximates the intensity of land use if all available crops have the same length of maturity (so that periods of land fallow will be the only source of multiple crop index variation). This assumption is progressively becoming less applicable for Taiwan where the farmers have an increasing range of crop choices with varying length of land occupation (fruits, sugar: full year; rice 1 : one season; rice 2: one season; sweet potato: two seasons; etc.).

The definition of the multicrop index is:

$$MC = (\Sigma S4_i)/S$$

$S4_i$ land put into crop i
S cultivatable area

There is no correction for the quality of the land in this measure of the cultivatable land (Sen definition), nor in the measure of the cropped land S4, which is the sum of lands used for each crop (Rudra definition). Thus double-triple usage of a physical piece of land is possible and counted by the multiple crop index.

C.2 Rice yields

The rice yield is the harvest of rice per hectare put to rice, and measures the technical ability of the farm to produce rice. Two rice seasons exist in Taiwan, with the January-May season usually producing higher yields than the June-October season.

The rice yields are defined as:

$$RYt = H(Rt)/S4(Rt)$$

H(Rt) : rice harvest in period t
S4(Rt): rice land in period t
RYt : rice yield in period t
t = 1,2

Only farmers who produce rice were counted.

C.3 Non-rice crop value yield

The non-rice crop value yield is the total income from all non-rice crops per cropped hectare[1]. The land is counted twice or more if it produced two or more non-rice harvests during the year. The non-rice yields are defined as:

$$OVY = \Sigma p_i y_i / \Sigma S4_i$$

p_i : price of crop i
y_i : harvest of crop i
$S4_i$: land put to crop i
OVY: other value yield

The total non-rice crop value was not deflated so that the time trend includes the price trend. The land measures were not corrected for fertility because part of the efficient use of land should be the appropriate crop choices for the land qualities.

C.4 The output per hectare

The output per hectare is the sum of all the farming incomes per equivalent hectare available to the farmer. This is the most often quoted measure of land productivity. The output value was deflated by the profit price deflator to make it comparable to the profit per hectare measure (so that output per hectare minus profit per hectare gives the variable cost per hectare in this reporting). This output value has been discussed in detail in the previous chapter, but the main results are repeated here.

C.5 Profit per hectare

The profit per hectare is the value of output minus variable costs (including hired forms of labour) per equivalent hectares and deflated with the profit deflator. This measure takes account of variable costs as well as outputs and also shows the net return to the farmer from all the self-supplied input factors.

C.6 Farm investment and savings per hectare

Bardhan (1973) argued that the advantage of having large farms might be their higher levels of investment and savings effort. The farm investment effort in all farm assets per hectare of equivalent land is calculated from the balance sheets and the savings effort per hectare is also given. These values were deflated with the index of consumer prices paid by the farmers' as the best approximation to a common deflator that would be appropriate for both the investment and the savings amounts. The investment and the savings per hectare are:

$$INV/ha = [\Sigma p_i(t)v_i(t) - \Sigma p_i(t-1)v_i(t-1)]/S(t)$$

$$SAV/ha = [FI(t) + NFI(t) - C(t)]/S(t)$$

p(t) v(t): value of a farm asset at end of year t
FI : farm income
NFI: non farm income
C : consumption
S(t): equivalent cultivatable land area

The difference between investment and saving is the amount of savings that is spent on consumer assets and is thus an indication of the relative willingness to invest in the farm activity by the household.

APPENDIX B

INFORMATION FOR CHAPTER II

- Growth rates of production in specific agricultural crops (table B.1)
- Agricultural exports (table B.2)
- Labour market situation (table B.3)
- Farm machine stock (table B.4)
- Farm machine stock by size (table B.5)
- Patterns of emigration-immigration into agriculture (table B.6) and comments

Table B.1: GROWTH RATES OF PRODUCTION IN SPECIFIC AGRICULTURAL CROPS

		1960		1968		1972		1976		1980		
		Amount	Index	Amount	Index	Amount	Index	Amount	Index	Amount	Index	
Rice (brown)	Q	1912018	81	2518014	107	2440329	104	2712985	115	2351824	100	MT
	HA	766409	120	789906	124	741570	116	786343	123	639151	100	ha
	P					5.95	33	12.96	72	18.07	100	NT$
Sweet Potatoe	Q	2978676	282	3444619	326	2927708	277	1850992	175	1055134	100	MT
	HA	235387	378	240316	386	210609	338	123735	199	62255	100	ha
	P					.973	38	1.790	70	2.570	100	NT$
Sugar Cane	Q	792132	94	886127	102	732939	87	814493	96	845825	100	MT
	HA	95543	90	95902	91	90329	86	109411	103	107200	100	ha
	P					.317	40	.664	84	.795	100	NT$
Bananas	Q	104216	49	645467	301	366411	171	213446	100	214323	100	MT
	HA	12709	137	43806	473	22830	246	11152	120	9268	100	ha
	P					2.390	38	4.320	68	6.370	100	NT$
Pineapple	Q	166730	73	311364	136	334384	146	278830	122	228804	100	MT
	HA	9746	133	11842	161	13128	179	9706	132	7352	100	ha
	P					1.327	28	2.749	58	4.740	100	NT$
Citrus	Q	52866	14	175578	47	290609	78	383972	103	374383	100	MT
	HA	8099	25	19138	59	26010	80	33682	103	32696	100	ha
	P					3.592	40	5.123	57	9.066	100	NT$
Vegetables	Q	802801	25	1209293	37	1703663	52	2446282	75	3260921	100	MT
	HA	91601	39	118462	51	148557	64	191966	82	233941	100	ha
	P					21.85	69	18.92	59	31.81	100	NT$
All Fruits*	Q					1261628	78	1373523	85	1615558	100	MT
	HA					109584	84	122728	95	129869	100	ha
	P					3.039	34	5.320	59	9.031	100	NT$

Source: PDAF Agricultural Yearbooks
Note: Q : quantity (metric ton: MT)
HA: land area (hectare)
P : price per kg (average over all prefectures)
* : included bananas and pinapples

Table B.2: AGRICULTURAL EXPORTS: AGRICULTURAL PRODUCTS

	Total Value X 1000NT$	% in Exports	Fresh Fruit Value X 1000NT$	Price per kg	%	Banana Value X 1000NT$	Price per kg	%	Vegetables Value X 1000NT$	Price per kg	%
1972	5683686	4.87	588984	5.20	.51	1210874	5.26	1.04	363748	4.54	.31
1974	6448910	3.08	461674	9.23	.22	744667	5.18	.36	406089	6.85	.19
1976	12981394	4.19	447062	9.30	.15	721496	8.43	.23	902360	8.72	.29
1978	15777698	3.37	527622	12.49	.11	647834	7.99	.14	1457462	10.85	.31
1979	15658211	2.70	499372	11.35	.09	892377	8.72	.15	1139137	9.19	.20

AGRICULTURAL EXPORTS: FOODS (continued)

	Total Value X 1000NT$	% in Exports	Canned Pineapple Value X 1000NT$	Price* per kg	%	Canned Mushroom Value X 1000NT$	Price* per kg	%	Canned Asparagus Value X 1000NT$	Price* per kg	%
1972	12491731	10.71	694370	8.84	.60	2219869	35.09	1.90	1658221	23.64	1.42
1974	24120072	11.50	784826	17.13	.37	1709910	35.02	.82	3226883	46.56	1.54
1976	25498486	8.23	537566	19.37	.17	2205416	43.04	.71	3788703	47.97	1.22
1978	35257743	7.53	352060	23.08	.08	3992581	53.62	.85	4206367	50.25	.90
1979	39226568	6.77	608051	21.32	.10	3277943	48.81	.57	3966407	57.33	.68

	Rice Value X 1000NT$	Price* per kg	%	Sugar Value X 1000NT$	Price* per kg	%
1972	74535	4.61	.07	3339144	6.85	2.86
1974	49860	9.71	.02	11387824	20.66	5.43
1976	490	14.41	0	5931413	11.51	1.92
1978	1961969	8.25	.42	2565930	7.26	.55
1979	3113020	7.61	.54	2969648	7.72	.51

Source: Taiwan Economics Statistics (Industry of Free China, Vol LIII, n 5) 1980
Note: %: percent in the total export of Taiwan (agricultural + industrial)
*: calculated as (value/weight)

Table B.3: LABOUR MARKET SITUATION

	Population Employable X 1000 (1)	Total Employed X 1000 (2)	% Total Employed (3)	% Employed Agriculture (4)	% Employed Agriculture Male (5)	% Employed Agriculture Female (6)	Males Employed Agriculture X 1000 (7)	Females Employed Agriculture X 1000 (8)
1960	5687	3344	63	56	51	74	1341	537
1968	7333	4337	64	49	45	62	1466	677
1972	8699	5812	72	40	36	50	1464	846
1976	9828	6837	76	35	32	40	1503	862
1980	10981	7797	79	29	28	29	1447	757

	Manufacture				Agriculture					
	Monthly Income (9)	Monthly Workdays (10)	Average Wage (11)	Wage Farm/Man (12)	Monthly Income (13)	Monthly Workdays (14)	Average Wage (15)	Constant GDP X 10^6 (16)	Agriculture % GDP (17)	Constant Agri. GDP X 10^6 (18)
1960	621	30.6	20.3	1.73	540	15.4	35.03	161021	29	46696
1968	1232	31.0	39.7	1.28	829	16.3	50.99	333119	19	63293
1972	1990	28.4	70.1	1.11	1276	16.3	78.13	515724	12	61887
1976	4707	27.9	144.5	1.34	2942	15.2	193.98	701117	11	77123
1980	9198	27.6	333.0	1.15	6515	17.0	383.24	1004613	8	80369

DGBAS Statistical Yearbook
(1) population over 15 years old and not enrolled in schools (household registration data)
(2) gainfully employed population (labour survey data)
(3) employment rate when old people are deducted (men +65, women +60) too (")
(4) employment in agriculture as percentage of employed (calculated)
(5) employment in agriculture as percentage of employed: males (")
(6) employment in agriculture as percentage of employed: females (")
(7) males employed in agriculture (")
(8) females employed in agriculture (")
(9) manufacture: monthly income (")
(10) manufacture: workdays (monthly hours divided by 8) (")
(11) manufacture: average daily wage: (9)/(10) (")
(12) wage of farming over manufacturing wage (")
(13) farming: monthly income: (14) X (13) (")
(14) farming: monthly workdays (total annual workdays in farming divided by 12 times the number of workers) (Chen, Wang, 1980)
(15) farming: wage (DGBAS, Commodity Price Statistics, prices paid by farmers)
(16) gross domestic product in constant value (GDP) (1976 price = 100) (DGBAS, Statistical yearbook)
(17) agricultural domestic product as percentage of GDP (")
(18) gross agricultural domestic product in constant value (GDP) (")

Table B.4: FARM MACHINE STOCK (units)

	Number of Households	Power Tiller	Power Sprayer	Water Pump	Rice Transplanter	Rice Combine	Rice Dryer	Pedal Thresher	Power Thresher
1960	785592	3239	317	8378	—	—	—	177338	—
1968	877114	12517	12901	49310	—	—	—	201706	na
1972	879526	24400	25309	65755	658	154	361	196637	na
1976	870787	46084	37489	123645	6538	2487	8413	128232	30470
1980	872267	65745	50656	141242	32581	13745	29109	na	35103
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)

(1) number of households involved in agriculture (PDAF Agricultural Yearbooks)
(2)-(9) PDAF Agricultural Yearbooks, Peng (1980)

Table B.5: FARM MACHINE STOCK BY SIZE (per 100 Households)

Size	Tiller	Combine	Transplanter	Dryer
-1 ha	6.27	.39	.36	1.61
1-2 ha	20.79	2.56	4.57	5.45
2+ ha	24.05	4.50	9.60	7.91

Source: Agricultural Census, 1980

<u>Comments to Table B.6</u> The examination of the labour flows to and from agriculture by age, shows that only the agegroups from 20 to 44 respond to the relative productivity levels in agriculture and industry. The migration patterns of the age groups show that structural processes can be associated with each age group, but only the age groups from 20 to 44 respond to relative economic conditions in the non-agricultural sector. a) The number of young entrants (those between 15 and 19 years old) into the agriculture has declined steadily. This is partially the result of the increasing enrollment in senior level schooling. More schooling replaces the waiting period for employment which used to be spend working on the home farm. b) Five years after entrance many have found non-agricultural employment. c) Another five years later some males have returned to agriculture, while females have continued to leave. Some males, after experience with the non-agricultural sector, decide that agriculture is their choice. The females are starting families and thus leave the work force. d) Another five years later there is further seapage away from agriculture to non-agriculture which continues for the age groups until 44. Processes b, c, d are influenced by the relative attractiveness of the agricultural sector. The period leading to 1977 saw a slow non-agricultural sector growth because of the oil crisis while on the other hand mechanization was rapidly spreading in the agriculture and made it more productive. The result was less outflow in process b, more inflow in c, and the reversal of the outflow in process d compared to the flow between the five years leading to 1972 and the years leading to 1982. e) Before the mechanization expansion between 1972 and 1977, the people between 40 and 44 years old continued to work in agriculture during the next five years of their life (similarly for the 45-9 age group). d) Loss of labour force because of retirement started for people of 50-4 as five years later fewer workers are left in the 55-9 bracket (similar for the older age groups) In the mechanization expansion period however, a lot of people left the agricultural sector of those over 40 years old. This can not be attributed to a flow to the non-agricultural sector since that sector was depressed. This means that mechanization seems to have led to early retirement for a lot of farmers.

Table B.6: PATTERNS OF EMIGRATION-IMMIGRATION INTO AGRICULTURE (1000 persons)

numbers of employed in the age bracket

Year	Sex	15-9	20-4	25-9	30-4	35-9	40-4	45-9	50-4	55-9	60-4	65+	Employed
		Age											
1967	M	161	85	164	171	162	120	105	91	59	32	15	1168
	F	140	72	64	69	67	55	45	24	12	4	2	554
1972	M	122	74	102	135	148	154	121	106	76	28	8	1076
	F	108	72	46	60	79	79	57	35	18	2	1	556
1977	M	95	85	107	102	142	164	138	102	90	56	10	1091
	F	51	50	38	51	70	82	62	43	24	7	0	478
1982	M	40	59	103	87	81	114	119	125	103	81	25	936
	F	18	24	33	43	44	59	70	61	43	19	2	416

flow between five years

Period	Sex	15-9	20-4	25-9	30-4	35-9	40-4	45-9	50-4	55-9	60-4	65+		Emigration	Employed Begin		End	Employment Change
		Age																
1967-72	M	122	-87	17	-29	-23	-8	1	1	-15	-31	-24	-15	-213	1168	—>	1076	-92
	F	108	-68	-26	-4	10	12	2	-10	-6	-10	-3	-2	-105	554	—>	556	2
1972-77	M	95	-37	33	0	7	16	-16	-19	-16	-20	-18	-8	-78	1076	—>	1091	15
	F	51	-58	-34	5	10	3	-17	-14	-11	-11	-2	-1	-130	556	—>	478	-78
1977-82	M	40	-36	18	-20	-21	-28	-45	-13	1	-9	-31	-10	-194	1091	—>	936	-155
	F	18	-27	-17	5	-7	-11	-12	-1	0	-5	-5	0	-90	478	—>	416	-62

based on DGBAS labour survey data: Numbers of workers employed in agriculture by age and sex (various issues of the statistical yearbook)

A cohort can be traced from 1976 to 1982:

1967: 161 newly employed 15-9 years old (161 male entrants into the sector)
1972: 74 still employed but now 20-5 years old (87 left the sector between 1967 and 1972)
1977: 107 again employed but now 25-9 years old (33 returned to the sector between 1972 and 1977)
1982: 87 still employed but now 30-4 years old (20 left the sector between 1977 and 1982)

APPENDIX C

INFORMATION FOR CHAPTER III

a. List of variables in the Daily Record Keeping Family Survey

Source: Provincial department of agriculture and forestry, Farm record keeping report (annually), on tape

flow data

farm expenses:
- Seed
- Fertilizer
- Requisite (until 1977 included herbicides)
- Herbicide
- Insecticide
- Rental cost (until 1977 included machine cost)
- other direct costs
- Building
- Tool
- Water charge
- Other indirect costs
- Livestock
- Feed
- Hired human
- Hired animal
- Hired machine
- Other
- Interest cost (farm asset cost)
- Land rental (land cost)
- Taxes (land associated cost)

farm receipts:
- Rice
- Sweet Potatoe
- Sugar
- Vegetables
- Beans

Special crops
Mushroom
Orange, citrus
Other fruit
Pigs
Poultry
Other livestock
Processed food
Forestry products
Fishery products
Other

off-farm expenses: attached to off-farm activities
extra ordinary losses (theft, disaster)

off-farm receipts: property
temporary services
full-time off-farm labour income
other

consumption expenses: 17 categories

<u>Stock data</u>

balance sheet at the beginning and at the end of the year
Assets: current:
Cash
Financial assets
Produce
Livestock
Growing stock
Processed stock
Other
fixed:
Land (owned)
Buildings
Trees
Machines
Liabilities: short:
Short loans
Accounts payable
Accounts prereceived
long:
Long loans

<u>other</u>

area: cultivatable: paddy, dry, other
cropped: First rice, second rice, other
annual crops, perpetual crops

manpower: family members: male, female, old, young

labour day input to the farm activity:
family male, female,
hired labour days

rice yields: first and second

<u>crop districts</u>

8 regions: North, Mid and South Rice, Sugar (used in sample), Tea, South-West Mixed, Banana-Pinapple, East Taiwan

b. <u>Sectorial data</u>

Sources:

PDAF, agricultural yearbooks

P Foodbureau, Food production in Taiwan (annual)
rice review magazine (quarterly)
Taiwan economic abstract (annual)

DGBAS, prices and price indices
(collected monthly through the Farmers' Associations and local markets in 55 towns)
statistical yearbook of Taiwan
(labour survey data based on quarterly surveys January, April, July, October)

JCRR (CAPD), annual reports

CAFC, the report of agricultural census of Taiwan-Fukien district of the Republic of China (1960, 1970, 1975, 1980)
land allocation data etc.

Table C.1: DISTRIBUTION OF SAMPLE OBSERVATIONS

		Number of Observations					% Observations				
		FT	PT2	PT1	LP	Total	FT	PT2	PT1	LP	Total
NR											
	S	74	42	77	80	273	13	8	14	14	49
	M	80	58	38	28	204	14	10	7	5	37
	L	40	17	17	6	80	7	3	3	1	14
		194	117	132	114	557	35	21	24	20	
MR											
	S	68	65	122	127	382	11	10	20	20	61
	M	68	51	57	18	194	11	8	9	3	31
	L	14	18	9	7	48	2	3	1	1	8
		150	134	188	152	624	24	21	30	24	
SR											
	S	32	47	66	119	264	6	9	13	23	50
	M	77	53	62	6	198	15	10	12	1	38
	L	47	13	4	1	65	9	2	1	0	12
		156	113	132	126	527	30	21	25	24	
SUG											
	S	48	24	81	94	247	8	4	14	17	44
	M	68	26	61	29	184	12	5	11	5	33
	L	80	38	13	4	135	14	7	2	1	24
		196	88	155	127	566	35	16	27	22	

	Number of Observations in Each Year									
	1972	73	74	75	76	77	78	79	80	Total
NR	60	62	64	63	63	62	62	60	61	557
MR	72	78	69	68	66	70	71	59	71	624
SR	42	45	64	64	62	64	64	61	61	527
SUG	62	64	63	64	64	63	60	62	64	566

Note: Participation and size are defined as:

%PT = FL / NFL + FL

EP = P + .87D + .18O

%PT: participation rate
FL: farm labour
NFL: non farm labour
FT: full-time farm
LP: low participant farm

EP: equivalent paddy land
P : paddy land
D : dry land
O : other land

APPENDIX D

INFORMATION FOR CHAPTER IV

-Introduction to the dummy variable regression tables

-NR : Labour use per hectare (Table D.1)

-MR : Labour use per hectare (Table D.2)

-SR : Labour use per hectare (Table D.3)

-SUG: Labour use per hectare (Table D.4)

-NR : Selected output amounts per hectare (Table D.5)

-MR : Selected output amounts per hectare (Table D.6)

-SR : Selected output amounts per hectare (Table D.7)

-SUG: Selected output amounts per hectare (Table D.8)

-NR : Selected intermediate inputs per hectare (Table D.9)

-MR : Selected intermediate inputs per hectare (Table D.10)

-SR : Selected intermediate inputs per hectare (Table D.11)

-SUG: Selected intermediate inputs per hectare (Table D.12)

-NR : simple productivity measures (Table D.13)

-MR : simple productivity measures (Table D.14)

-SR : simple productivity measures (Table D.15)

-SUG: simple productivity measures (Table D.16)

INTRODUCTION TO THE REGRESSION TABLES

We applied the dummy variable model on each of the production variables for each region and these multi-characteristic regressions are reported in the following tables. Reported are the dummy variable coefficients and their standard deviations. Also reported for each characteristic are the F-statistic for the null-hypothesis that all the coefficients associated with the characteristic were zero (underneath the F-statistic value is the associated significance level, if this value is more than .05 or .10 then the null-hypothesis can be rejected). The reported R^2 is the corrected R^2 for the degrees of freedom in the regression.

The multi-characteristics tables are not simple to read, but the same structure will be used throughout this study. Each dummy variable regression reported is of the form:

$$a = a_0 + \sum_{s=1}^{2} a_s d_s + \sum_{p=1}^{3} a_p d_p + \sum_{t=1}^{8} a_t d_t + \sum_{s=1}^{2} a_{sb} d_s d_b + \epsilon$$

s: size
p: participation
t: year
b: 1972-76 period

These are the guidelines for each dummy variable regression reported:

- a_0 : the base is the large, full-time farm in 1980. (L,FT,1980). This coefficient is always significant except when negative.

- if $a_s < 0$: positive effect of farm size (larger farms show a higher variable value)

- if $a_p < 0$: positive effect from participation (full-time farms show a higher variable value)

- if a_{sb} and a_s of the same sign then the value levels of the large and smaller farms grew closer together through time.

- if $a_{72} > a_{73} > a_{74} \ldots > 0$: there has been a negative trend in the development for the large farms.

- if a_{sb} and a_t of the same sign then both farms sizes show the same trend

- a_s = ΔS : small farm (up to 1 ha)
  ΔM : medium farm (between 1 and 2 ha)

  a_p = ΔPT2 : participation level 2 (between 50% and 75%)
  ΔPT1 : participation level 1 (between 25% and 50%)
  ΔLP : low participation level (less than 25%)

  a_{sb} = ΔSB : small farm until 1976
  ΔMB : medium farm until 1976

  a_t = Δ1972 : year 1972, etc.

- F-s : F-test for H_0 : ΔS = ΔM = 0
  F-p : F-test for H_0 : ΔPT2 = ΔPT1 = ΔLP = 0
  F-b : F-test for H_0 : ΔSB = ΔMB = 0
  F-t : F-test for H_0 : Δ1972 = ... = Δ1979 = 0
  F : F-test for H_0 : all coefficients zero
  * : t-test for H_0 : the coefficient is zero at .05 sign.
  ** : t-test for H_0 : " at .10 significance level.
  beneath each F-statistic is the significance level in brackets.

- NR : North Rice region
  MR : Mid Rice region
  SR : South Rice region
  SUG: Sugar region

An example based on the table D.1. for the total labour input shows how the table should be read, we consider the NR region:

-a small full-time farmer in 1972 had the following amount:

$$L,1980,FT + \Delta S + \Delta 1972 + \Delta SB = 258 + 447 + 92 + 19 = 816$$

-a small, low participant farmer in 1972:

$$L,1980,FT + \Delta S + \Delta 1972 + \Delta SB + \Delta LP = 258 + 447 + 92 + 19 - 402 = 414$$

-a large full-time farm in 1972:

$$L,1980,FT + \Delta 1972 = 258 + 92 = 350$$

-a small full-time farmer in 1979:

$$L,1980,FT + \Delta S + \Delta 1979 = 258 + 447 + 48 = 732$$

-a small low participant farmer in 1979:

$$L,1980,FT + \Delta S + \Delta 1979 + \Delta LP = 258 + 447 + 48 - 402 = 351$$

-a large full-time farmer in 1980:

$$L,1980,FT + \Delta 1979 = 258 + 48 = 306$$

The other farm group multiple crop indices can be constructed similarly. This dummy variable approach and its presentations are consistently used throughout this study.

Table D.1: NORTH RICE: LABOUR USE per HECTARE: DUMMY VARIABLE REGRESSION

	size and break coefficients				base	participation coefficients			hypothesis tests				
	ΔS	ΔSB	ΔM	ΔMB	L,1980,FT	ΔPT2	ΔPT1	ΔLP	F-s	F-p	F-b	F-t	F
T LABOUR	447*	19	121	-15	258	-90	-248*	-402*	20.02	20.75	.09	.23	9.09
R^2=.18	(94)	(116)	(95)	(120)	(98)	(51)	(50)	(54)	(0)	(0)	(.91)	(.99)	(0)
MALE FAM LAB	304*	-13	79	-10	160	-47	-163*	-256*	22.31	20.66	.01	.21	8.81
R^2=.17	(61)	(75)	(62)	(79)	(64)	(33)	(32)	(35)	(0)	(0)	(.99)	(.99)	(0)
FEM FAMILY LAB	94*	17	27	11	48	5	-36*	-83*	16.47	18.63	.22	.72	8.74
R^2=.17	(21)	(26)	(22)	(27)	(22)	(12)	(11)	(12)	(0)	(0)	(.80)	(.67)	(0)
HIRED LABOUR	49	15	15	-17	50	-48*	-44*	-63*	1.27	3.39	.43	.09	1.47
R^2=.01	(40)	(49)	(41)	(51)	(42)	(22)	(21)	(23)	(.28)	(.02)	(.65)	(.99)	(.11)
ANIMAL LAB	1.43	2.21	.41	.05	.11	.07	-.12	-.92	1.12	.69	2.40	1.33	2.97
R^2=.05	(1.25)	(1.54)	(1.27)	(1.59)	(1.30)	(.68)	(.67)	(.72)	(.32)	(.56)	(.09)	(.22)	(0)
MACHINE HIRED	.97*	-.55**	.40	-.21	1.02	.11	.51*	.66*	9.19	7.88	1.89	4.81	13.69
R^2=.26	(.27)	(.34)	(.28)	(.35)	(.28)	(.15)	(.14)	(.16)	(0)	(0)	(.15)	(0)	(0)
MACHINE OWNED	31986*	-20643	20021	-13712	28802	7657	20535*	1679	2.99	3.10	.78	.37	2.33
R^2=.03	(13635)	(16863)	(13864)	(17389)	(14263)	(7429)	(7197)	(7886)	(.05)	(.03)	(.46)	(.94)	(0)
T FARM ASSETS	18643	-4507	14769	-15928	104515	3414	12957	-10990	.41	1.30	.29	.38	.94
R^2=0	(20504)	(25359)	(20848)	(26149)	(21448)	(11173)	(10823)	(11859)	(.66)	(.27)	(.75)	(.93)	(.51)

*: significantly (.05) different from zero (**:sign .10) (standard deviations in brackets) (the reported R^2 is the corrected R^2)

a: quantities per hectare paddy equivalent cultivatable land area

b: type of labour above:	Male (family)	Female (family)	Hired Human	Hired Animal	hired machine	owned machine	T farm asset
c: price in 1980 :	-----	-----	383.24	345.93	4592.64	1	1
d: units reported above:	man-days	man-days	man-days	day	ha serviced	stock value	stock value

e: labour: family labour + hired human labour
f: T farm assets: machine owned + trees + livestock + tools + miscaleneous farm durables (deflated with an asset deflator)

Table D.1: NORTH RICE: LABOUR USE per HECTARE: DUMMY VARIABLE REGRESSION (continued)

	annual shift coefficients							
	Δ1972	Δ1973	Δ1974	Δ1975	Δ1976	Δ1977	Δ1978	Δ1979
T LABOUR	92 (123)	15 (122)	33 (122)	9 (123)	45 (123)	12 (79)	16 (79)	48 (79)
MALE FAM LAB	25 (80)	-7 (80)	14 (79)	-11 (80)	18 (80)	-11 (51)	4 (51)	35 (51)
FEM FAMILY LAB	29 (28)	-1 (28)	-10 (28)	3 (28)	4 (28)	13 (18)	7 (18)	9 (18)
HIRED LABOUR	37 (52)	23 (52)	29 (52)	17 (52)	22 (52)	11 (33)	5 (33)	4 (34)
ANIMAL LABOUR	.48 (1.63)	2.81 (1.62)	.39 (1.62)	.17 (1.63)	.24 (1.64)	1.89 (1.04)	.86 (1.05)	.72 (1.05)
MACHINE HIRED	-1.06* (.36)	-1.15* (.35)	-1.08* (.35)	-1.08* (.35)	-.97* (.36)	-1.20* (.23)	-.50* (.23)	-.12 (.23)
MACHINE OWNED	-4676 (17867)	-7832 (17711)	-16125 (17744)	-15474 (17826)	-5896 (17895)	-10778 (11475)	-9370 (11429)	-5375 (11497)
T FARM ASSETS	-7052 (26869)	-2088 (26633)	-17407 (26683)	-25378 (26806)	-6630 (26910)	-2927 (17256)	-6316 (17187)	3567 (17289)

*: significantly (.05) different from zero (**:sign .10) (standard deviations in brackets) (the reported R^2 is the corrected R^2)

a: quantities per hectare paddy equivalent cultivatable land area

b: type of labour above:	Male (family)	Female (family)	Hired Human	Hired Animal	hired machine	owned machine	T farm asset
c: price in 1980 :	-----	-----	383.24	345.93	4592.64	1	1
d: units reported above:	man-days	man-days	man-days	day	ha serviced	stock value	stock value

e: labour: family labour + hired human labour
f: T farm assets: machine owned + trees + livestock + tools + miscaleneous farm durables (deflated with an asset deflator)

Table D.2: MID RICE: LABOUR USE per HECTARE: DUMMY VARIABLE REGRESSION

	size and break coefficients				base	participation coefficients			hypothesis tests				
	ΔS	ΔSB	ΔM	ΔMB	L,1980,FT	ΔPT2	ΔPT1	ΔLP	F-s	F-p	F-b	F-t	F
T LABOUR	267*	50	94	-4	301	-33	-194*	-297*	13.01	31.09	.56	.74	9.94
R^2=.18	(79)	(96)	(82)	(101)	(85)	(35)	(32)	(35)	(0)	(0)	(.57)	(.65)	(0)
MALE FAM LAB	129*	28	34	16	201	-29*	-122*	-204*	18.47	71.36	.29	.37	17.35
R^2=.28	(35)	(42)	(36)	(44)	(37)	(15)	(14)	(15)	(0)	(0)	(.75)	(.94)	(0)
FEM FAMILY LAB	109*	7	58**	-24	76	-1	-65*	-100*	10.69	26.94	1.23	1.29	9.26
R^2=.17	(30)	(36)	(31)	(38)	(32)	(13)	(12)	(13)	(0)	(0)	(.29)	(.25)	(0)
HIRED LABOUR	30	13	2	4	24	-3	-7	6	1.33	.29	.12	1.22	1.77
R^2=.02	(35)	(43)	(37)	(45)	(38)	(16)	(15)	(16)	(.27)	(.83)	(.89)	(.28)	(.04)
ANIMAL LAB	.54	3.09	.91	.39	-.19	.29	.86	1.92*	.18	2.59	3.69	2.48	4.54
R^2=.08	(1.65)	(2.01)	(1.72)	(2.10)	(1.78)	(.73)	(.68)	(.73)	(.83)	(.05)	(.03)	(.01)	(0)
MACHINE HIRED	.20	-.04	.06	.09	1.79	.39*	.83*	.98*	.35	14.69	.16	4.83	11.99
R^2=.21	(.37)	(.45)	(.39)	(.48)	(.40)	(.16)	(.15)	(.17)	(.70)	(0)	(.85)	(0)	(0)
MACHINE OWNED	-9104	-569	15190	-22896	65823	4103	-4702	-9036	5.74	1.59	3.00	2.62	5.89
R^2=.11	(14064)	(17177)	(14662)	(18008)	(15107)	(6240)	(5795)	(6231)	(0)	(.18)	(.05)	(.01)	(0)
T FARM ASSETS	-10109	27487	4195	-2611	143222	687	-12926	1129	.65	.93	1.83	1.46	1.63
R^2=.02	(25005)	(30539)	(26069)	(32017)	(26858)	(11093)	(10303)	(11078)	(.52)	(.43)	(.16)	(.17)	(.06)

*: significantly (.05) different from zero (**:sign .10) (standard deviations in brackets) (the reported R^2 is the corrected R^2)

a: quantities per hectare paddy equivalent cultivatable land area

b: type of labour above:	Male (family)	Female (family)	Hired Human	Hired Animal	hired machine	owned machine	T farm asset
c: price in 1980 :	-----	-----	383.24	345.93	4592.64	1	1
d: units reported above:	man-days	man-days	man-days	day	ha serviced	stock value	stock value

e: labour: family labour + hired human labour
f: T farm assets: machine owned + trees + livestock + tools + miscaleneous farm durables (deflated with an asset deflator)

Table D.2: MID RICE: LABOUR USE per HECTARE: DUMMY VARIABLE REGRESSION (continued)

	annual shift coefficients							
	Δ1972	Δ1973	Δ1974	Δ1975	Δ1976	Δ1977	Δ1978	Δ1979
T LABOUR	54 (100)	55 (101)	63 (102)	58 (101)	-12 (104)	32 (49)	68 (19)	-10 (51)
MALE FAM LAB	-13 (44)	-10 (44)	-27 (45)	-1 (45)	-31 (45)	-0 (22)	10 (22)	1 (23)
FEM FAMILY LAB	26 (38)	46 (38)	28 (39)	39 (38)	7 (39)	12 (19)	30 (19)	-11 (20)
HIRED LABOUR	41 (45)	19 (45)	63 (46)	20 (46)	12 (46)	20 (22)	28 (22)	-0 (23)
ANIMAL LAB	1.14 (2.09)	.31 (2.10)	1.39 (2.13)	3.09 (2.13)	-1.35 (2.16)	.82 (1.03)	.65 (1.03)	.75 (1.08)
MACHINE HIRED	-1.63* (.47)	-1.52* (.48)	-1.41* (.48)	1.36* (.48)	1.01* (.49)	-.98* (.23)	-.53* (23)	.07 (.24)
MACHINE OWNED	-34936** (17929)	-38388* (17984)	-38844* (18191)	-32030** (18202)	-17229 (18507)	-23876* (8771)	-13871 (8758)	2359 (9175)
T FARM ASSETS	-59652** (31875)	-48846 (31974)	-53917** (32342)	-45648 (32361)	-22904 (32904)	-25571 (15594)	-15509 (15571)	1214 (16312)

*: significantly (.05) different from zero (**:sign .10) (standard deviations in brackets) (the reported R^2 is the corrected R^2)

a: quantities per hectare paddy equivalent cultivatable land area

b: type of labour above:	Male (family)	Female (family)	Hired Human	Hired Animal	hired machine	owned machine	T farm asset
c: price in 1980 :	-----	-----	383.24	345.93	4592.64	1	1
d: units reported above:	man-days	man-days	man-days	day	ha serviced	stock value	stock value

e: labour: family labour + hired human labour
f: T farm assets: machine owned + trees + livestock + tools + miscaleneous farm durables (deflated with an asset deflator)

Table D.3: SOUTH RICE: LABOUR USE per HECTARE: DUMMY VARIABLE REGRESSION

	size and break coefficients				base	participation coefficients			hypothesis tests				
	ΔS	ΔSB	ΔM	ΔMB	L,1980,FT	ΔPT2	ΔPT1	ΔLP	F-s	F-p	F-b	F-t	F
T LABOUR	300*	-4	93*	22	201	15	-77*	-183*	51.30	26.89	.35	1.73	13.85
R^2=.27	(37)	(47)	(37)	(48)	(39)	(21)	(21)	(24)	(0)	(0)	(.70)	(.09)	(0)
MALE FAM LAB	175*	-1	65*	21	113	-2	-74*	-126*	42.99	33.51	.74	.56	11.83
R^2=.24	(22)	(29)	(22)	(29)	(24)	(13)	(13)	(15)	(0)	(0)	(.48)	(.81)	(0)
FEM FAMILY LAB	143*	-5	43*	4	30	31*	-4	-74*	38.76	22.17	.12	1.38	11.50
R^2=.23	(20)	(26)	(20)	(27)	(21)	(12)	(12)	(13)	(0)	(0)	(.89)	(.20)	(0)
HIRED LABOUR	-18**	2	-15	-3	58	-13*	1	17*	1.72	8.23	.18	2.21	6.14
R^2=.13	(10)	(12)	(10)	(13)	(10)	(6)	(6)	(6)	(.18)	(0)	(.83)	(.03)	(0)
ANIMAL LAB	2.34	1.97	1.78	.23	.57	-2.17*	-.14	3.75*	1.31	13.88	1.22	.48	6.56
R^2=.14	(1.45)	(1.84)	(1.43)	(1.90)	(1.52)	(.84)	(.83)	(.95)	(.27)	(0)	(.30)	(.87)	(0)
MACHINE HIRED	.39	-.11	.68*	-.57	2.03	-.14	.12	.36**	2.96	2.39	1.96	3.31	8.14
R^2=.17	(.29)	(.38)	(.29)	(.39)	(.31)	(.17)	(.17)	(.20)	(.05)	(.07)	(.14)	(0)	(0)
MACHINE OWNED	6314	-2115	-11368	14973	49206	4688	-1876	11655	2.50	1.26	1.44	1.08	2.72
R^2=.05	(12029)	(15230)	(11882)	(15676)	(12603)	(6922)	(6894)	(7883)	(.08)	(.29)	(.24)	(.38)	(0)
T FARM ASSETS	13392	-10654	-26241	16302	94001	11664	25567**	26208**	3.19	1.42	.87	1.07	2.13
R^2=.03	(23903)	(30262)	(23610)	(31149)	(25043)	(13755)	(13699)	(15665)	(.04)	(.24)	(.42)	(.38)	(.01)

*: significantly (.05) different from zero (**:sign .10) (standard deviations in brackets) (the reported R^2 is the corrected R^2)

a: quantities per hectare paddy equivalent cultivatable land area

b: type of labour above:	Male (family)	Female (family)	Hired Human	Hired Animal	hired machine	owned machine	T farm asset
c: price in 1980 :	-----	-----	383.24	345.93	4592.64	1	1
d: units reported above:	man-days	man-days	man-days	day	ha serviced	stock value	stock value

e: labour: family labour + hired human labour
f: T farm assets: machine owned + trees + livestock + tools + miscaleneous farm durables (deflated with an asset deflator)

Table D.3: SOUTH RICE: LABOUR USE per HECTARE: DUMMY VARIABLE REGRESSION (continued)

	Δ1972	Δ1973	Δ1974	Δ1975	Δ1976	Δ1977	Δ1978	Δ1979
			annual shift coefficients					
T LABOUR	93**	135*	56	57	47	34	52**	16
	(53)	(53)	(51)	(50)	(50)	(30)	(30)	(30)
MALE FAM LAB	16	23	2	-6	-9	-9	6	-1
	(32)	(32)	(31)	(31)	(31)	(18)	(18)	(19)
FEM FAMILY LAB	46	61*	24	34	24	26	31**	9
	(29)	(29)	(28)	(28)	(28)	(17)	(17)	(17)
HIRED LABOUR	31*	51*	30*	29*	32*	16*	14**	8
	(14)	(14)	(13)	(13)	(13)	(8)	(8)	(8)
ANIMAL LAB	.66	1.27	1.15	.28	1.84	1.54	1.15	1.12
	(2.07)	(2.06)	(1.99)	(1.98)	(1.97)	(1.18)	(1.18)	(1.19)
MACHINE HIRED	-1.34*	-1.32*	-1.27*	-1.03*	-1.01*	-.95*	.40	-.08
	(.42)	(.43)	(.41)	(.41)	(.41)	(.24)	(.24)	(.25)
MACHINE OWNED	-40537*	-35808*	-35543*	-32945*	-23687	-15496	-5048	-7097
	(17194)	(17092)	(16451)	(16293)	(16315)	(9849)	(9776)	(9906)
T FARM ASSETS	-38873	-15961	-20455	-25885	-8232	-6332	-8895	31451
	(34165)	(33963)	(32688)	(32375)	(32419)	(19569)	(19424)	(19683)

*: significantly (.05) different from zero (**:sign .10) (standard deviations in brackets) (the reported R^2 is the corrected R^2)

a: quantities per hectare paddy equivalent cultivatable land area

	Male (family)	Female (family)	Hired Human	Hired Animal	hired machine	owned machine	T farm asset
b: type of labour above:	Male (family)	Female (family)	Hired Human	Hired Animal	hired machine	owned machine	T farm asset
c: price in 1980 :	-----	-----	383.24	345.93	4592.64	1	1
d: units reported above:	man-days	man-days	man-days	day	ha serviced	stock value	stock value

e: labour: family labour + hired human labour
f: T farm assets: machine owned + trees + livestock + tools + miscaleneous farm durables (deflated with an asset deflator)

Table D.4: SUGAR: LABOUR USE per HECTARE: DUMMY VARIABLE REGRESSION

	size and break coefficients				base	participation coefficients			hypothesis tests				
	ΔS	ΔSB	ΔM	ΔMB	L,1980,FT	ΔPT2	ΔPT1	ΔLP	F-s	F-p	F-b	F-t	F
T LABOUR	344*	-28	127*	-14	281	-52**	-173*	-311*	49.26	47.32	.19	.92	16.06
R^2=.29	(37)	(46)	(38)	(49)	(38)	(27)	(24)	(27)	(0)	(0)	(.83)	(.50)	(0)
MALE FAM LAB	184*	-23	68*	-10	134	-25**	-103*	-190*	53.28	66.81	.52	1.52	19.27
R^2=.33	(19)	(24)	(20)	(25)	(19)	(14)	(13)	(14)	(0)	(0)	(.59)	(.15)	(0)
FEM FAMILY LAB	162*	-10	60*	-1	109	-12	-70*	-130*	37.22	28.84	.12	.64	11.27
R^2=.21	(20)	(25)	(21)	(27)	(20)	(15)	(13)	(15)	(0)	(0)	(.89)	(.75)	(0)
HIRED LABOUR	-3	5	0	-4	37	-15**	-1	9	.05	2.08	.26	.68	1.30
R^2=.01	(11)	(14)	(12)	(15)	(12)	(8)	(8)	(8)	(.95)	(.10)	(.77)	(.71)	(.20)
ANIMAL LAB	2.01	2.38	2.38**	1.79	2.08	-.63	1.96*	.44	1.50	2.30	.96	1.34	3.41
R^2=.06	(1.38)	(1.73)	(1.43)	(1.87)	(1.41)	(1.03)	(.91)	(1.01)	(.22)	(.08)	(.39)	(.22)	(0)
MACHINE HIRED	-.03	.21	-.11	.21	1.24	-.06	.02	-.16	.18	.78	.51	4.47	4.58
R^2=.09	(.18)	(.23)	(.19)	(.24)	(.18)	(.13)	(.12)	(.13)	(.83)	(.51)	(.60)	(0)	(0)
MACHINE OWNED	17094*	-10095**	967	2290	26968	2064	-8650*	-11356*	10.03	5.47	2.95	1.61	4.44
R^2=.08	(4813)	(6016)	(5002)	(6420)	(4917)	(3572)	(3192)	(3495)	(0)	(0)	(.05)	(.12)	(0)
T FARM ASSETS	34720*	-8096	16909**	-13417	63497	-2409	-19479*	-28251*	7.35	7.02	.59	1.09	3.10
R^2=.05	(9288)	(11609)	(9652)	(12389)	(9488)	(6894)	(6159)	(6745)	(0)	(0)	(.56)	(.37)	(0)

*: significantly (.05) different from zero (**:sign .10) (standard deviations in brackets) (the reported R^2 is the corrected R^2)

a: quantities per hectare paddy equivalent cultivatable land area

		Male (family)	Female (family)	Hired Human	Hired Animal	hired machine	owned machine	T farm asset
b: type of labour above:		Male (family)	Female (family)	Hired Human	Hired Animal	hired machine	owned machine	T farm asset
c: price in 1980	:	-----	-----	383.24	345.93	4592.64	1	1
d: units reported above:		man-days	man-days	man-days	day	ha serviced	stock value	stock value

e: labour: family labour + hired human labour
f: T farm assets: machine owned + trees + livestock + tools + miscaleneous farm durables (deflated with an asset deflator)

Table D.4: SUGAR: LABOUR USE per HECTARE: DUMMY VARIABLE REGRESSION (continued)

	annual shift coefficients							
	Δ1972	Δ1973	Δ1974	Δ1975	Δ1976	Δ1977	Δ1978	Δ1979
T LABOUR	32 (50)	-4 (50)	-22 (50)	-3 (50)	47 (50)	-30 (38)	-53 (38)	-27 (38)
MALE FAM LAB	4 (26)	-23 (26)	-25 (26)	-14 (25)	20 (26)	-17 (20)	-34** (20)	2 (20)
FEM FAMILY LAB	7 (27)	4 (27)	-13 (27)	-12 (27)	-1 (27)	-28 (21)	-27 (21)	-29 (21)
HIRED LABOUR	21 (15)	15 (15)	17 (15)	23 (15)	28** (15)	16 (12)	7 (12)	0 (12)
ANIMAL LAB	2.82 (1.87)	.88 (1.86)	.02 (1.86)	-1.50 (1.87)	1.17 (1.87)	1.14 (1.42)	.89 (1.43)	.22 (1.42)
MACHINE HIRED	-1.04* (.24)	-.96* (.24)	-.85* (.24)	-.85* (.24)	-.53* (.24)	-.42* (.19)	.10 (.19)	.03 (.19)
MACHINE OWNED	-14346* (6491)	-12712* (6462)	-16340* (6467)	-13161* (6501)	-11582** (6500)	-12110* (4934)	-6455 (4983)	-24 (4942)
T FARM ASSETS	-4481 (12526)	43 (12470)	-7750 (12480)	-4806 (12545)	1359 (12543)	-16109** (9521)	-327 (9616)	9792 (9537)

*: significantly (.05) different from zero (**:sign .10) (standard deviations in brackets) (the reported R^2 is the corrected R^2)

a: quantities per hectare paddy equivalent cultivatable land area

b: type of labour above:	Male (family)	Female (family)	Hired Human	Hired Animal	hired machine	owned machine	T farm asset
c: price in 1980 :	-----	-----	383.24	345.93	4592.64	1	1
d: units reported above:	man-days	man-days	man-days	day	ha serviced	stock value	stock value

e: labour: family labour + hired human labour
f: T farm assets: machine owned + trees + livestock + tools + miscaleneous farm durables (deflated with an asset deflator)

Table D.5: NORTH RICE: SELECTED OUTPUT AMOUNTS per HECTARE: DUMMY VARIABLE REGRESSION (Kg/ha)

	size and break coefficients				base	participation coefficients			hypothesis tests				
	ΔS	ΔSB	ΔM	ΔMB	L,1980,FT	ΔPT2	ΔPT1	ΔLP	F-s	F-p	F-b	F-t	F
RICE	1555*	-1096*	2350*	-848	4272	418	1352*	1476*	10.34	11.92	1.46	2.88	8.49
R^2=.17	(519)	(641)	(578)	(662)	(543)	(283)	(275)	(298)	(0)	(0)	(.23)	(0)	(0)
SWEET POTATO	260	545**	206	629**	230	-176	-487*	-687*	.49	8.28	1.84	1.46	6.48
R^2=.13	(262)	(324)	(266)	(334)	(274)	(143)	(139)	(150)	(.61)	(0)	(.16)	(.17)	(0)
SUGAR	-76	43	-94	-134	207	-129	-13	-161	.03	.31	.17	1.49	1.07
R^2=.02	(359)	(443)	(365)	(458)	(375)	(196)	(190)	(206)	(.96)	(.81)	(.84)	(.16)	(.39)
VEGETABLES	22246*	-4710	1940	-59	11404	-2209	-16891*	-22250*	14.68	16.97	.43	.40	5.52
R^2=.11	(6330)	(7825)	(6439)	(8085)	(6623)	(3455)	(3361)	(3638)	(0)	(0)	(.65)	(.92)	(0)
ORANGE	-180	-165	-308*	-142	279	150*	-0	-28	4.27	2.89	.76	.26	3.00
R^2=.05	(110)	(136)	(112)	(140)	(115)	(60)	(58)	(63)	(.01)	(.03)	(.47)	(.98)	(0)
FRUIT	-797*	378*	-851*	311	1058	-244*	-307*	-267*	15.48	5.99	1.94	.79	5.42
R^2=.11	(155)	(192)	(158)	(198)	(162)	(85)	(82)	(89)	(0)	(0)	(.14)	(.62)	(0)
CEREAL	33	31	2	7	41	-40**	-53*	-57*	.76	2.72	.31	.79	1.41
R^2=.01	(42)	(52)	(43)	(54)	(44)	(23)	(22)	(24)	(.47)	(.04)	(.73)	(.61)	(.14)
SPECIAL CROP	-282	298	-311	-19	500	-86	-201	25	.81	1.09	1.28	.52	1.11
R^2=0	(246)	(303)	(249)	(313)	(256)	(134)	(130)	(141)	(.44)	(.35)	(.28)	(.84)	(.35)
HOG	457	796	997	-205	121	512	-700	-960**	.79	2.90	.92	.32	1.34
R^2=.01	(886)	(1096)	(901)	(1132)	(927)	(484)	(471)	(509)	(.45)	(.03)	(.40)	(.96)	(.18)
POULTRY	51**	19	82	-11	38	7	6	-20	3.63	.81	.67	.39	1.53
R^2=.01	(31)	(38)	(31)	(39)	(32)	(17)	(16)	(18)	(.03)	(.49)	(.52)	(.93)	(.09)
DRY LAND%	-.14*	.02	-.21*	-.02	.30	.03	-.08*	-.12*	9.66	10.00	.48	.57	6.30
R^2=.13	(.05)	(.06)	(.05)	(.06)	(.05)	(.03)	(.03)	(.03)	(0)	(0)	(.61)	(.81)	(0)
TOTAL OUTPUT	171502*	21894	85106	-17223	184372	9933	-130850*	-185060*	5.15	14.07	.29	.07	4.10
R^2=	(59986)	(74155)	(61023)	(76619)	(62769)	(32740)	(31848)	(34478)	(0)	(0)	(.75)	(.99)	(0)

Prices: Rice: 14.32 NT$/kg; Sweet Potato: 3.668 NT$/kg; Sugar: .795 NT$/kg; Vegetables: 6.531 NT$/kg;
Orange: 9.066 NT$/kg; Fruit: 9.022 NT$/kg; Cereal: 9.664 NT$/kg; Special Crop: 11.83 NT$/kg;
Hog: 48.258 NT$/kg; Poultry: 129 NT$ per animal

Table D.5: NORTH RICE: SELECTED OUTPUT AMOUNTS per HECTARE: DUMMY VARIABLE REGRESSION (Kg/ha) (continued)

	annual shift coefficients							
	Δ1972	Δ1973	Δ1974	Δ1975	Δ1976	Δ1977	Δ1978	Δ1979
RICE	100 (680)	-987 (674)	-1114* (675)	-293 (679)	368 (681)	-159 (435)	-671 (435)	-755 (478)
SWEET POTATO	501 (343)	40 (340)	215 (341)	171 (243)	-197 (344)	155 (219)	75 (220)	-29 (221)
SUGAR	298 (470)	758 (467)	-50 (467)	-56 (470)	-42 (471)	-79 (301)	-80 (301)	-46 (303)
VEGETABLES	-8316 (8298)	-5070 (8225)	-2517 (8241)	-5026 (8287)	-1395 (8312)	-5144 (5305)	-2869 (5308)	-1044 (5340)
ORANGE	129 (144)	109 (142)	151 (143)	148 (144)	140 (144)	-35 (92)	24 (92)	14 (92)
FRUIT	-264 (203)	-259 (202)	-344** (202)	-385** (203)	-395** (204)	-108 (130)	-56 (130)	39 (130)
CEREAL	37 (55)	-37 (55)	-30 (55)	-28 (55)	-30 (50)	-13 (35)	-11 (35)	-20 (35)
SPECIAL CROPS	-20 (321)	-51 (319)	-154 (319)	137 (321)	-246 (322)	-36 (205)	-23 (206)	7 (207)
HOG	275 (1162)	574 (1152)	825 (1154)	858 (1160)	-26 (1164)	422 (743)	403 (743)	346 (748)
POULTRY	-8 (40)	-32 (40)	-19 (40)	-17 (40)	-26 (41)	-25 (26)	-20 (26)	-37 (26)
DRY LAND%	.01 (.06)	-.05 (.06)	-.01 (.06)	-.01 (.06)	-.00 (.06)	-.05 (.04)	-.03 (.04)	-.01 (.04)
TOTAL OUTPUT	-20217 (78643)	-31960 (77951)	-3879 (78098)	-19153 (78531)	-29280 (78774)	-12857 (50272)	-11733 (50306)	-12207 (50608)

Prices: Rice: 14.32 NT$/kg; Sweet Potato: 3.668 NT$/kg; Sugar: .795 NT$/kg; Vegetables: 6.531 NT$/kg; Orange:9.066 NT$/kg; Fruit: 9.022 NT$/kg; Cereal: 9.664 NT$/kg; Special Crop: 11.83 NT$/kg; Hog: 48.258 NT$/kg; Poultry: 129 NT$ per animal

Table D.6: MID RICE: SELECTED OUTPUT AMOUNTS per HECTARE: DUMMY VARIABLE REGRESSION (Kg/ha)

	size and break coefficients				base	participation coefficients			hypothesis tests				
	ΔS	ΔSB	ΔM	ΔMB	L,1980,FT	ΔPT2	ΔPT1	ΔLP	F-s	F-p	F-b	F-t	F
RICE	-3141*	2402*	-1329	1415	9047	1186*	2257*	2738*	12.74	20.22	3.46	3.61	6.92
R^2=.12	(870)	(1058)	(906)	(1109)	(935)	(384)	(358)	(387)	(0)	(0)	(.03)	(0)	(0)
SWEET POTATO	-214	104	1	83	92	95	345*	2	.96	3.21	.04	2.44	4.81
R^2=.08	(322)	(392)	(336)	(411)	(346)	(142)	(133)	(143)	(.38)	(.02)	(.96)	(.01)	(0)
SUGAR	2400	-5373	2084	-1437	-961	1031	879	2879*	.37	1.91	3.01	.64	1.24
R^2=.06	(2797)	(3400)	(2913)	(3563)	(3004)	(1234)	(1151)	(1242)	(.69)	(.13)	(.05)	(.75)	(.24)
VEGETABLES	6837*	-191	4395	-2328	7572	-3984*	-7191*	-9758*	3.76	22.56	.69	.53	5.89
R^2=.11	(2833)	(3445)	(2951)	(3610)	(3043)	(1251)	(1166)	(1258)	(.02)	(0)	(.50)	(.84)	(0)
ORANGE	19	-253	104	-283	-56	37	65	123	.24	1.14	.40	3.19	2.04
R^2=.02	(252)	(307)	(263)	(321)	(271)	(111)	(104)	(112)	(.79)	(.33)	(.67)	(0)	(.01)
FRUIT	2948*	-345	-617	683	2612	-2103*	-4534*	-4692*	10.01	20.12	.46	1.00	5.65
R^2=.10	(1617)	(1966)	(1684)	(2060)	(1737)	(714)	(665)	(718)	(0)	(0)	(.63)	(.43)	(0)
CEREAL	110	-175	284*	-297*	-19	5	-36	79	5.32	1.91	2.39	.28	1.87
R^2=.02	(117)	(143)	(123)	(150)	(127)	(52)	(49)	(52)	(0)	(.13)	(.09)	(.97)	(.02)
SPECIAL CROP	100	-36	45	30	-31	68	-28	-39	.95	2.33	.53	1.57	1.44
R^2=.01	(99)	(119)	(103)	(126)	(106)	(44)	(41)	(44)	(.39)	(.07)	(.59)	(.13)	(.12)
HOG	705	-173	-204	265	1105	-350	-709*	-982*	3.29	3.64	.43	.22	1.22
R^2=.01	(714)	(868)	(744)	(910)	(767)	(315)	(294)	(317)	(.04)	(.01)	(.65)	(.99)	(.25)
POULTRY	76	17	18	17	15	5	-22	12	2.87	.98	.04	.73	1.65
R^2=.02	(53)	(64)	(55)	(67)	(57)	(23)	(22)	(23)	(.06)	(.40)	(.96)	(.67)	(.06)
DRY LAND%	.03	-.08	-.02	-.06	.09	-.04*	-.11*	-.09*	1.77	9.22	.93	.79	2.60
R^2=.04	(.05)	(.06)	(.06)	(.07)	(.06)	(.02)	(.02)	(.02)	(.17)	(0)	(.40)	(.61)	(0)
TOTAL OUTPUT	103984*	1710	22864	-5627	271765	-54873*	-112330*	-134460*	6.05	14.51	.02	1.02	4.64
R^2=.08	(51017)	(62025)	(53128)	(64992)	(54796)	(22517)	(20991)	(22659)	(0)	(0)	(.98)	(.42)	(0)

Prices: Rice: 14.32 NT$/kg; Sweet Potato: 3.668 NT$/kg; Sugar: .795 NT$/kg; Vegetables: 6.531 NT$/kg; Orange: 9.066 NT$/kg; Fruit: 9.022 NT$/kg; Cereal: 9.664 NT$/kg; Special Crop: 11.83 NT$/kg; Hog: 48.258 NT$/kg; Poultry: 129 NT$ per animal

Table D.6: MID RICE: SELECTED OUTPUT AMOUNTS per HECTARE: DUMMY VARIABLE REGRESSION (Kg/ha) (continued)

	annual shift coefficients							
	Δ1972	Δ1973	Δ1974	Δ1975	Δ1976	Δ1977	Δ1978	Δ1979
RICE	-2069**	-3623*	-3577*	-3207*	-1839	-675	-1079*	-476
	(1106)	(1109)	(1121)	(1119)	(1140)	(543)	(542)	(568)
SWEET POTATO	728**	551	914*	360	173	61	-25	143
	(410)	(411)	(415)	(414)	(422)	(201)	(201)	(210)
SUGAR	3629	4188	2638	2413	2219	-1449	28	1025
	(3554)	(3564)	(3605)	(3594)	(3666)	(1745)	(1741)	(1824)
VEGETABLES	-2463	-1817	-1970	-2208	-2466	-2856	-1999	-3325**
	(3601)	(3611)	(3652)	(3641)	(3714)	(1768)	(1764)	(1848)
ORANGE	839*	225	260	241	244	-11	64	-7
	(321)	(322)	(325)	(324)	(331)	(157)	(157)	(165)
FRUIT	-592	743	1867	647	819	1418	502	722
	(2055)	(2060)	(2084)	(2078)	(2119)	(1009)	(1007)	(1054)
CEREAL	69	59	119	79	144	3	10	-6
	(150)	(150)	(152)	(152)	(155)	(74)	(73)	(77)
SPECIAL CROPS	118	4	24	-10	141	-24	71	19
	(125)	(126)	(127)	(126)	(129)	(62)	(61)	(64)
HOG	-89	-238	-319	-350	-429	-245	-153	-472
	(907)	(910)	(920)	(918)	(936)	(446)	(445)	(466)
POULTRY	38	16	-9	2	4	-1	52	11
	(67)	(67)	(68)	(68)	(69)	(33)	(33)	(34)
DRY LAND%	.14*	.10	.11	.12**	.11	.03	.04	.05
	(.07)	(.07)	(.06)	(.07)	(.07)	(.03)	(.03)	(.03)
TOTAL OUTPUT	-17064	-45650	-11160	-71481	-33589	-32358	-7432	-56380
	(64829)	(65013)	(65757)	(65562)	(66872)	(31835)	(31761)	(33272)

Prices: Rice: 14.32 NT$/kg; Sweet Potato: 3.668 NT$/kg; Sugar: .795 NT$/kg; Vegetables: 6.531 NT$/kg;
Orange: 9.066 NT$/kg; Fruit: 9.022 NT$/kg; Cereal: 9.664 NT$/kg; Special Crop: 11.83 NT$/kg;
Hog: 48.258 NT$/kg; Poultry: 129 NT$ per animal

Table D.7: SOUTH RICE: SELECTED OUTPUT AMOUNTS per HECTARE: DUMMY VARIABLE REGRESSION (Kg/ha)

	size and break coefficients				base	participation coefficients			hypothesis tests				
	ΔS	ΔSB	ΔM	ΔMB	L,1980,FT	ΔPT2	ΔPT1	ΔLP	F-s	F-p	F-b	F-t	F
RICE	-1231*	514	-899	-350	6270	391	609*	884**	1.45	1.27	.98	2.38	2.33
R^2=.04	(725)	(922)	(718)	(951)	(760)	(421)	(416)	(475)	(.24)	(.28)	(.38)	(.02)	(0)
SWEET POTATO	-381	1675*	214	698	-96	396	195	1145*	.95	2.72	2.76	4.00	6.59
R^2=.14	(655)	(833)	(649)	(859)	(687)	(380)	(376)	(430)	(.39)	(.04)	(.07)	(0)	(0)
SUGAR	8288	-171	7827	-7084	5594	-9537*	-5293	-2366	.67	1.82	.65	1.36	1.45
R^2=.01	(7439)	(9459)	(7367)	(9751)	(7799)	(4318)	(4271)	(4876)	(.51)	(.14)	(.52)	(.21)	(.12)
VEGETABLES	11661*	744	6551*	-505	3044	-2632*	-6418*	-11969*	15.77	25.25	.22	.40	6.52
R^2=.14	(2191)	(2786)	(2170)	(2872)	(2297)	(1272)	(1258)	(1436)	(0)	(0)	(.80)	(0)	(0)
ORANGE	47	-136	16	16	20	-53*	-62	-95	.07	.33	.77	2.82	1.93
R^2=.03	(150)	(191)	(149)	(196)	(157)	(87)	(86)	(98)	(.92)	(.80)	(.46)	(0)	(.02)
FRUIT	-2050*	885	-2223*	2250**	4723	247	231	265	2.56	.08	1.95	1.65	1.90
R^2=.03	(1015)	(1291)	(1005)	(1331)	(1064)	(589)	(583)	(665)	(.08)	(.97)	(.14)	(.11)	(.02)
CEREAL	326*	-73	82	5	-12	-143**	-165*	-227*	5.55	2.85	.29	.54	1.47
R^2=.01	(128)	(162)	(126)	(167)	(134)	(74)	(73)	(84)	(0)	(.04)	(.75)	(.82)	(.11)
SPECIAL CROP	85	-53	-1	-10	-84	75	98	38	.73	1.83	.13	1.07	1.19
R^2=.01	(114)	(144)	(112)	(149)	(119)	(66)	(65)	(74)	(.48)	(.14)	(.88)	(.38)	(.27)
HOG	-87	416	-1032	819	800	775	300	124	1.15	.64	.22	.70	.69
R^2=0	(1027)	(1307)	(1018)	(1347)	(1077)	(597)	(590)	(673)	(.32)	(.59)	(.81)	(.70)	(.79)
POULTRY	46	2	-7	13	54	40*	9	-4	2.84	1.82	.09	.89	1.60
R^2=.02	(34)	(44)	(34)	(45)	(36)	(20)	(20)	(23)	(.06)	(.14)	(.92)	(.53)	(.07)
BEAN	-566*	115	-429**	-1	1272	57	41	-73	3.02	.32	.20	1.04	1.84
R^2=.02	(230)	(293)	(228)	(302)	(241)	(134)	(132)	(150)	(.05)	(.81)	(.82)	(.40)	(.03)
DRY LAND%	.07	.02	.02	.06	.22	-.02	-.06**	-.14*	1.06	5.18	.36	.39	1.41
R^2=.01	(.06)	(.07)	(.06)	(.08)	(.06)	(.03)	(.03)	(.04)	(.35)	(0)	(.70)	(.93)	(.14)
TOTAL OUTPUT	57535	31934	-48471	57889	237641	25316	-26151	-67350	3.05	1.72	.26	1.08	1.34
R^2=.01	(64814)	(82414)	(64190)	(84958)	(67950)	(37624)	(37217)	(42483)	(.05)	(.16)	(.77)	(.37)	(.17)

Prices: Rice: 14.32 NT$/kg; Sweet Potato: 3.668 NT$/kg; Sugar: .795 NT$/kg; Vegetables: 6.531 NT$/kg;
Orange: 9.066 NT$/kg; Fruit: 9.022 NT$/kg; Cereal: 9.664 NT$/kg; Special Crop: 11.83 NT$/kg;
Hog: 48.258 NT$/kg; Poultry: 129 NT$ per animal

Table D.7: SOUTH RICE: SELECTED OUTPUT AMOUNTS per HECTARE: DUMMY VARIABLE REGRESSION (Kg/ha) (continued)

	annual shift coefficients							
	Δ1972	Δ1973	Δ1974	Δ1975	Δ1976	Δ1977	Δ1978	Δ1979
RICE	-378	149	1362	1001	1746**	1067**	461	-53
	(1040)	(1034)	(996)	(991)	(987)	(594)	(589)	(598)
SWEET POTATO	976	1294	2024*	397	-799	372	117	120
	(940)	(935)	(899)	(895)	(892)	(536)	(533)	(540)
SUGAR	10102	3070	936	1433	7048	6971	138	14864*
	(10668)	(10608)	(10210)	(10161)	(10124)	(6089)	(6050)	(6130)
VEGETABLES	-1478	-698	1802	-1184	-1333	-968	-301	-2786
	(3142)	(3125)	(3008)	(2993)	(2982)	(1794)	(1782)	(1806)
ORANGE	98	63	516*	60	52	-4	-3	-2
	(215)	(214)	(206)	(206)	(204)	(123)	(122)	(124)
FRUIT	-3371*	-3418*	-3467*	-3404*	-2886*	-1651*	352	-1116
	(1456)	(1448)	(1393)	(1387)	(1381)	(831)	(826)	(836)
CEREAL	100	-19	34	102	58	40	36	166
	(183)	(182)	(175)	(174)	(174)	(105)	(104)	(105)
SPECIAL CROPS	244	292**	93	103	138	39	125	47
	(162)	(162)	(156)	(155)	(155)	(93)	(92)	(94)
HOG	84	-207	-504	-326	-375	483	1462	-182
	(1474)	(1465)	(1410)	(1404)	(1399)	(841)	(836)	(847)
POULTRY	-20	-46	-53	-49	-56	-46	-57*	-57*
	(49)	(49)	(47)	(47)	(47)	(28)	(28)	(28)
BEAN	-235*	41	-60	-233	53	147	366**	144
	(330)	(328)	(316)	(314)	(313)	(188)	(187)	(190)
DRY LAND%	-.03	-.05	-.04	-.04	-.05	-.06	-.04	.01
	(.08)	(.08)	(.08)	(.08)	(.08)	(.05)	(.05)	(.05)
TOTAL OUTPUT	-15501	-49721	-50256	-56677	-40090	24774	89710	-51639
	(92954)	(92428)	(88963)	(88533)	(88216)	(53058)	(52712)	(53415)

Prices: Rice: 14.32 NT$/kg; Sweet Potato: 3.668 NT$/kg; Sugar: .795 NT$/kg; Vegetables: 6.531 NT$/kg;
Orange: 9.066 NT$/kg; Fruit: 9.022 NT$/kg; Cereal: 9.664 NT$/kg; Special Crop: 11.83 NT$/kg;
Hog: 48.258 NT$/kg; Poultry: 129 NT$ per animal

Table D.8: SUGAR: SELECTED OUTPUT AMOUNTS per HECTARE: DUMMY VARIABLE REGRESSION (Kg/ha)

	size and break coefficients				base	participation coefficients			hypothesis tests				
	ΔS	ΔSB	ΔM	ΔMB	L,1980,FT	ΔPT2	ΔPT1	ΔLP	F-s	F-p	F-b	F-t	F
RICE	-974	765	-855	503	3289	165	-694	-1218*	1.33	3.18	.49	1.77	2.17
R^2=.03	(619)	(773)	(641)	(822)	(631)	(459)	(408)	(450)	(.27)	(.02)	(.61)	(.08)	(.01)
SWEET POTATO	598	1027	136	1174	32	615	-65	932	.17	.67	.33	1.14	1.91
R^2=.02	(1169)	(1461)	(1211)	(1553)	(1192)	(866)	(771)	(850)	(.84)	(.57)	(.72)	(.33)	(.02)
SUGAR	-994	8043	-3997	8973	28692	2696	-5641	-6711	.22	1.37	.64	1.31	.96
R^2=.01	(6506)	(8132)	(6738)	(8645)	(6636)	(4822)	(4289)	(4733)	(.80)	(.25)	(.53)	(.23)	(.50)
VEGETABLES	7236*	-4697*	3765*	-2258	5691	-2893*	-3294*	-2392*	10.94	4.13	2.98	.78	3.39
R^2=.05	(1572)	(1966)	(1629)	(2089)	(1604)	(1165)	(1037)	(1144)	(0)	(.01)	(.05)	(.63)	(0)
ORANGE	1879*	-148	278	606	-883	505	-239	-493	4.52	.86	.42	1.07	1.58
R^2=.02	(746)	(932)	(773)	(991)	(761)	(553)	(492)	(543)	(.01)	(.47)	(.66)	(.38)	(.07)
FRUIT	1048	-62	939	-837	3358	-1210*	-1220*	-1345*	.89	2.67	.43	2.11	2.11
R^2=.03	(818)	(1023)	(847)	(1087)	(835)	(606)	(539)	(596)	(.41)	(.05)	(.65)	(.03)	(.01)
CEREAL	-267	457**	-291	225	886	48	-103	58	1.11	.53	1.68	.74	.83
R^2=0	(204)	(254)	(210)	(270)	(207)	(150)	(134)	(148)	(.33)	(.66)	(.19)	(.65)	(.65)
SPECIAL CROP	206	327	81	50	334	-192	-333*	-393*	.69	3.56	1.35	.85	2.13
R^2=.03	(186)	(232)	(192)	(247)	(189)	(138)	(122)	(135)	(.50)	(.01)	(.26)	(.56)	(.01)
HOG	-42	474*	316*	-192	257	26	-22	-311*	3.47	2.94	6.79	1.27	2.73
R^2=.04	(165)	(207)	(171)	(220)	(169)	(123)	(109)	(120)	(.03)	(.03)	(0)	(.26)	(0)
POULTRY	72	32	245*	-219	4	-92**	-105*	-97**	5.98	1.96	4.66	.31	1.62
R^2=.02	(75)	(94)	(78)	(100)	(77)	(56)	(50)	(55)	(0)	(.12)	(0)	(.96)	(.06)
DRY LAND%	.09	.05	.07	.01	.21	-.01	-.02	.05	1.13	.87	.28	2.10	2.48
R^2=.04	(.06)	(.08)	(.06)	(.08)	(.06)	(.05)	(.04)	(.05)	(.33)	(.45)	(.76)	(.03)	(0)
TOTAL OUTPUT	74875*	29177	85366*	-53100**	165290	-42036*	-81775*	-105690*	6.50	14.14	4.50	.56	4.45
R^2=.08	(24194)	(30240)	(25057)	(32147)	(24678)	(17931)	(15949)	(17600)	(0)	(0)	(.01)	(.81)	(0)

Prices: Rice: 14.32 NT$/kg; Sweet Potato: 3.668 NT$/kg; Sugar: .795 NT$/kg; Vegetables: 6.531 NT$/kg;
Orange: 9.066 NT$/kg; Fruit: 9.022 NT$/kg; Cereal: 9.664 NT$/kg; Special Crop: 11.83 NT$/kg;
Hog: 48.258 NT$/kg; Poultry: 129 NT$ per animal

Table D.8: SUGAR: SELECTED OUTPUT AMOUNTS per HECTARE: DUMMY VARIABLE REGRESSION (Kg/ha) (continued)

	annual shift coefficients							
	Δ1972	Δ1973	Δ1974	Δ1975	Δ1976	Δ1977	Δ1978	Δ1979
RICE	-825	-833	64	-484	1050	641	93	215
	(833)	(829)	(830)	(834)	(834)	(634)	(640)	(634)
SWEET POTATO	3120*	2388	1480	2647**	488	1294	652	123
	(1574)	(1567)	(1568)	(1576)	(1576)	(1198)	(1208)	(1198)
SUGAR	-4240	-2558	-1758	-8402	2256	8176	4754	15331*
	(8760)	(8721)	(8730)	(8774)	(8770)	(6666)	(6726)	(6670)
VEGETABLES	-2260	-1673	-1735	-1207	-1930	-3800	-2147	-1564
	(2117)	(2108)	(2110)	(2121)	(2120)	(1611)	(1625)	(1612)
ORANGE	1261	676	1705	422	575	1306**	1510**	841
	(1004)	(1000)	(1001)	(1006)	(1005)	(764)	(771)	(765)
FRUIT	-2367*	-1654	-1623	-666	-724	-2093*	-1072	350
	(1102)	(1097)	(1098)	(1103)	(1103)	(838)	(846)	(839)
CEREAL	-310	-291	-422	-433	-503**	-383**	-161	-176
	(273)	(272)	(272)	(274)	(273)	(208)	(210)	(208)
SPECIAL CROPS	60	10	-61	-294	126	-123	123	-159
	(250)	(249)	(249)	(250)	(250)	(190)	(192)	(190)
HOG	381	257	92	148	52	362*	299**	175
	(223)	(222)	(222)	(223)	(223)	(170)	(171)	(170)
POULTRY	53	48	41	31	53	45	112	81
	(101)	(101)	(101)	(102)	(102)	(77)	(78)	(77)
DRY LAND%	.06	.01	.01	-.01	.04	-.17*	-.06	.07
	(.08)	(.08)	(.08)	(.08)	(.08)	(.06)	(.06)	(.06)
TOTAL OUTPUT	12338	-13573	1911	-12558	16146	16523	29733	23420
	(32573)	(32429)	(32462)	(32628)	(32611)	(24790)	(25010)	(24805)

Prices: Rice: 14.32 NT$/kg; Sweet Potato: 3.668 NT$/kg; Sugar: .795 NT$/kg; Vegetables: 6.531 NT$/kg;
Orange: 9.066 NT$/kg; Fruit: 9.022 NT$/kg; Cereal: 9.664 NT$/kg; Special Crop: 11.83 NT$/kg;
Hog: 48.258 NT$/kg; Poultry: 129 NT$ per animal

Table D.9: NORTH RICE: SELECTED INTERMEDIATE INPUTS per HECTARE: DUMMY VARIABLE REGRESSION

	size and break coefficients				base	participation coefficients			hypothesis tests				
	ΔS	ΔSB	ΔM	ΔMB	L,1980,FT	ΔPT2	ΔPT1	ΔLP	F-s	F-p	F-b	F-t	F
SEED	5520*	82	1322	-597	3635	-989	-4354*	-989	9.00	11.53	.10	.14	4.34
R^2=.11	(1773)	(2192)	(1804)	(2265)	(1856)	(968)	(942)	(968)	(0)	(0)	(.90)	(.99)	(0)
FERTILIZER(kg)	5444*	-233	352	904	8569	1140	-3368*	-4733*	7.65	8.37	.19	.49	3.08
R^2=.05	(2184)	(2700)	(2222)	(2790)	(2286)	(1192)	(1160)	(1255)	(0)	(0)	(.83)	(.87)	(0)
REQUISITES	1037	1423	732	-592	4176	441	-358	-1664*	.30	2.23	1.56	1.20	1.64
R^2=.02	(1350)	(1669)	(1374)	(1725)	(1413)	(737)	(717)	(776)	(.74)	(.08)	(.21)	(.30)	(.06)
HERBICIDES	26	-21	40	-35	1717	-30	3	-52	.04	.22	.02	37.86	42.17
R^2=.53	(135)	(167)	(137)	(172)	(141)	(74)	(72)	(78)	(.96)	(.88)	(.98)	(0)	(0)
INSECTICIDES	1239**	625	-349	1034	3758	-209	-1580*	-2490*	6.47	15.69	.70	1.17	4.54
R^2=.09	(701)	(866)	(713)	(895)	(733)	(382)	(372)	(403)	(0)	(0)	(.50)	(.32)	(0)
WATER(ha)	.78*	-.15	.33	-.19	1.31	.17	.48*	.26**	6.55	4.20	.17	5.33	6.75
R^2=.13	(.26)	(.32)	(.26)	(.33)	(.27)	(.14)	(.14)	(.15)	(0)	(0)	(.84)	(0)	(0)
LIVESTOCK	5432	9851	13799	394	-1233	11054	-9100	-11578	.83	3.37	.46	.35	1.49
R^2=.01	(12569)	(15538)	(12786)	(16053)	(13152)	(6860)	(6673)	(7224)	(.43)	(.02)	(.63)	(.95)	(.10)
FEED(kg)	35	127	124	-9	62	63	-88	-130*	1.10	3.29	1.23	.22	1.40
R^2=.01	(106)	(133)	(109)	(137)	(113)	(59)	(57)	(62)	(.33)	(.02)	(.29)	(.99)	(.14)
VARIABLE COST	45419	39378	48075	-3337	58494	16547	-48380*	-63081*	.83	5.27	.96	.15	1.84
R^2=.02	(37972)	(46942)	(38629)	(48501)	(39733)	(20725)	(20160)	(21825)	(.44)	(0)	(.38)	(.99)	(.03)
% VC IN OUTPUT	-4.34	-.04	-2.35	2.90	38.27	.01	3.52*	7.41	1.31	7.71	.74	1.31	2.46
R^2=.04	(2.92)	(3.61)	(2.97)	(3.73)	(3.06)	(1.60)	(1.55)	(1.68)	(.27)	(0)	(.48)	(.27)	(0)

*: significantly (.05) different from zero (**:sign .10) (standard deviations in brackets) (the reported R^2 is the corrected R^2)

a: per hectare paddy equivalent cultivatable land area
b: values expressed in constant NT$, except fertilizer at 159.28 NT$/kg), feed at 189.48 NT$/kg) and the water at 1898.19 NT$/ha)
c: Herbicides were reported in the requisites before 1978
d: the variable costs include the costs of hired labour services (human, animal,machine) reported in Table D.9-12

Table D.9: NORTH RICE: SELECTED INTERMEDIATE INPUTS per HECTARE: DUMMY VARIABLE REGRESSION (continued)

	annual shift coefficients							
	Δ1972	Δ1973	Δ1974	Δ1975	Δ1976	Δ1977	Δ1978	Δ1979
SEED	-735 (2325)	-310 (2304)	123 (2309)	-740 (2322)	-647 (2329)	-1093 (1486)	-392 (1487)	-645 (1496)
FERTILIZER(kg)	-3388 (2864)	-3717 (2839)	-2123 (2844)	-2023 (2860)	-2428 (2869)	-2422 (1831)	-1875 (1832)	-773 (1843)
REQUISITES	-1945 (1770)	-1500 (1755)	-1785 (1758)	-805 (1768)	-776 (1773)	800 (1132)	-1584 (1133)	-1770 (1139)
HERBICIDES	-1709* (177)	-1705* (175)	-1707* (176)	-1706* (177)	-1704* (177)	1730* (113)	-688* (113)	-367* (113)
INSECTICIDES	-1859* (919)	-1783** (911)	-1627** (917)	-1135 (912)	-927 (920)	-185 (587)	322 (588)	-424 (591)
WATER(ha)	.45 (.34)	-.62** (.33)	.64* (.33)	.47 (.34)	-.07* (.34)	-.70 (.21)	-1.11* (.21)	-.17 (.22)
LIVESTOCK	3892 (16478)	10914 (16332)	14561 (16364)	8346 (16454)	1498 (16505)	7775 (10533)	7070 (10540)	4904 (10604)
FEED(kg)	14 (141)	18 (140)	34 (140)	82 (141)	-15 (141)	52 (90)	53 (90)	41 (91)
VARIABLE COST	7424 (49783)	-885 (49344)	12881 (49437)	11754 (49711)	-10033 (49866)	17619 (31823)	15532 (31844)	2983 (32036)
% VC IN OUTPUT	6.32** (3.82)	2.38 (3.80)	.44 (3.81)	.86 (3.83)	.50 (3.84)	3.27 (2.45)	4.19** (2.45)	2.75 (2.47)

*: significantly (.05) different from zero (**:sign .10) (standard deviations in brackets) (the reported R^2 is the corrected R^2)

a: per hectare paddy equivalent cultivatable land area
b: values expressed in constant NT$, except fertilizer at 159.28 NT$/kg), feed at 189.48 NT$/kg) and the water at 1898.19 NT$/ha)
c: Herbicides were reported in the requisites before 1978
d: the variable costs include the costs of hired labour services (human, animal,machine) reported in Table D.9-12

Table D.10: MID RICE: SELECTED INTERMEDIATE INPUTS per HECTARE: DUMMY VARIABLE REGRESSION

	size and break coefficients				base	participation coefficients			hypothesis tests				
	ΔS	ΔSB	ΔM	ΔMB	L,1980,FT	$\Delta PT2$	$\Delta PT1$	ΔLP	F-s	F-p	F-b	F-t	F
SEED	2128	-83	1318	-1228	2142	962	181	-1179	1.10	2.80	.57	1.02	1.59
R^2=.01	(1665)	(2025)	(1735)	(2122)	(1789)	(735)	(685)	(734)	(.33)	(.04)	(.57)	(.41)	(.07)
FERTILIZER(kg)	1581	3023	500	-60	14902	-1472**	-3842*	-5242*	.85	15.73	3.47	1.00	4.96
R^2=.09	(1885)	(2291)	(1962)	(2400)	(2024)	(831)	(775)	(837)	(.43)	(0)	(.03)	(.43)	(0)
REQUISITES	1717	2400	5340	-4884	4621	-387	-2802	-1436	.64	.40	1.31	1.15	.93
R^2=0	(6826)	(8299)	(7108)	(8696)	(7332)	(3012)	(2809)	(3032)	(.53)	(.76)	(.27)	(.33)	(.53)
HERBICIDES	6	-47	35	-46	1371	132*	208*	195*	.09	4.86	.04	43.83	55.93
R^2=.57	(142)	(173)	(148)	(181)	(153)	(62)	(58)	(63)	(.92)	(0)	(.96)	(0)	(0)
INSECTICIDES	-1141	3486*	-881	1254	11785	-1318*	-3472*	-3828*	.44	21.56	5.24	4.47	8.61
R^2=.16	(1262)	(1535)	(1315)	(1608)	(1356)	(557)	(519)	(561)	(.64)	(0)	(0)	(0)	(0)
WATER(ha)	-.01	.19	.24	-.12	2.13	-.07	.0	.30**	1.02	2.21	.93	6.68	4.59
R^2=.08	(.35)	(.42)	(.36)	(.44)	(.37)	(.15)	(.14)	(.15)	(.36)	(.09)	(.40)	(0)	(0)
LIVESTOCK	5548	-1149	-814	2902	-414	-2317	-1862	-4107	2.19	.76	.49	1.52	1.20
R^2=0	(6207)	(7547)	(6464)	(7908)	(6667)	(2740)	(2553)	(2757)	(.11)	(.52)	(.61)	(.15)	(.27)
FEED(kg)	102	3	-42	54	220	-53	-140*	-163*	3.42	4.92	.25	.20	1.50
R^2=.01	(110)	(134)	(115)	(140)	(118)	(49)	(45)	(49)	(.03)	(0)	(.76)	(.99)	(.10)
VARIABLE COST	38192	14999	-2982	11272	104941	-10837	-35983*	-39869*	3.71	4.03	.09	.79	2.17
R^2=.03	(31066)	(37769)	(32351)	(39576)	(33367)	(13711)	(12782)	(13798)	(.02)	(.01)	(.92)	(.61)	(.01)
% VC IN OUTPUT	-4.07	7.39**	-5.38	6.70	38.41	3.36*	5.20*	7.57*	1.15	8.63	1.54	4.80	4.91
R^2=.09	(3.47)	(4.21)	(3.61)	(4.41)	(3.72)	(1.53)	(1.42)	(1.54)	(.32)	(0)	(.22)	(0)	(0)

*: significantly (.05) different from zero (**:sign .10) (standard deviations in brackets) (the reported R^2 is the corrected R^2)

a: per hectare paddy equivalent cultivatable land area
b: values expressed in constant NT$, except fertilizer at 159.28 NT$/kg), feed at 189.48 NT$/kg) and the water at 1898.19 NT$/ha)
c: Herbicides were reported in the requisites before 1978
d: the variable costs include the costs of hired labour services (human, animal,machine) reported in Table D.9-12

Table D.10: MID RICE: SELECTED INTERMEDIATE INPUTS per HECTARE: DUMMY VARIABLE REGRESSION (continued)

	annual shift coefficients							
	Δ1972	Δ1973	Δ1974	Δ1975	Δ1976	Δ1977	Δ1978	Δ1979
SEED	1364	973	2196	40	128	990	1473*	1316
	(2117)	(2123)	(2147)	(2141)	(2184)	(1040)	(1037)	(1086)
FERTILIZER(kg)	-4654**	-3606	-3152	-3606	-4150**	-2366*	-2235**	-1777
	(2395)	(2401)	(2429)	(2422)	(2470)	(1176)	(1173)	(1229)
REQUISITES	-1472	-1725	8100	-562	-634	3783	-1283	-536
	(8674)	(8699)	(8798)	(8772)	(8947)	(4259)	(4250)	(4452)
HERBICIDES	-1489*	-1479*	-1473*	-1477*	-1495*	-1519*	-489*	-306*
	(181)	(181)	(183)	(183)	(186)	(89)	(88)	(93)
INSECTICIDES	-7020*	-6559*	-7111*	-5708*	-5415*	-3397*	-2104*	-1859*
	(1604)	(1609)	(1627)	(1622)	(1655)	(787)	(786)	(823)
WATER(ha)	-.66	-.47	-.47	-.47	.24	-.79*	-1.04*	-.05
	(.44)	(.44)	(.45)	(.45)	(.46)	(.22)	(.22)	(.23)
LIVESTOCK	9661	4821	3201	2427	3003	3246	10035*	2162
	(7887)	(7910)	(8001)	(7977)	(8136)	(3873)	(3864)	(4048)
FEED(kg)	-39	-61	-86	-87	-82	-49	-47	-56
	(140)	(141)	(142)	(142)	(145)	(69)	(69)	(72)
VARIABLE COST	-918	-25887	-13400	-38792	-29445	-197	3261	-19383
	(39476)	(39588)	(40041)	(39923)	(40720)	(19385)	(19340)	(20263)
% VC IN OUTPUT	.36	-4.53	-7.29	-4.38	-6.34	8.87*	4.08**	1.32
	(4.40)	(4.41)	(4.46)	(4.45)	(4.54)	(2.16)	(2.16)	(2.26)

*: significantly (.05) different from zero (**:sign .10) (standard deviations in brackets) (the reported R^2 is the corrected R^2)

a: per hectare paddy equivalent cultivatable land area
b: values expressed in constant NT$, except fertilizer at 159.28 NT$/kg), feed at 189.48 NT$/kg) and the water at 1898.19 NT$/ha)
c: Herbicides were reported in the requisites before 1978
d: the variable costs include the costs of hired labour services (human, animal,machine) reported in Table D.9-12

Table D.11: SOUTH RICE: SELECTED INTERMEDIATE INPUTS per HECTARE: DUMMY VARIABLE REGRESSION

	size and break coefficients				base	participation coefficients			hypothesis tests				
	ΔS	ΔSB	ΔM	ΔMB	L,1980,FT	ΔPT2	ΔPT1	ΔLP	F-s	F-p	F-b	F-t	F
SEED	4487*	-1662	1434	-429	4428	-1130	-2434*	-3489*	9.82	6.95	.94	.73	2.93
R^2=.05	(1252)	(1592)	(1240)	(1641)	(1313)	(727)	(719)	(821)	(0)	(0)	(.39)	(.66)	(0)
FERTILIZER(kg)	5856*	1099	2770**	728	10949	-3072*	-4957*	-6357*	8.94	15.79	.17	.61	4.15
R^2=.08	(1537)	(1954)	(1522)	(2014)	(1611)	(892)	(882)	(1007)	(0)	(0)	(.85)	(.77)	(0)
REQUISITES	2003	-481	-562	815	8214	-591	-1941*	-3457*	3.45	4.75	.51	2.91	3.77
R^2=.07	(1499)	(1907)	(1485)	(1966)	(1572)	(871)	(861)	(983)	(.03)	(.03)	(.60)	(0)	(0)
HERBICIDES	-205	290	-110	205	1838	-257*	-246*	-90	.65	2.66	.73	22.16	24.31
R^2=.40	(191)	(243)	(189)	(251)	(200)	(111)	(110)	(125)	(.52)	(.05)	(.48)	(0)	(0)
INSECTICIDES	-826	2692	-1080	1104	12746	383	-1595*	-3492*	.36	8.43	1.84	3.62	5.77
R^2=.12	(1291)	(1642)	(1279)	(1692)	(1353)	(749)	(741)	(846)	(.70)	(0)	(.16)	(0)	(0)
WATER(ha)	.24	-.36	.15	-.70*	1.33	.04	.09	.03	.44	.11	2.33	4.27	2.89
R^2=.05	(.27)	(.34)	(.26)	(.35)	(.28)	(.15)	(.15)	(.17)	(.64)	(.95)	(.10)	(0)	(0)
LIVESTOCK	-7318	5859	-33571	24584	24635	11217	-4385	822	2.10	.50	.61	.64	.76
R^2=0	(22225)	(28261)	(22012)	(29133)	(23301)	(12902)	(12762)	(14568)	(.12)	(.68)	(.54)	(.75)	(.72)
FEED(kg)	10	63	-77	93	172	37	42	3	1.94	.64	.53	.80	.99
R^2=0	(70)	(88)	(69)	(91)	(73)	(40)	(40)	(46)	(.15)	(.59)	(.59)	(.61)	(.47)
VARIABLE COST	11423	19185	-50896	44616	132857	13432	-9428	-11278	2.88	.40	.46	.89	1.10
R^2=0	(40306)	(51252)	(39919)	(52834)	(42257)	(23398)	(23145)	(26419)	(.06)	(.75)	(.63)	(.52)	(.35)
% VC IN OUTPUT	-7.61*	.51	-6.90*	2.27	49.01	.96	4.82*	13.35*	3.08	16.65	.27	3.05	5.86
R^2=.12	(3.13)	(3.99)	(3.10)	(4.11)	(3.29)	(1.82)	(1.80)	(2.06)	(.05)	(0)	(.76)	(0)	(0)

*: significantly (.05) different from zero (**:sign .10) (standard deviations in brackets) (the reported R^2 is the corrected R^2)

a: per hectare paddy equivalent cultivatable land area
b: values expressed in constant NT$, except fertilizer at 159.28 NT$/kg), feed at 189.48 NT$/kg) and the water at 1898.19 NT$/ha)
c: Herbicides were reported in the requisites before 1978
d: the variable costs include the costs of hired labour services (human, animal,machine) reported in Table D.9-12

Table D.11: SOUTH RICE: SELECTED INTERMEDIATE INPUTS per HECTARE: DUMMY VARIABLE REGRESSION (continued)

	annualshift coefficients							
	Δ1972	Δ1973	Δ1974	Δ1975	Δ1976	Δ1977	Δ1978	Δ1979
SEED	1379 (1796)	1348 (1785)	802 (1718)	440 (1710)	892 (1704)	2162 (1025)	1441 (1018)	944 (1032)
FERTILIZER(kg)	-1756 (2204)	-943 (2191)	-2350 (2109)	-2004 (2099)	-237 (2091)	-146 (1258)	-541 (1250)	-1106 (1266)
REQUISITES	-5025* (2151)	-4513* (2139)	-3614** (2059)	-2023 (2049)	-1818 (2041)	1424 (1228)	-2407* (1220)	-1603 (1236)
HERBICIDES	-1766* (274)	-1779* (273)	-1788* (262)	-1785* (261)	-1777* (260)	-1573* (157)	-222 (156)	44 (158)
INSECTICIDES	-8308* (1851)	-7899* (1841)	-7705* (1772)	-6731* (1763)	-6391* (1757)	-3893* (1057)	-3403* (1050)	-2932* (1064)
WATER(ha)	-.17 (.38)	.42 (.38)	.13 (.37)	.22 (.36)	.66** (.36)	-.40* (.22)	-.48* (.22)	.34 (.22)
LIVESTOCK	-10776 (31875)	-15211 (31695)	-17585 (30507)	-13339 (30359)	-10923 (30250)	12868 (18194)	26791 (18076)	-7434 (18317)
FEED(kg)	-34 (100)	-67 (99)	-138 (95)	-125 (95)	-119 (95)	-46 (57)	-27 (57)	-76 (57)
VARIABLE COST	-19920 (57806)	-39539 (57479)	-59147 (55325)	-55854 (55057)	-41223 (54860)	15913 (32996)	32953 (32781)	-34159 (33218)
% VC IN OUTPUT	-1.42 (4.50)	-.09 (4.48)	-9.87* (4.31)	-8.78* (4.28)	-5.03 (4.27)	2.01 (2.57)	-1.72 (2.55)	-.54 (2.59)

*: significantly (.05) different from zero (**:sign .10) (standard deviations in brackets) (the reported R^2 is the corrected R^2)

a: per hectare paddy equivalent cultivatable land area
b: values expressed in constant NT$, except fertilizer at 159.28 NT$/kg), feed at 189.48 NT$/kg) and the water at 1898.19 NT$/ha)
c: Herbicides were reported in the requisites before 1978
d: the variable costs include the costs of hired labour services (human, animal,machine) reported in Table D.9-12

Table D.12: SUGAR: SELECTED INTERMEDIATE INPUTS per HECTARE: DUMMY VARIABLE REGRESSION

	size and break coefficients				base	participation coefficients			hypothesis tests				
	ΔS	ΔSB	ΔM	ΔMB	L,1980,FT	ΔPT2	ΔPT1	ΔLP	F-s	F-p	F-b	F-t	F
SEED	3302*	-2407*	1452	-1128	5459	-1180	-1979*	-3097*	6.16	6.71	2.03	.30	2.30
R^2=.03	(978)	(1223)	(1013)	(1300)	(998)	(725)	(645)	(712)	(0)	(0)	(.13)	(.97)	(0)
FERTILIZER(kg)	4138*	-1558	953	259	11606	-1803*	-3651*	-3867*	10.50	12.45	1.43	1.69	5.04
R^2=.10	(1030)	(1288)	(1067)	(1369)	(1051)	(764)	(679)	(750)	(0)	(0)	(.24)	(.10)	(0)
REQUISITES	1834	-2240	871	-2466	5146	-1293	-1994*	-3333*	1.40	5.72	1.62	1.70	3.13
R^2=.05	(1128)	(1410)	(1168)	(1499)	(1151)	(836)	(744)	(821)	(.25)	(0)	(.20)	(.10)	(0)
HERBICIDES	-218*	238*	-163	175	948	-22	-49	-33	3.74	.30	2.83	20.23	17.13
R^2=.30	(80)	(100)	(83)	(106)	(82)	(60)	(52)	(58)	(.02)	(.83)	(.06)	(.0)	(0)
INSECTICIDES	1953*	-269*	1782*	-1107	5455	-945	-2093*	-2531*	3.04	7.28	.61	2.73	4.67
R^2=.09	(830)	(1037)	(859)	(1102)	(846)	(615)	(547)	(604)	(.05)	(0)	(.55)	(.01)	(0)
WATER(ha)	.28	-.02	-.05	-.03	1.43	.04	-.28*	-.19	2.55	2.38	.01	7.78	5.41
R^2=.10	(.19)	(.23)	(.19)	(.25)	(.19)	(.14)	(.12)	(.13)	(.08)	(.07)	(.99)	(0)	(0)
LIVESTOCK	295	4744*	4865*	-4337*	154	440	-586	-3122*	5.64	2.54	10.49	2.91	3.96
R^2=.07	(1754)	(2193)	(1817)	(2330)	(1789)	(1300)	(1156)	(1276)	(0)	(.06)	(0)	(0)	(0)
FEED(kg)	34	86	204*	-162**	49	-58	-84	-125	5.49	2.21	4.91	.66	1.80
R^2=.02	(34)	(87)	(72)	(93)	(71)	(52)	(46)	(51)	(0)	(.09)	(.01)	(.72)	(.03)
VARIABLE COST	24265	19142	54280*	-41641**	60067	-19641	-29953*	-47149*	4.73	4.85	4.72	.96	2.56
R^2=.04	(17508)	(21882)	(18133)	(23263)	(17858)	(12975)	(11541)	(12736)	(.01)	(0)	(.01)	(.47)	(0)
% VC IN OUTPUT	-2.27	-.04	-2.56	.58	37.95	3.18	8.31*	2.85	.46	7.37	.02	4.14	3.99
R^2=.07	(2.74)	(3.42)	(2.83)	(3.64)	(2.79)	(2.02)	(1.80)	(1.99)	(.63)	(0)	(.98)	(0)	(0)

*: significantly (.05) different from zero (**:sign .10) (standard deviations in brackets) (the reported R^2 is the corrected R^2)

a: per hectare paddy equivalent cultivatable land area
b: values expressed in constant NT$, except fertilizer at 159.28 NT$/kg), feed at 189.48 NT$/kg) and the water at 1898.19 NT$/ha)
c: Herbicides were reported in the requisites before 1978
d: the variable costs include the costs of hired labour services (human, animal,machine) reported in Table D.9-12

Table D.12: SUGAR: SELECTED INTERMEDIATE INPUTS per HECTARE: DUMMY VARIABLE REGRESSION (continued)

	annual shift coefficients							
	Δ1972	Δ1973	Δ1974	Δ1975	Δ1976	Δ1977	Δ1978	Δ1979
SEED	-15	-496	-1030	-715	-250	-1076	-668	-614
	(1317)	(1311)	(1313)	(1319)	(1319)	(1002)	(1011)	(1003)
FERTILIZER(kg)	-3611*	-3289*	-1296	-1748	-1804	-1956	-619	-551
	(1387)	(1381)	(1382)	(1390)	(1389)	(1056)	(1065)	(1056)
REQUISITES	-1835	-1014	-142	293	1642	1237	-846	50
	(1519)	(1512)	(1513)	(1521)	(1520)	(1156)	(1166)	(1156)
HERBICIDES	-937*	-934*	-939*	-939*	-936*	-772*	-205*	-182*
	(108)	(108)	(108)	(108)	(108)	(82)	(83)	(82)
INSECTICIDES	-2601*	-2336*	-2183*	-1748*	-639*	-1541**	475	1059
	(1117)	(1112)	(1113)	(1119)	(1118)	(850)	(858)	(851)
WATER(ha)	-.67*	.49	-.63*	-.55*	.16	-.78*	-.99*	-.19
	(.25)	(.25)	(.25)	(.25)	(.25)	(.19)	(.19)	(.19)
LIVESTOCK	6709*	3495	642	7	549	3117**	3052**	2413
	(2362)	(2351)	(2354)	(2366)	(2365)	(1797)	(1813)	(1799)
FEED(kg)	110	31	63	38	44	66	129	108
	(94)	(94)	(94)	(94)	(94)	(72)	(72)	(72)
VARIABLE COST	28182	5604	1148	-1407	16482	24731	33389**	21144
	(23572)	(23467)	(13491)	(23611)	(23599)	(17938)	(18098)	(17950)
% VC IN OUTPUT	9.67*	2.72	-2.71	-.18	1.68	8.71*	3.94	.95
	(3.68)	(3.67)	(3.67)	(3.69)	(3.69)	(2.80)	(2.83)	(2.81)

*: significantly (.05) different from zero (**:sign .10) (standard deviations in brackets) (the reported R^2 is the corrected R^2)

a: per hectare paddy equivalent cultivatable land area
b: values expressed in constant NT$, except fertilizer at 159.28 NT$/kg), feed at 189.48 NT$/kg) and the water at 1898.19 NT$/ha)
c: Herbicides were reported in the requisites before 1978
d: the variable costs include the costs of hired labour services (human, animal,machine) reported in Table D.9-12

Table D.13: NORTH RICE: SIMPLE PRODUCTIVITY MEASURES: DUMMY VARIABLE REGRESSION

	size and break coefficients				base	participation coefficients			hypothesis tests				
	ΔS	ΔSB	ΔM	ΔMB	L,1980,FT	ΔPT2	ΔPT1	ΔLP	F-s	F-p	F-b	F-t	F
MULTIPLE CROP	49*	0	39*	-6	178	-5	-16*	-29*	16.11	12.03	.36	.55	7.28
R^2=.14	(9)	(11)	(9)	(11)	(9)	(5)	(5)	(5)	(0)	(0)	(.69)	(.)	(0)
RICE YIELD1	225	168	139	37	4202	272*	220**	-54	.58	3.39	.35	4.22	4.64
R^2=.10	(221)	(272)	(222)	(267)	(232)	(117)	(113)	(122)	(.56)	(.02)	(.71)	(0)	(0)
RICE YIELD2	278	125	176	87	3241	272*	-29	147	.89	2.62	.11	14.04	10.73
R^2=.20	(218)	(267)	(219)	(272)	(228)	(116)	(111)	(121)	(.41)	(.05)	(.89)	(0)	(0)
NON-RICE YIELD	71775*	-43198	21951	-19189	99654	833	-29820*	-13621	7.48	2.53	1.44	1.98	4.16
R^2=.10	(21834)	(27420)	(21843)	(27705)	(22902)	(11875)	(11842)	(16345)	(0)	(.06)	(.24)	(.05)	(0)
OUTPUT/HA	171502*	21894	85106	-17223	184372	9933	-130850*	-185060*	5.15	14.07	.29	.07	4.10
R^2=.08	(59986)	(74155)	(61023)	(76619)	(62769)	(32740)	(31848)	(34478)	(.01)	(0)	(.75)	(.99)	(0)
PROFIT/HA	126082*	-17484	37031	-13887	125878	-6614	82465*	-121980*	12.92	18.68	.10	.26	5.88
R^2=.12	(32366)	(40010)	(32925)	(41340)	(33867)	(17666)	(17184)	(18603)	(0)	(0)	(.91)	(.98)	(0)
INVEST/HA	14715	-8670	3957	-2028	23738	8013	3933	-6429	1.00	1.02	.21	1.46	1.13
R^2=0	(13839)	(17108)	(14078)	(17676)	(14481)	(7553)	(7347)	(7954)	(.37)	(.38)	(.80)	(.17)	(.33)
SAVING/HA	57536*	-28702	11892	-8488	42357	30527*	10534	34654*	5.79	3.14	.75	1.14	3.44
R^2=.06	(23665)	(29255)	(24074)	(30227)	(24763)	(12916)	(12564)	(13602)	(0)	(.03)	(.47)	(.33)	(0)

*: significantly (.05) different from zero (**: sign .10) (standard deviations in brackets) (the reported R^2 is the corrected R^2)

a: multiple crop index: cropped area per cultivatable area
b: rice yields: first or second season rice harvest per area planted to rice (kg)
c: non-rice yields: non-rice crop value per area planted to non-rice crops (undeflated value)
d: output/ha: output value per equivalent cultivatable hectare (deflated with a profit deflator)
e: profit/ha: profit value per equivalent cultivatable hectare (deflated with a profit deflator)
f: investment/hectare: investment per equivalent cultivatable hectare (deflated with the consumer price index)
g: saving/hectare: saving per equivalent cultivatable hectare (deflated with the consumer price index)

Table D.13: NORTH RICE: SIMPLE PRODUCTIVITY MEASURES: DUMMY VARIABLE REGRESSION (continued: annual coefficients)

	annual shift coefficients							
	Δ1972	Δ1973	Δ1974	Δ1975	Δ1976	Δ1977	Δ1978	Δ1979
MULTIPLE CROP INDEX	-2	2	6	2	-7	2	-1	-8
	(11)	(11)	(11)	(11)	(11)	(7)	(7)	(7)
RICE YIELD1	-338	-975*	-872*	-808*	-515**	-169	-72	-530*
	(286)	(283)	(283)	(285)	(286)	(179)	(179)	(180)
RICE YIELD2	-122	-1048*	-1598*	-731*	-276	38	-457*	-235
	(281)	(278)	(279)	(280)	(281)	(176)	(176)	(178)
NON-RICE YIELD	-64680*	-53868**	-49126	-11060	-42153	-35611	-44303*	-12356
	(28830)	(28496)	(28741)	(28886)	(29083)	(20848)	(20688)	(21668)
OUTPUT/HA	-20217	-31960	-3879	-19153	-29280	-12856	-11733	-12207
	(78643)	(77951)	(78098)	(78531)	(78774)	(50272)	(50306)	(50608)
PROFIT/HA	-27641	-31074	-16760	-30906	-19246	-30475	27265	-15190
	(42432)	(42059)	(42138)	(42374)	(42503)	(27124)	(27143)	(27306)
FARM INVESTMENT/HA	-22310	-5583	-10299	983	-21383	-15195	-26508*	-7969
	(18143)	(17984)	(18018)	(18117)	(18174)	(11598)	(11606)	(11676)
SAVINGS/HA	-36684	-22967	-25118	-12268	-24488	-40802	-31554	4160
	(31026)	(30752)	(30810)	(30981)	(31077)	(19833)	(19847)	(19965)

*: significantly (.05) different from zero (**: sign .10) (standard deviations in brackets) (the reported R^2 is the corrected R^2)

a: multiple crop index: cropped area per cultivatable area
b: rice yields: first or second season rice harvest per area planted to rice (kg)
c: non-rice yields: non-rice crop value per area planted to non-rice crops (undeflated value)
d: output/ha: output value per equivalent cultivatable hectare (deflated with a profit deflator)
e: profit/ha: profit value per equivalent cultivatable hectare (deflated with a profit deflator)
f: investment/hectare: investment per equivalent cultivatable hectare (deflated with the consumer price index)
g: saving/hectare: saving per equivalent cultivatable hectare (deflated with the consumer price index)

Table D.14: MID RICE: SIMPLE PRODUCTIVITY MEASURES: DUMMY VARIABLE REGRESSION

	size and break coefficients				base	participation coefficients			hypothesis tests				
	ΔS	ΔSB	ΔM	ΔMB	L,1980,FT	ΔPT2	ΔPT1	ΔLP	F-s	F-p	F-b	F-t	F
MULTIPLE CROP	3	20	15	19	195	18*	25*	8	1.69	7.40	.72	.68	2.84
R^2=.04	(14)	(17)	(14)	(18)	(15)	(6)	(6)	(6)	(.18)	(0)	(.49)	(.71)	(0)
RICE YIELD1	-477**	271	-387	11	6233	-17	-163	95	1.80	2.09	1.31	9.19	5.93
R^2=.12	(254)	(308)	(262)	(321)	(274)	(120)	(112)	(123)	(.17)	(.10)	(.27)	(0)	(0)
RICE YIELD2	-518*	433	-232	36	5461	-118	-204	8	3.89	1.93	3.34	16.94	9.96
R^2=.20	(254)	(299)	(253)	(311)	(265)	(116)	(109)	(119)	(.02)	(.12)	(.04)	(0)	(0)
NON-RICE YIELD	16487	24289	-16249	28471	150795	-37227*	-47847*	-64707*	2.80	10.45	.29	3.12	6.30
R^2=.13	(32052)	(36392)	(32806)	(37604)	(34349)	(11335)	(10710)	(12694)	(.06)	(0)	(.75)	(0)	(0)
OUTPUT/HA	103984*	1710	22864	-5627	271765	-54873*	-112330*	-134460*	6.05	14.51	.02	1.02	4.64
R^2=.08	(51017)	(62025)	(53128)	(64992)	(54796)	(22517)	(20991)	(22659)	(0)	(0)	(.98)	(.42)	(0)
PROFIT/HA	65792*	-13289	25846	-16899	166824	-44034*	-76344*	-94588*	7.39	29.17	.15	1.70	7.90
R^2=.14	(24677)	(30001)	(25698)	(31436)	(26505)	(10891)	(10153)	(10960)	(0)	(0)	(.86)	(.10)	(0)
INVEST/HA	11126	-20163	-4606	2293	40696	-13388	-9005	-16145	.99	1.03	1.26	.77	.97
R^2=0	(22412)	(27247)	(23339)	(28551)	(24072)	(9892)	(9221)	(9954)	(.37)	(.38)	(.28)	(.63)	(.49)
SAVING/HA	47286	-50879	38051	-29757	82023	-2145	-740	69436*	.89	9.68	.91	2.01	4.54
R^2=.08	(36098)	(43887)	(37592)	(45987)	(38772)	(15932)	(14852)	(16032)	(.41)	(0)	(.40)	(.04)	(0)

*: significantly (.05) different from zero (**: sign .10) (standard deviations in brackets) (the reported R^2 is the corrected R^2)

a: multiple crop index: cropped area per cultivatable area
b: rice yields: first or second season rice harvest per area planted to rice (kg)
c: non-rice yields: non-rice crop value per area planted to non-rice crops (undeflated value)
d: output/ha: output value per equivalent cultivatable hectare (deflated with a profit deflator)
e: profit/ha: profit value per equivalent cultivatable hectare (deflated with a profit deflator)
f: investment/hectare: investment per equivalent cultivatable hectare (deflated with the consumer price index)
g: saving/hectare: saving per equivalent cultivatable hectare (deflated with the consumer price index)

Table D.14: MID RICE: SIMPLE PRODUCTIVITY MEASURES: DUMMY VARIABLE REGRESSION (continued: annual coefficients)

	annual shift coefficients							
	Δ1972	Δ1973	Δ1974	Δ1975	Δ1976	Δ1977	Δ1978	Δ1979
MULTIPLE CROP INDEX	-10	-18	-15	-21	-25	-4	-3	-10
	(18)	(18)	(18)	(18)	(18)	(9)	(9)	(9)
RICE YIELD1	-632*	-1205*	-800*	-1098*	-337	-993*	-463*	-471*
	(322)	(324)	(328)	(327)	(333)	(167)	(168)	(177)
RICE YIELD2	-361	-1213*	-1068*	-1154*	-48	-125	-992*	-426*
	(312)	(315)	(318)	(316)	(323)	(160)	(161)	(170)
NON-RICE YIELD	-111080*	-102500*	-79833*	-80328*	-54122	-35921*	-26003	1675
	(38033)	(38244)	(38487)	(38396)	(39055)	(17522)	(17894)	(18825)
OUTPUT/HA	-17064	-45650	-11161	-71481	-33589	-32358	-7432	-56380
	(64829)	(65013)	(65757)	(65562)	(66872)	(31835)	(31761)	(33272)
PROFIT/HA	-16145	-19763	2239	-32689	-4144	-32160*	-10694	-36997*
	(31357)	(31446)	(31806)	(31712)	(32345)	(15398)	(15362)	(16093)
FARM INVESTMENT/HA	-10102	-4597	-10934	-10545	-8393	-23720	2817	-21585
	(28479)	(28560)	(28887)	(28801)	(29376)	(13984)	(13952)	(14617)
SAVINGS/HA	-53023	-48729	-57007	-28646	-7108	-65730*	-47400*	-50495*
	(45871)	(46001)	(46528)	(46389)	(47316)	(22525)	(22473)	(23542)

*: significantly (.05) different from zero (**: sign .10) (standard deviations in brackets) (the reported R^2 is the corrected R^2)

a: multiple crop index: cropped area per cultivatable area
b: rice yields: first or second season rice harvest per area planted to rice (kg)
c: non-rice yields: non-rice crop value per area planted to non-rice crops (undeflated value)
d: output/ha: output value per equivalent cultivatable hectare (deflated with a profit deflator)
e: profit/ha: profit value per equivalent cultivatable hectare (deflated with a profit deflator)
f: investment/hectare: investment per equivalent cultivatable hectare (deflated with the consumer price index)
g: saving/hectare: saving per equivalent cultivatable hectare (deflated with the consumer price index)

Table D.15: SOUTH RICE: SIMPLE PRODUCTIVITY MEASURES: DUMMY VARIABLE REGRESSION

	size and break coefficients				base	participation coefficients			hypothesis tests				
	ΔS	ΔSB	ΔM	ΔMB	L,1980,FT	ΔPT2	ΔPT1	ΔLP	F-s	F-p	F-b	F-t	F
MULTIPLE CROP	27*	1	15	-6	217	-7	-22*	-40*	2.39	8.30	.23	1.17	2.42
R^2=.04	(13)	(16)	(13)	(17)	(14)	(7)	(7)	(9)	(.09)	(0)	(.79)	(.31)	(0)
RICE YIELD1	468	-205	-78	2	5538	130	627**	-124	.92	1.66	.08	.99	.98
R^2=0	(619)	(779)	(612)	(804)	(651)	(361)	(361)	(418)	(.40)	(.18)	(.92)	(.44)	(.48)
RICE YIELD2	-152	-146	-62	5	4179	114	119	-36	.31	.76	.37	4.25	3.16
R^2=.06	(216)	(268)	(207)	(272)	(224)	(125)	(124)	(145)	(.73)	(.52)	(.69)	(0)	(0)
NON-RICE YIELD	166	24206*	-3163	12236	84250	-10652**	-9705**	-18087*	.15	2.79	2.34	4.11	6.43
R^2=.14	(9533)	(12211)	(9382)	(12487)	(10039)	(5571)	(5482)	(6481)	(.85)	(.04)	(.10)	(0)	(0)
OUTPUT/HA	57535	31934	-48471	57889	237641	25316	-26151	-67350	3.05	1.72	.26	1.08	1.34
R^2=.01	(64814)	(82414)	(64190)	(84985)	(67950)	(37624)	(37217)	(42483)	(.05)	(.16)	(.77)	(.37)	(.17)
PROFIT/HA	46112	12750	2425	13273	104784	11884	-16723	-56072*	3.17	5.05	.07	1.56	2.11
R^2=.03	(28026)	(35636)	(27756)	(36736)	(29382)	(16269)	(16092)	(18370)	(.04)	(0)	(.93)	(.13)	(.01)
INVEST/HA	7068	-5680	-5719	1284	26967	27455*	8493	-8044	.33	2.21	.06	1.99	1.64
R^2=.02	(23786)	(30245)	(23557)	(31178)	(24937)	(13808)	(13658)	(15591)	(.72)	(.09)	(.94)	(.05)	(.06)
SAVING/HA	19799	-55706	-32715	323	52033	29760	39152	107934*	2.16	6.34	1.68	1.89	3.96
R^2=.10	(38416)	(48848)	(38047)	(50357)	(40275)	(22301)	(22059)	(25180)	(.12)	(0)	(.19)	(.06)	(0)

*: significantly (.05) different from zero (**: sign .10) (standard deviations in brackets) (the reported R^2 is the corrected R^2)

a: multiple crop index: cropped area per cultivatable area
b: rice yields: first or second season rice harvest per area planted to rice (kg)
c: non-rice yields: non-rice crop value per area planted to non-rice crops (undeflated value)
d: output/ha: output value per equivalent cultivatable hectare (deflated with a profit deflator)
e: profit/ha: profit value per equivalent cultivatable hectare (deflated with a profit deflator)
f: investment/hectare: investment per equivalent cultivatable hectare (deflated with the consumer price index)
g: saving/hectare: saving per equivalent cultivatable hectare (deflated with the consumer price index)

Table D.15: SOUTH RICE: SIMPLE PRODUCTIVITY MEASURES: DUMMY VARIABLE REGRESSION (continued: annual coefficients)

	annual shift coefficients							
	Δ1972	Δ1973	Δ1974	Δ1975	Δ1976	Δ1977	Δ1978	Δ1979
MULTIPLE CROP INDEX	4	21	32	24	23	15	16	8
	(19)	(18)	(18)	(18)	(18)	(11)	(11)	(11)
RICE YIELD1	101	-152	190	250	752	418	-346	705
	(893)	(884)	(845)	(843)	(839)	(521)	(517)	(534)
RICE YIELD2	-281	-227	-13	-327	289	-665*	-465*	-174
	(304)	(302)	(289)	(288)	(287)	(181)	(185)	(187)
NON-RICE YIELD	-65130*	-59762*	-53425*	-48179*	-38941*	245	-4184	-13330
	(13722)	(13726)	(13152)	(13089)	(13108)	(7980)	(7887)	(8147)
OUTPUT/HA	-15501	-49721	-50256	-56677	-40090	24774	89710	-51639
	(92954)	(92428)	(88963)	(88533)	(88216)	(53058)	(52712)	(53415)
PROFIT/HA	4418	-10182	8891	-822	1132	8860	56756*	-17480
	(40194)	(39966)	(38468)	(38282)	(38145)	(22943)	(22793)	(23067)
FARM INVESTMENT/HA	-20570	-18606	-16519	-11850	-11251	-24338	31337	-39673*
	(34113)	(33920)	(32648)	(32490)	(32374)	(19472)	(19345)	(19602)
SAVINGS/HA	-19946	2929	-14287	26785	9165	-17617	82133*	2225
	(55096)	(54784)	(52730)	(52475)	(52287)	(31448)	(31243)	(31660)

*: significantly (.05) different from zero (**: sign .10) (standard deviations in brackets) (the reported R^2 is the corrected R^2)

a: multiple crop index: cropped area per cultivatable area
b: rice yields: first or second season rice harvest per area planted to rice (kg)
c: non-rice yields: non-rice crop value per area planted to non-rice crops (undeflated value)
d: output/ha: output value per equivalent cultivatable hectare (deflated with a profit deflator)
e: profit/ha: profit value per equivalent cultivatable hectare (deflated with a profit deflator)
f: investment/hectare: investment per equivalent cultivatable hectare (deflated with the consumer price index)
g: saving/hectare: saving per equivalent cultivatable hectare (deflated with the consumer price index)

Table D.16: SUGAR: SIMPLE PRODUCTIVITY MEASURES: DUMMY VARIABLE REGRESSION

	size and break coefficients				base	participation coefficients			hypothesis tests				
	ΔS	ΔSB	ΔM	ΔMB	L,1980,FT	ΔPT2	ΔPT1	ΔLP	F-s	F-p	F-b	F-t	F
MULTIPLE CROP	9	9	2	14	170	3	-13*	-26*	.55	6.01	.68	1.02	1.96
R^2=.02	(9)	(9)	(10)	(12)	(10)	(7)	(6)	(7)	(.57)	(0)	(.50)	(.42)	(.02)
RICE YIELD1	-283	394	-562	170	6469	109	-911**	124	1.06	4.58	.27	1.57	2.48
R^2=.14	(450)	(540)	(387)	(503)	(381)	(293)	(295)	(381)	(.35)	(0)	(.77)	(.14)	(0)
RICE YIELD2	-186	89	-80	283	4937	68	-264	210	.24	2.20	.46	5.25	3.63
R^2=.10	(269)	(309)	(249)	(304)	(272)	(169)	(168)	(217)	(.78)	(.09)	(.63)	(0)	(0)
NON-RICE YIELD	21754*	-11077	15133*	-9656	74561	-7325	-11956*	7307	5.76	2.90	1.04	7.12	12.54
R^2=.24	(6418)	(7934)	(6643)	(8422)	(6690)	(4643)	(4145)	(4612)	(0)	(.03)	(.35)	(0)	(0)
OUTPUT/HA	74875*	29177	85366*	-53100**	165290	-42036*	-81775*	-105690*	6.50	14.14	4.50	.56	4.45
R^2=.08	(24194)	(30240)	(25057)	(32147)	(24678)	(17931)	(15949)	(17600)	(0)	(0)	(.01)	(.81)	(0)
PROFIT/HA	50610*	10035	31086*	-11459	105224	-22395*	-51822*	-58536*	8.84	19.57	1.23	.67	5.65
R^2=.03	(12063)	(15078)	(12494)	(16029)	(12305)	(8940)	(7952)	(8778)	(0)	(0)	(.29)	(.72)	(0)
INVEST/HA	-12230**	9973	-5209	200	36141	-3155	-811	-5864	2.04	.67	1.24	3.26	2.48
R^2=.05	(6332)	(7915)	(6558)	(8414)	(6459)	(4693)	(4174)	(4607)	(.13)	(.57)	(.29)	(0)	(0)
SAVING/HA	5276	-2033	16476	-26462	27485	6022	17327*	33879*	.97	4.96	1.91	.73	2.27
R^2=.03	(12299)	(15372)	(12738)	(16342)	(12545)	(9115)	(8107)	(8947)	(.38)	(0)	(.15)	(.66)	(0)

*: significantly (.05) different from zero (**: sign .10) (standard deviations in brackets) (the reported R^2 is the corrected R^2)

a: multiple crop index: cropped area per cultivatable area
b: rice yields: first or second season rice harvest per area planted to rice (kg)
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d: output/ha: output value per equivalent cultivatable hectare (deflated with a profit deflator)
e: profit/ha: profit value per equivalent cultivatable hectare (deflated with a profit deflator)
f: investment/hectare: investment per equivalent cultivatable hectare (deflated with the consumer price index)
g: saving/hectare: saving per equivalent cultivatable hectare (deflated with the consumer price index)

Table D.16: SUGAR: SIMPLE PRODUCTIVITY MEASURES: DUMMY VARIABLE REGRESSION (continued: annual coefficients)

	annual shift coefficients							
	Δ1972	Δ1973	Δ1974	Δ1975	Δ1976	Δ1977	Δ1978	Δ1979
MULTIPLE CROP INDEX	-5 (13)	-9 (13)	8 (13)	11 (13)	6 (13)	6 (10)	12 (10)	2 (10)
RICE YIELD1	-531 (491)	-1303* (495)	-728 (493)	-1221* (499)	-419 (520)	-335 (434)	-818** (448)	-541 (465)
RICE YIELD2	-208 (333)	-189 (336)	-59 (331)	-1219* (335)	171 (339)	-356 (294)	-412 (309)	-123 (305)
NON-RICE YIELD	-50040* (8643)	-44885* (8606)	-34313* (8613)	-19969* (8666)	-28885* (8661)	-6950 (6563)	-21322* (6619)	-7568 (6590)
OUTPUT/HA	12338 (32573)	-13573 (32429)	1911 (32462)	-12558 (32628)	16146 (32611)	16523 (24790)	29733 (25010)	23420 (24805)
PROFIT/HA	-15844 (16242)	-19177 (16186)	762 (16186)	-11151 (16264)	-336 (16260)	-8208 (12360)	-3656 (12470)	2276 (12368)
FARM INVESTMENT/HA	-26054* (8526)	-25793* (8488)	-17362* (8496)	-27689* (8540)	-35523* (8536)	-7407 (6488)	-21473* (6546)	-11809** (6492)
SAVINGS/HA	-8613 (16558)	2340 (16485)	11664 (16502)	17457 (16586)	12220 (16578)	-1948 (12602)	6202 (12714)	1246 (12609)

*: significantly (.05) different from zero (**: sign .10) (standard deviations in brackets) (the reported R^2 is the corrected R^2)

a: multiple crop index: cropped area per cultivatable area
b: rice yields: first or second season rice harvest per area planted to rice (kg)
c: non-rice yields: non-rice crop value per area planted to non-rice crops (undeflated value)
d: output/ha: output value per equivalent cultivatable hectare (deflated with a profit deflator)
e: profit/ha: profit value per equivalent cultivatable hectare (deflated with a profit deflator)
f: investment/hectare: investment per equivalent cultivatable hectare (deflated with the consumer price index)
g: saving/hectare: saving per equivalent cultivatable hectare (deflated with the consumer price index)

APPENDIX E

INFORMATION ON THE ESTIMATIONS OF CHAPTER V

Hypothesis Test Results:

The General Linear model:
- -test for constant returns to scale (Table E.1)
- -test for linearity of the function (Table E.2)
- -test for constant male productivity (Table E.3)

The Linear Dummy model:
- -test for linearity in the linear size dummy model (Table E.4)
- -test for linearity in the linear size-participation model (Table E.5-6)

Information About the Fit of the Estimated Models (Table E.7)

Coefficients of the Generalized Linear Function (Table E.8)

Sign Patterns of the Generalized Linear Function and comments about the model (Table E.9)

Error Structure: test statistics
- -Linear model (Table E.10)
- -Generalized linear model (Table E.11)

Error Structure:
- of the Generalized Linear Function:
  - -Size, Participation, Year (Table E.12)
  - -Size, Participation (Table E.13)
- of the Linear Function:
  - -Size, Participation (Table E.14)

The Pattern of the Size or Size-Participation Effects:
- -Linear Dummy Models (Table E.15-18)
- -Generalized Linear model (Table E.19-22)

HYPOTHESIS TEST RESULTS

The Generalized Linear Model

$$\Pi = 2\sum_i a_i V_i^{1/2} + 2\sum_{i\neq j}\sum a_{ij} V_i^{1/2} V_j^{1/2} + \sum_i \beta_i V_i$$

(1) test for constant returns to scale in the family supplied factors

$(H_0 : a_i = 0 \quad \forall i; \quad H_a : a_i \neq 0)$

Table E.1: F-STATISTICS FOR THE TEST OF CONSTANT RETURNS TO SCALE

NRa	${}_{400}F_4=1.038$	<<	CRS	NRb	2.3 <	${}_{124}F_5=2.471$	< 3.2	CRS
MRa	${}_{459}F_4=2.009$	<<	CRS	MRb		${}_{116}F_5=0.613$	<<	CRS
SRa	${}_{228}F_4=9.005$	>>	NCRS	SRb		${}_{252}F_5=1.828$	<<	CRS
SUGa	${}_{216}F_4=2.020$	<<	CRS	SUGb		${}_{225}F_5=0.745$	<<	CRS
SUGc	${}_{77}F_4=1.470$	<<	CRS					

a: all paddy farms b:paddy-dry farms c: all dry farms
<< H_0 not rejected at .01 and .05
>> H_0 rejected at .01 and .05

Conclusion: Except for the paddy farmers in the South Rice region, all production technologies are constant returns to scale.

The next set of tests are based on the CRS case, where appropriate.

(2) test for linearity of the function

$(H_0 : a_{ij} = 0 \quad \forall i \neq j \; ; \; H_a : a_{ij} \neq 0)$ (SRa: NCRS case)

Table E.2: F-STATISTICS FOR THE TEST OF LINEARITY

NRa	$_{404}F_6$ =2.012 <<	NRb	$_{104}F_{10}$=2.725 >>
MRa	$_{463}F_6$ =5.812 >>	MRb	$_{121}F_{10}$=1.636 <<
SRa	$_{228}F_{10}$=9.183 >>	SRb	< $_{257}F_{10}$=1.910 <
SUGa	$_{218}F_6$ =0.927 <<	SUGb	$_{230}F_{10}$=3.319 >>
SUGc	< $_{81}F_6$ =2.532 <		

Conclusion: Linearity cannot be rejected in the NRa, the SUGa and the MRb regions (significance level .05), and in the SUGc and SRb regions if the rejection criterium is strengthened (significance level .01).

(3) test for constant male marginal productivities

$(H_0 : a_{Mj} = 0 \quad \forall j; \; H_a : a_{Mj} \neq 0)$ (SRa: NCRS case)

Table E.3: F-STATISTICS FOR THE TEST OF CONSTANT MALE LABOUR RETURNS

NRa	$_{404}F_4$=0.119 <<	NRb	$_{104}F_6$=0.879 <<	CRS
MRa	$_{463}F_4$=2.067 <<	MRb	$_{121}F_6$=1.263 <<	CRS
SRa	$_{228}F_4$=0.959 <<	SRb	$_{257}F_6$=0.759 <<	CRS
SUGa	$_{218}F_4$=1.276 <<	SUGb	$_{230}F_6$=0.994 <<	CRS
SUGc	$_{81}F_4$=1.551 <<			

a: all paddy farms   b:paddy-dry farms   c: all dry farms
<< H_0 not rejected at .01 and .05
>> H_0 rejected at .01 and .05

Conclusion: the male marginal productivity could be a constant for all cases.

The Linear Dummy Models

$$\Pi_i = \Sigma(\gamma_0^i + \Sigma \gamma_s^i d_s + \Sigma \gamma_p^i d_p) V^i$$

with: p: participation
s:size
i:factor i

(1) test for linearity in the size-dummy linear model

$(H_0 : \gamma_s^i = 0 \ \forall i,s;\ H_a : \gamma_s^i \neq 0)$ (Restriction: $\gamma_p^i = 0\ \forall i,p$)

Table E.4: F-TEST FOR LINEARITY IN THE SIZE LINEAR MODEL

NRa	${}_{402}F_8$= 6.926 >>	NRb	${}_{104}F_{10}$=1.383 <<
MRa	${}_{461}F_8$= 8.302 >>	MRb	${}_{121}F_{10}$=1.072 <<
SRa	${}_{230}F_8$=11.782 >>	SRb	${}_{257}F_{10}$=3.479 >>
SUGa	${}_{216}F_8$= 1.163 <<	SUGb	${}_{230}F_{10}$=1.065 <<
SUGc	< ${}_{83}F_4$= 2.840 <		

Conclusions: The technology could be linear in the MRb, SUGa and SUGb regions.

(2) test for non-significancy of the participation coefficients in the size participation dummy linear model

$(H_0 : \gamma_p^i = 0 \ \forall i,p; \quad H_a : \gamma_p^i \neq 0)$

Table E.5: F-TEST FOR PARTICIPATION EFFECTS IN THE SIZE-PARTICIPATION LINEAR MODEL

NRa	${}_{390}F_{12}$=3.319 >>	NRb	< ${}_{89}F_{15}$=2.200 <
MRa	${}_{449}F_{12}$=5.435 >>	MRb	${}_{106}F_{15}$=1.596 <<
SRa	${}_{218}F_{12}$=0.734 <<	SRb	<${}_{242}F_{15}$=1.625 <
SUGa	<${}_{204}F_{12}$=2.078 <	SUGb	${}_{215}F_{15}$=2.467 >>
SUGc	${}_{71}F_{12}$=2.681 >>		

(3) test for non-significancy of the <u>size coefficients</u> in the size-participation dummy linear model

$(H_0 : \gamma_s^i = 0 \ \forall i,s; \quad H_a : \gamma_s^i \neq 0)$

Table E.6: F-TEST FOR SIZE EFFECTS IN THE SIZE-PARTICIPATION LINEAR MODEL

NRa	${}_{390}F_8 = 7.892$ >>	NRb	${}_{89}F_{10} = 1.446$ <<
MRa	${}_{449}F_8 = 12.308$ >>	MRb	${}_{106}F_{10} = 0.994$ <<
SRa	${}_{218}F_8 = 5.194$ >>	SRb	${}_{242}F_{10} = 2.713$ >>
SUGa	${}_{204}F_8 = 0.986$ <<	SUGb	${}_{215}F_{10} = 0.609$ <<
SUGc	${}_{71}F_4 = 12.637$ >>		

Conclusion: there are neither size nor participation effects in the MRb and the SUGa regions (significance level .05), or if the criterium is strengthened, also in the NRb region.

Table E.7: INFORMATION ABOUT THE FIT OF THE ESTIMATED FUNCTIONS

	Linear Dummy Size-Participation			Linear Dummy Size			Linear			Generalized Linear (CRS except in SRa)			To Explain	
	R^2	SSE/DF	DF	R^2	SSE/DF	DF	R^2	SSE/DF	DF	R^2	SSE/DF	DF	SST/(NOBS-1)	NOBS
NR a	86.80	.39695	390	85.46	.42443	402	83.45	.47351	410	83.95	.46599	404	2.83606	414
b	89.38	.27897	89	85.44	.32727	104	83.50	.33826	114	86.93	.29380	104	1.97009	119
MR a	89.53	.24355	449	88.01	.27167	461	86.29	.30551	469	87.25	.28779	463	2.21058	473
b	91.88	.35288	106	90.05	.37896	121	89.17	.38105	131	90.46	.36341	121	3.39782	136
SR a	92.91	.41091	218	92.65	.40520	230	89.61	.55205	238	92.59	.41080	228	5.23871	242
b	88.00	.55028	242	86.79	.57036	257	85.00	.62332	267	86.04	.60276	257	4.08619	272
SUGa	86.77	.39473	204	85.15	.41838	216	84.51	.42081	224	84.89	.42163	218	2.67492	228
b	92.77	.34184	215	91.52	.37454	230	91.13	.37555	240	92.25	.34246	230	4.15360	245
c	88.80	.27625	71	83.72	.34338	83	81.49	.37243	87	84.42	.33684	81	1.93120	91

a: all paddy farms b: paddy-dry farms c: all dry farms CRS: Constant returns to scale

SRa: non-homothetic generalized linear estimated function

SSE: sums of squared error DF: degrees of freedom SST: sums of squared to explain NOBS: number of observation

Table E.8: GENERALIZED LINEAR COEFFICIENTS $\Pi = \sum_i \alpha_i 2V_i^{1/2} + 2\sum_{i\neq j}\sum \alpha_{ij} V_i^{1/2} V_j^{1/2} + \sum_i \beta_i V_i$

Variable	NRa	NRb	MRa	MRb	SRa	SRb	SUGa	SUGb	SUGc
P	76859*	-35070	198530*	188580*	135390*	174940*	80997*	49609	
	(29938)	(43203)	(37887)	(76330)	(49088)	(42215)	(31882)	(41358)	
$(4PD)^{1/2}$		-58017**		31449		-17159		4814	
		(32272)		(39625)		(35083)		(23502)	
$(4PM)^{1/2}$	824	10	348	-2803	-2898	-779	1517	-2606	
	(1590)	(2521)	(2342)	(2654)	(3328)	(3478)	(2092)	(2670)	
$(4PF)^{1/2}$	-3616**	-2619	-7925*	-7774*	-10571*	-3394	-4187**	-654	
	(2020)	(3881)	(2184)	(3162)	(3258)	(2815)	(2249)	(2506)	
$(4PA)^{1/2}$	-1334*	3160*	-2348*	-503	516	-1593**	-154	1515**	
	(563)	(1189)	(644)	(1243)	(785)	(849)	(909)	(893)	
D		68220**		8236		123380*		30623	143250*
		(38626)		(57942)		(48350)		(19431)	(38192)
$(4DM)^{1/2}$		-71		-2884		-2545		842	-5273*
		(2694)		(2122)		(2414)		(1757)	(2810)
$(4DF)^{1/2}$		1708		1365		-766		2136	-5631*
		(3118)		(2351)		(2214)		(1693)	(2912)
$(4DA)^{1/2}$		-259		-339		-612		-1029*	-69
		(1002)		(874)		(831)		(482)	(1181)
M	256*	372*	113	49	697*	-42	-207	295	788**
	(114)	(141)	(184)	(255)	(324)	(343)	(189)	(265)	(431)
$(4MF)^{1/2}$	5	126	300*	123	191	191	261	223	137
	(121)	(248)	(146)	(186)	(234)	(198)	(174)	(163)	(255)
$(4MA)^{1/2}$	-22	-100	-34	138**	119	59	-62	-88	-83
	(45)	(78)	(47)	(78)	(72)	(57)	(78)	(57)	(117)
F	100	-242	120	306	455	113	-60	-390	-403
	(218)	(481)	(180)	(273)	(327)	(311)	(251)	(210)	(305)
$(4FA)^{1/2}$	132*	92	151*	53	-14	41	95	70	293*
	(52)	(78)	(51)	(66)	(65)	(62)	(87)	(58)	(111)
A	46*	-35	41*	-18	5	65**	52**	5	-10
	(18)	(30)	(16)	(26)	(23)	(26)	(27)	(23)	(39)

add to SRa: 26404 × $2P^{1/2}$ (28242) -6491* × $2M^{1/2}$ (2190) +5168* × $2F^{1/2}$ (2135) -889 × $2A^{1/2}$ (546) (The Non-homothetic terms for this farm group)

P: Paddy land D: Dry land M: Male labour F: Female labour A: Farm Assets (standard deviations in brackets)

Table E.9: SIGN PATTERN OF THE GENERALIZED LINEAR FUNCTION: coefficients and diagonal of the second order derivative (average)

NRa⁺

	P	M	F	A	
P	+	+	-	-	>
M	+	+	+	-	<
F	-	+	+	+	<
A	-	-	+	+	>

NRb

	P	D	M	F	A	
P	-	-	+	-	+	<
D	-	+	-	+	-	>
M	-	-	+	+	-	>
F	-	+	+	-	+	<
A	+	-	-	+	-	<

MRa

P	+	+	-	-	>
M	+	+	+	-	<
F	-	+	+	+	<
A	-	-	+	+	>

MRb⁺

P	+	+	-	-	-	>
D	+	+	-	+	-	>
M	-	-	+	+	+	<
F	-	+	+	+	+	>
A	-	-	+	+	-	<

SRa (NCRS)

P	+	-	-	+	+	>
M	-	+	+	+	-	>
F	-	+	+	-	+	>
A	+	+	-	+	-	<

SRb

P	+	-	-	-	-	>
D	-	+	-	-	-	>
M	-	-	-	+	+	<
F	-	-	+	+	+	<
A	-	-	+	+	+	>

SUGa⁺

P	+	+	-	-	>
M	+	-	+	-	<
F	-	+	-	+	<
A	-	-	+	+	<

SUGb

P	+	+	-	-	+	<
D	+	+	+	+	-	<
M	-	+	+	+	-	>
F	-	+	+	-	+	<
A	+	-	-	+	+	<

SUGc

	D	M	F	A	
D	+	-	-	-	>
M	-	+	+	-	>
F	-	+	-	+	<
A	-	-	+	-	<

P: Paddy land
D: Dry land
M: male labour
F: female labour
A: farm assets

NCRS: non-homothetic
⁺ : Linear function can not be rejected (sign. .05)

MODEL:

$$\Pi = \sum_{i \neq j} \sum a_{ij} (4V_i V_j)^{1/2} + \sum_i \beta_i V_i \quad [+ \sum_i a_i^{SRa} (4V_i)^{1/2}]$$

The previous page signs refer to the following sign of the coefficient of the generalized linear function and the sign of the diagonal of the second order derivative matrix.

If $a_{ij} > 0$ then (+) If $a_{ij} < 0$ then (-)

If $1/H \sum_h (\partial^2 \Pi_h / \partial V_i^2) < 0$ then (<)

where H is the number of households in the sample,

or $\partial^2 \Pi / \partial V_i^2 = -(\partial \Pi / \partial V_i - \beta_i)/2V_i < 0$ if $\partial \Pi / \partial V_i > \beta_i$

For the non-homothetic situations we have the following structure of the generalized function:

$$\Pi(\lambda v) = \lambda \, \Pi(v) - \sum_i a_i V_i^{1/2} (\lambda - \lambda^{1/2})$$

where $(\lambda - \lambda^{1/2}) > 0$ if $\lambda > 1$

The expansion of the profit along a ray from the origin in the input space is dependent on the position of the ray and on the coefficients a_i.

As an example:

If $\lambda = 2$ and if $a_i > 0 \;\forall i$ then there will be less than double the amount of profit (DRS), but if $a_i < 0 \;\forall i$, then there will be more than a doubling of the profit (IRS) along all rays out of the origin in the input space.

If some $a_i > 0$ and some $a_i < 0$ then along some rays you will have more than double, while on others less than double the profit, depending on whether

$$\left| \sum_i 2a_i V_i^{1/2} \right| > \left| \sum_j 2a_j V_j^{1/2} \right|$$

or the reverse. For the SRa case we have $\hat{a}_P$ and $\hat{a}_F > 0$, while $\hat{a}_M$ and $\hat{a}_A < 0$, so no clear statement can be given.

Table E.10: STRUCTURE OF THE ESTIMATION ERROR OF THE LINEAR MODEL: TEST STATISTICS

Error Structure: Linear Function $\hat{e} = \Pi - \Sigma_i \hat{\beta}_i V_i = \gamma_0 + \Sigma_s \gamma_s d_s + \Sigma_p \gamma_p d_p + \Sigma_t \gamma_t d_t \quad H_a : \gamma_k = 0 \; \forall k=s,p,t$

	SIZE-PARTICIPATION-YEAR DUMMY MODEL					SIZE-PARTICIPATION DUMMY MODEL			SIZE MODEL
	$ALL_{13}=0$	$\Delta PT_3=0$	$\Delta S_2=0$	$\Delta Y_8=0$	DF	$ALL_5=0$	$\Delta PT_3=0$	$\Delta S_2=0$	$ALL_2=0$
NRa	2.273>>	5.472>>	2.035<<	1.470<<	400	3.523>>	4.991>>	2.120<<	1.283<<
NRb	.805<<	.369<<	.702<<	1.113<<	105	.309<<	.133<<	.589<<	.586<<
MRa	3.976>>	5.716>>	1.605<<	3.416>>	459	4.679>>	6.656>>	1.779<<	1.653<<
MRb	1.273<<	.513<<	1.620<<	1.620<<	122	.692<<	.518<<	1.268<<	.963<<
SRa	1.745<<	1.049<<	<3.849<	1.469<<	228	2.152<<	1.448<<	>4.322>	<3.188<
SRb	1.145<<	1.976<<	1.106<<	.857<<	258	1.611<<	2.002<<	1.970<<	1.014<<
SUGa	1.374<<	2.016<<	1.026<<	1.507<<	214	1.141<<	1.423<<	.864<<	.713<<
SUGb	<1.848<	2.453<<	.566<<	1.792<<	231	1.887<<	<2.963<	.748<<	.268<<
SUGc	.501<<	.443<<	.964<<	.552<<	77	.561<<	.482<<	.748<<	.691<<

<<: H_0 not rejected at .05 and .10
>>: H_0 rejected at .05 and .10

Table E.11: STRUCTURE OF THE ESTIMATION ERROR OF THE GENERALIZED LINEAR FUNCTION: TEST STATISTICS

Error Structure: Generalized Linear Function $\hat{e} = \Pi - (\Sigma_i \hat{\beta}_i V_i - 2\Sigma_{i\neq j} \Sigma_{ij} \hat{\alpha}_{ij} V_{ij}^{1/2} V_{ij}^{1/2}) = \gamma_0 + \Sigma_s \gamma_s d_s + \Sigma_p \gamma_p d_p + \Sigma_t \gamma_t d_t \quad H_a : \gamma_k = 0 \; \forall k=s,p,t$

	SIZE-PARTICIPATION-YEAR DUMMY MODEL					SIZE-PARTICIPATION DUMMY MODEL			SIZE MODEL
	$ALL_{13}=0$	$\Delta PT_3=0$	$\Delta S_2=0$	$\Delta Y_8=0$	DF	$ALL_5=0$	$\Delta PT_3=0$	$\Delta S_2=0$	$ALL_2=0$
NRa	<2.114<	5.219>>	1.341<<	<1.504<	400	>3.058>	4.547>>	1.367<<	.804<<
NRb	.868<<	.570<<	.918<<	1.107<<	105	.483<<	.218<<	.807<<	.898<<
MRa	3.604>>	4.314>>	1.711<<	3.430>>	459	3.726>>	4.937>>	1.841<<	1.863<<
MRb	1.410<<	.162<<	.561<<	1.666<<	122	.287<<	.109<<	.533<<	.564<<
SRa (NCRS)	1.314<<	.260<<	1.792<<	1.609<<	228	.825<<	.236<<	1.395<<	1.725<<
SRb	.954<<	.927<<	1.312<<	.919<<	258	1.013<<	.879<<	1.510<<	1.217<<
SUGa	1.126<<	1.202<<	1.215<<	1.244<<	214	.930<<	1.154<<	.850<<	1.052<<
SUGb	2.283>>	1.660<<	1.169<<	2.723>>	231	1.493<<	2.158<<	1.330<<	.487<<
SUGc	.269<<	.164<<	.658<<	.320<<	77	.307<<	.218<<	.468<<	.454<<

<<: H_0 not rejected at .05 and .10
>>: H_0 rejected at .05 and .10

Table E.12: STRUCTURE OF THE ESTIMATION ERROR OF THE GENERALIZED LINEAR FUNCTION $(\Pi-\hat{\Pi})$ (SIZE,PARTICIPATION,YEAR DUMMY MODEL)

DF1	ΔS	ΔM	L,1980,FT	ΔPT2	ΔPT1	ΔLP	F-s 2	F-p 3	F-t 8	F 13	DF2
NRa	-3859	-14278	30173*	-107	-30559*	-23419*	1.341	5.219	1.504	2.114	400
	(12542)	(12582)	(15240)	(9637)	(9008)	(9189)					
NRb	-15343	-10862	47416*	3642	-12697	-8303	.918	.570	1.107	.868	105
	(11755)	(11953)	(19860)	(12003)	(12343)	(19313)					
MRa	18510**	20762**	21376**	-20558*	-22046*	-20328*	1.711	4.314	3.430	3.604	459
	(10953)	(11258)	(12590)	(7448)	(6666)	(7283)					
MRb	365	11235	12952	517	-7582	2073	.561	.162	1.666	1.140	122
	(14842)	(15046)	(26220)	(13637)	(14756)	(14560)					
SRa(NCRS)	32266**	17147	-18722	2126	-7751	-6559	1.792	.260	1.609	1.314	228
	(18665)	(17182)	(18070)	(14215)	(13207)	(14163)					
SRb	-5987	11401	20259	-19897	-8140	-4932	1.312	.927	.919	.954	258
	(14699)	(13570)	(18442)	(12133)	(12568)	(16855)					
SUGa	14733	20879	750	-17385	-20880	-10305	1.215	1.202	1.244	1.126	214
	(13451)	(13413)	(15921)	(14170)	(11839)	(12709)					
SUGb	10593	13287	25035**	-8877	-21687*	-20193	1.169	1.660	2.723	2.283	231
	(10965)	(8800)	(13748)	(9954)	(10153)	(13068)					
SUGc	7356	-8719	-12322	-2203	-4519	-7127	.658	.164	.320	.296	78
	(27896)	(29585)	(32262)	(20697)	(17712)	(15282)					

a) * : different from zero at significance level of .05
** : different from zero at significance level of .10

b) The function was estimated through the origin.

Table E.12 (continued)

	Δ1972	Δ1973	Δ1974	Δ1975	Δ1976	Δ1977	Δ1978	Δ1979
NRa	-29704*	-22201	5560	-3890	-16227	728	-9157	-21664
	(14473)	(13751)	(13866)	(13880)	(13903)	(13598)	(13409)	(13524)
NRb	-41921**	-52467*	-45495*	-36063**	-21453	-41100	-53620*	-36474
	(21769)	(22081)	(21566)	(21719)	(21443)	(22002)	(24030)	(25139)
MRa	-34961*	-39009*	-18446*	-38044*	-12369	-27425*	-22313*	-25653*
	(9852)	(9406)	(9734)	(10068)	(9756)	(9739)	(9350)	(10108)
MRb	21975	-21378	15691	-26980	4912	-23166	-15690	-17728
	(24561)	(24324)	(25282)	(24286)	(25560)	(24508)	(28498)	(26386)
SRa	17130	-16918	-7899	8904	21151	-12071	15946	-19715
	(19059)	(17509)	(16009)	(16457)	(16754)	(16045)	(16167)	(16389)
SRb	-14526	-31375	-9014	-22704	-35240**	-17359	2495	-25835
	(20695)	(21254)	(19419)	(18879)	(18963)	(19180)	(19137)	(19506)
SUGa	-17266	-25655	15213	-3196	8914	13870	-606	-20170
	(19266)	(18484)	(18452)	(16824)	(18213)	(15501)	(15894)	(16816)
SUGb	-45544*	-42815*	479	-28738**	-27221**	-31206**	-28276	-9329
	(15877)	(15580)	(15667)	(16577)	(16349)	(16470)	(17622)	(17656)
SUGc	7399	19125	18687	372	4678	-	25369	19790
	(24905)	(27132)	(25988)	(24110)	(22188)		(26523)	(22684)

Table E.13: STRUCTURE OF THE ESTIMATION ERROR OF THE GENERALIZED LINEAR FUNCTION ($\Pi-\hat{\Pi}$) (Size-participation)

	ΔS	ΔM	L,FT	ΔPT2	ΔPT1	ΔLP	F-s 2	F-p 3	F 5	DF.2
NRa	-4246 (12555)	-14703 (12594)	19461 (11927)	-1095 (9589)	-28696* (9008)	-21700* (8980)	1.367	4.547	3.058	408
NRb	-14326 (11707)	-10289 (11853)	8437 (10172)	1943 (11917)	-7709 (12027)	-5677 (19025)	.807	.218	.483	113
MRa	20308** (11156)	21653** (11458)	-2509 (11356)	-23649* (7544)	-23551* (6744)	-20680* (7382)	1.841	4.937	3.726	467
MRb	-6902 (14263)	-14821 (14863)	6523 (14771)	7348 (13376)	2034 (14614)	2260 (14679)	.533	.109	.287	130
SRa(NCRS)	26542 (18710)	11624 (17186)	-15454 (14398)	5199 (14269)	-3100 (13227)	-5457 (14280)	1.395	.236	.825	236
SRb	-2188 (14531)	13189 (13459)	993 (11723)	-19190 (11951)	-7877 (12478)	-5816 (16649)	1.151	.879	1.013	266
SUGa	13230 (13436)	20120 (13345)	-3355 (11998)	-14227 (14077)	-16492 (11534)	-5863 (12395)	1.154	.850	.930	222
SUGb	13650 (11218)	14009 (9026)	-283 (6592)	-9388 (10204)	-26074* (10298)	-18814 (13375)	1.320	2.158	1.493	239
SUGc	3483 (26305)	-9455 (27795)	-283 (27189)	2478 (19215)	-3107 (16583)	9054 (14487)	.469	.218	.307	85

a) * : different from zero at significance level of .05
** : different from zero at significance level of .10

b) The Generalized Linear function was estimated through the origin.

Table E.14: STRUCTURE OF THE ESTIMATION ERROR OF THE LINEAR FUNCTION $(\Pi-\hat{\Pi})$ (Size-participation)

DF1	ΔS	ΔM	L,FT	ΔPT2	ΔPT1	ΔLP	F-s 2	F-p 3	F 5	DF2
NRa	-5856 (12715)	-18907 (12754)	22415 (12079)	630 (9711)	-28290* (9122)	-24743* (9094)	2.120	4.990	3.523	408
NRb	-11824 (13208)	-12806 (13372)	4973 (11476)	7312 (13445)	-224 (13568)	5582 (21666)	.589	.133	.309	113
MRa	21116** (11512)	21554** (11823)	-201 (11718)	-29032* (7785)	-28238* (6960)	-21231* (7618)	1.779	6.656	4.679	467
MRb	-201 (15083)	-18454 (15717)	7671 (15620)	8958 (14145)	-6431 (15455)	8125 (15523)	1.268	.518	.692	130
SRa	-22998 (21438)	-47803* (19692)	6342 (16497)	24540 (16350)	17174 (15155)	557 (16362)	4.322	1.448	2.151	236
SRb	4762 (14983)	17497 (13878)	1824 (12088)	-30008* (12323)	-11034 (12866)	-12250 (17167)	1.097	2.002	1.611	266
SUGa	12550 (13572)	17699 (13480)	528 (12120)	-17520 (14220)	-21420** (11652)	a-6477 (12521)	.864	1.423	1.141	222
SUGb	13596 (11929)	9209 (9599)	2472 (7010)	-11971 (10851)	-31653* (10951)	-28444* (14224)	.748	2.963	1.887	239
SUGc	5568 (28419)	-12070 (30028)	5535 (29374)	-7611 (20759)	-14571 (17916)	6013 (15652)	.748	.482	.561	85

a) * : different from zero at significance level of .05
** : different from zero at significance level of .10

b) The Linear function was estimated through the origin.

Table E.15: NR: LINEAR MODEL WITH DUMMY VARIABLES
SHADOW PRICE SHIFTS

		Size Participation Dummy (LSP)					
		ΔS	ΔM	L,FT	ΔPT	ΔPT	ΔLP
a	P	-4247n	58054	-17450n	-17287n	32257	11604n
	M	-55n	-278	442	45n	-250	-108n
	F	-540	-674	656	-246n	-17n	222n
	A	22.9	-.3n	42.5	-.7n	-19.8	-22.7
b	P	46001n	40437n	-6700n	-19640n	-5557n	49576n
	D	30631n	6722n	14964n	-29750n	-78651	45657n
	M	-51n	-172n	229n	251n	18n	-617n
	F	-401n	-484n	613	-487n	-163n	622n
	A	-56.7n	10.2n	11.6	41.2n	61.4	33.0n

		Size Dummy (LS)			No Dummy (L)	
		ΔS	ΔM	L		(SD)
a	P	-42721	23342	10427n	14656	(5199)
	M	52n	-119	311	270	(28)
	F	-567	-715	737	153	(54)
	A	41.4	20.6	13.8	34.6	(3)
b	P	5128n	21955n	17662n	28183	(8702)
	D	34437n	11426	134n	7096n	(9199)
	M	-92n	-83	270	214	(48)
	F	-308n	-696	448	101n	(109)
	A	2.6n	22.4	11.4	17.9	(4)

n: not significantly different from zero
a: all paddy farms b: paddy-dry farms c: all dry farms
P: paddy land D: dry land
M: male labour F: female labour
A: farm assets

F-test in the LSP model for H : dummy coefficients = zero

	ΔP = 0	ΔS = 0	
NRa	${}_{390}F_{12}$ = 3.319>>	${}_{390}F_{8}$ = 7.892>>	
NRb	${}_{89}F_{15}$ = 2.200<<	${}_{99}F_{10}$ = 1.446<<	(could be linear)

Table E.16: MR: LINEAR MODEL WITH DUMMY VARIABLES
SHADOW PRICE SHIFTS

		Size Participation Dummy (LSP)					
		ΔS	ΔM	L,FT	ΔPT	ΔPT	ΔLP
a	P	-40160	-13302n	49224	53070	38352	38627
	M	111n	47n	235	-155	-122n	23n
	F	213	492	40n	-237	-257	-145n
	A	24.1	-26.0	24.0	-12.3n	-10.4n	-45.3
b	P	-32304n	-20771n	66065n	24145n	44288n	42126n
	D	8950n	16839n	-39107n	25716n	57494n	86872n
	M	-82n	-108n	276	-68n	-37n	-378
	F	18n	82n	99n	-164n	-161n	-41n
	A	36.2n	1.25n	16.5n	16.3n	-11.0n	-17.5n

		Size Dummy (LS)			No Dummy (L)	
		ΔS	ΔM	L		(SD)
a	P	-47606	-22877n	66134	41129	(5858)
	M	127n	43n	218	292	(32)
	F	86n	405	50n	222	(40)
	A	27.6	-10.2n	5.1n	10.3	(3)
b	P	-47210n	-43643n	98283	76407	(9441)
	D	26375n	33352n	-8234n	10241n	(10332)
	M	-52n	-145n	211	141	(41)
	F	102n	213n	-44n	31n	(61)
	A	26.6n	12.5n	12.4n	23.9	(5)

n: not significantly different from zero
a: all paddy farms   b: paddy-dry farms   c: all dry farms
P: paddy land   D: dry land
M: male labour   F: female labour
A: farm assets

F-test in the LSP model for H : dummy coefficients = zerol

	ΔP = 0	ΔS = 0
MRa	$_{449}F_{10}$ = 5.435>>	$_{449}F_{8}$ = 12.308>>
MRb	$_{106}F_{15}$ = 1.596<<	$_{106}F_{10}$ = .994<< (could be linear)

Table E.17: SR: LINEAR MODEL WITH DUMMY VARIABLES
SHADOW PRICE SHIFTS

		Size Participation Dummy (LSP)					
		ΔS	ΔM	L,FT	ΔPT	ΔPT	ΔLP
a	P	-17298n	17739n	23506	-21911n	-7522n	26338n
	M	-429n	-565	833	112n	-197n	-86n
	F	611n	326n	-426n	74n	175n	-144n
	A	-15.8n	-.5n	37.3	13.9n	11.1n	11.2n
b	P	-46792n	-68464n	113052	-33827n	-42427n	2869n
	D	-61621n	24872n	7178n	-24696n	36281n	-15102n
	M	424	379	-73n	-146n	-192n	63n
	F	290n	319n	-274n	250n	208n	230n
	A	-32.8n	-23.6n	51.4	15.7n	28.9n	2.9n

		Size Dummy (LS)			No Dummy (L)	
		ΔS	ΔM	L		(SD)
a	P	-23170n	17405n	26112n	38800	(8176)
	M	-428	-632n	813	494	(56)
	F	790	507	-461	-89n	(67)
	A	-25.1n	.7n	40.9	37.8	(6)
b	P	-42681n	-84673	104097	56758	(8379)
	D	-61825n	19263n	14532n	9297n	(12844)
	M	368	345	-153n	79n	(51)
	F	314n	320n	-157n	181	(61)
	A	-26.5n	-5.7n	59.5	51.6	(6)

n: not significantly different from zero
a: all paddy farms b: paddy-dry farms c: all dry farms
P: paddy land D: dry land
M: male labour F: female labour
A: farm assets

F-test in the LSP model for H : dummy coefficients = zerol

	ΔP = 0	ΔS = 0
SRa	$_{218}F_{12}$ = .734<<	$_{218}F_{8}$ = 5.194>>
SRb	$_{242}F_{15}$ = 1.625<	$_{242}F_{10}$ = 2.713>>

Table E.18: SUG: LINEAR MODEL WITH DUMMY VARIABLES
SHADOW PRICE SHIFTS

		Size Participation Dummy (LSP)					
		ΔS	ΔM	L,FT	ΔPT	ΔPT	ΔLP
a	P	9549n	22251n	47015	-15668n	11737n	24358n
	M	-203n	-246n	134n	174n	-20n	-93n
	F	227n	179n	-122n	-90n	23n	-121n
	A	25.1n	-2.0n	76.0	-5.5n	-81.0	-57.1
b	P	-9898n	-23501n	63533	-13428n	-13659n	243n
	D	9501n	381n	58114	-55022	-34017n	-8715n
	M	56n	95n	68n	-70n	58n	-453n
	F	-31n	88n	88n	12n	-5n	352n
	A	11.8n	16.0n	19.8	31.0	-22.6n	-44.3n
c	D	64752	-7643n		76401n	14319n	55135
	M	-499	450		-78n	-182n	112n
	F	2n	-91n		-52n	51n	106n
	A	-33.7n	92.1		-74.1n	.5n	-102.6

		Size Dummy (LS)			No Dummy (L)	
		ΔS	ΔM	L		(SD)
a	P	7905	10774n	47498	47866	(6747)
	M	-198	-219n	227	81n	(50)
	F	357	303n	-254	2	(58)
	A	-31.2n	-15.8n	67.0	59.1	(5)
b	P	-35707n	-21043n	55292	52257	(6315)
	D	-9757n	-29380n	42638	36942	(6179)
	M	33n	120n	123	144	(43)
	F	156n	183n	30n	85n	(47)
	A	-14.6n	-15.4n	31.9	26.8	(4)
c	D	53727	27007		40936	(10125)
	M	-482	365		263	(83)
	F	-6	-22n		-33n	(79)
	A	-11.0	48.4		41.7	(10)

The base for the SUGc region are the farms of both medium and large size together

F-test in the LSP model for H : dummy coefficients = zero

	ΔP = 0	ΔS = 0
SUGa	$<_{204}F_{12} = 2.078<$	$_{204}F_{8} = .986<<$ (could be linear)
SUGb	$_{215}F_{15} = 2.467>>$	$_{242}F_{10} = 2.713>>$
SUGc	$_{71}F_{12} = 2.681>>$	$_{71}F_{4} = 12.637>>$

Table E.19: NR: GENERALIZED LINEAR MODEL
SHIFT IN CALCULATED SHADOW PRICES

		Size Participation Dummy						
		ΔS	ΔM	L,FT	ΔPT	ΔPT	ΔLP	F-stat
a	P	-17461	-9656	22506	-611n	516n	14174	<9.944
	M	-11	-9	281	-4n	-4n	2n	<3.368<
	F	30n	60n	100	28n	59	51n	1.531
	A	19.7	11.2	21.4	-2.4n	-6.0	-18.9	<19.201
b	P	-30608	-5639n	22622	-19370	2353n	-1279n	<3.845
	D	26155n	-52983	-23319	-2033n	-91051	-120680	<6.235
	M	197	113	86	59n	4n	-200	<9.862
	F	-100n	-214	378	-77n	-158	-174n	<3.549
	A	-8.3n	21.3	24.5	7.7n	25.4	42.9	<4.521

		Size Dummy					Linear Model	(SD)
		ΔS	ΔM	L	AV	F-stat		
a	P	-14271	-8977	24157	13181	<7.439	14656	(5199)
	M	-11	-9	280	271n	<4.876	270	(28)
	F	47n	65n	121	172	1.329	153	(54)
	A	15.0	17.7	17.7	29.5n	<10.547	34.6	(3)
b	P	-28107	-8434n	17756	5143	<6.041	28183	(8702)
	D	14347n	-40564n	-55762	-63652	<2.745<	7096n	(9199)
	M	165	131	94	194	<12.646	214	(48)
	F	-106n	-205	302	200	<5.076	101n	(109)
	A	-4.9	18.4n	35.9	40.0	<3.759<	17.9	(4)

n: not significantly different from zero
a: all paddy farms   b: paddy-dry farms   c: all dry farms
P: paddy land   D: dry land   A: farm assets
M: male labour   F: female labour

F-test for generalized linear model against linear model:

NRa $_{404}F_{6}$ = 2.012<< (linearity not rejected)
NRb $_{104}F_{10}$ = 2.275>>

Table E.20: MR: GENERALIZED LINEAR MODEL
SHIFT IN CALCULATED SHADOW PRICES

	Size Participation Dummy						
	ΔS	ΔM	L,FT	ΔPT	ΔPT	ΔLP	F-stat
a P	-23957	-7957n	45503	2113n	23761	34897	<10.432
M	40n	23n	266	7n	-5n	2n	1.260
F	81n	24n	182	18n	-60	-186	<9.585
A	9.6n	2.9n	.4n	-.8n	-12.5	-18.2	<7.467
b P	-72991	-42533	68131	13588n	41171	66067	<13.410
D	-30834	-16841	-1872n	9011n	30456	41873	<7.908
M	21n	-2n	150	30n	57n	181	<3.081
F	281	218	-112	-89n	-188	-231	<9.921
A	35.4	22.1	40.2	-10.4n	-24.1	-53.3	<13.507

	Size Dummy					Linear Model	(SD)
	ΔS	ΔM	L	AV	F-stat		
a P	-11763n	-4711n	53917	44953	1.797	41129	(5858)
M	37n	20n	269	299	2.657	292	(32)
F	25n	19n	156	178	.140	222	(40)
A	3.1n	1.1n	-3.8n	-1.5	.370	10.3	(3)
b P	-62219	-49599	93415	46172	<12.304	76407	(9441)
D	-24229	-22082	15602	-3372	<3.936<	10241n	(10332)
M	53n	-11n	201	222	1.327	141	(41)
F	249	248	-227	-20	<11.836	31n	(61)
A	26.3	26.2	22.7	44.5	<5.268<	23.9	(5)

n: not significantly different from zero
a: all paddy farms b: paddy-dry farms c: all dry farms
P: paddy land D: dry land A: farm assets
M: male labour F: female labour

F-test for generalized linear model against linear model:

MRa $_{463}F_{6}$ = 5.812>>
MRb $_{121}F_{10}$ = 1.636<< (linearity not rejected)

Table E.21: SR: GENERALIZED LINEAR MODEL
SHIFT IN CALCULATED SHADOW PRICES

	Size Participation Dummy						
	ΔS	ΔM	L,FT	ΔPT	ΔPT	ΔLP	F-stat
a P	-37860	-8217n	51651	-24777	-9187n	41240	<15.138
M	-236	-168	562	10n	-144n	-403	<28.267
F	712	316	-396	70n	71n	183	<30.767
A	-3.1n	6.7n	51.6	-4.0n	-16.0	-31.5	<21.317
b P	-45582	-30754	69052	-2006n	300n	-4162n	<3.156
D	-22620n	-4544n	-47565	15432n	32293n	81192	2.037
M	-35n	-3n	70	33n	98	62n	<2.809<
F	112	71	85	1n	-39	-41n	<6.378
A	22.0	9.0	38.6	.2n	-15.4	-19.9	<7.915

	Size Dummy					Linear Model	
	ΔS	ΔM	L	AV	F-stat		(SD)
a P	-15869n	-12224n	49043	35609	1.004	33800	(8776)
M	-507	-240	563	183	<32.603	494	(56)
F	838	359	-388	227	<73.423	-89	(67)
A	-25.5	-1.2n	51.2	35.6	<26.491	37.8	(6)
b P	-46634	-30814	68508	36566	<7.911	56758	(8379)
D	5677n	-2437n	-39301	-35978	.041	9297	(12844)
M	.4n	18n	88	96	.356	79	(51)
F	93	64	81	146	<11.841	181	(61)
A	13.6	6.1n	36.9	44.9	<5.358	51.6	(6)

n: not significantly different from zero
a: all paddy farms b: paddy-dry farms c: all dry farms
P: paddy land D: dry land A: farm assets
M: male labour F: female labour

F-test for generalized linear model against linear model:

SRa NCRS: $_{228}F_{10}$ = 9.183>>
SRb <$_{257}F_{10}$ = 1.910< (linearity not rejected)

Table E.22: SUG: GENERALIZED LINEAR MODEL
SHIFT IN CALCULATED SHADOW PRICES

		Size Participation Dummy						
		ΔS	ΔM	L,FT	ΔPT	ΔPT	ΔLP	F-stat
a	P	-17781	-8572	51332	3936n	7705	15453	<5.775
	M	-83n	-47n	78n	25n	146n	241	1.809
	F	162	56n	6n	-33n	-106	-247	<17.162
	A	2.9n	5.5n	58.0	-.9n	2.8n	.5	.694
b	P	-10316	-4353n	53424	4137n	10603	18023	<3.584
	D	18057	8148n	59050	-6704n	-14321	-17448	1.600
	M	82	63	107	-16n	-.7n	-60	<4.514
	F	-107	-44n	116	-7n	101	120n	1.278
	A	-.7n	.7n	28.8	7.1n	-5.8n	-.7n	.757
c	D	-35149	9454n		6949n	41655	79714	<29.840
	M	118	305		-22n	-140	-464	<16.915
	F	-8n	-68n		-4n	-66n	-127n	.353
	A	30.2	69.2n		7.2n	-10.9n	-40.9	< 2.741<

		Size Dummy					Linear Model	
		ΔS	ΔM	L	AV	F-stat		(SD)
	P	-11286	-4919n	54203	46948	<5.404	47866	(6747)
	M	35n	25n	113	139	.087	81n	(50)
	F	52n	-5n	-27n	-3	2.994	2n	(58)
	A	3.5n	6.3n	58.0	61.9	1.189	59.1n	(5)
b	P	-783n	-1224n	55542	54905	.087	52257	(6315)
	D	7806n	4295n	56061	59760	.942	36942	(6179)
	M	63	62	102	141	<8.132	144	(43)
	F	-29n	-12n	124	111	.212	85n	(47)
	A	-3.9n	1.5n	30.2	28.5	.259	26.8	(4)
c	D	-35053	45282		21785	<10.898	40936	(10125)
	M	118n	119n		198	2.844	263	(83)
	F	-.8n	123n		-129	.006	-33n	(79)
	A	30.2n	54.4n		74.7n	<3.745<	41.7	(10)

the base for the SUGc region are the farms of both medium and large size together

F-test for generalized linear model against linear model:

SUGa $<_{218}F_6$ = .927<< (linearity not rejected)
SUGb $_{230}F_{10}$ = 3.319>>
SUGc $<_{81}F_6$ = 2.532< (linearity not rejected)

Table E.23: NR: ESTIMATED SHADOW PRICES FOR SMALL FULL-TIME, LARGE FULL-TIME, SMALL PART-TIME FARMS

	Generalized linear model				
	SFT	LFT	SPT	(LFT) (SD)	SAMPLE AVER
a⁺P	5055*	22506"	19229	(3765)	13181
M	270*	281"	272*	(4)	271
F	130	100"	181*	(39)	172
A	41.1*	21.4"	22.2	(3.1)	29.5
b P	-7986*	22622"	-9265*	(7292)	5143
D	2836	-23319"	-117844*	(19571)	-63652
M	283*	86"	83	(29)	194
F	278	378"	104*	(54)	200
A	16.2	24.5"	59.1*	(7.5)	40.0

a: all paddy farms
b: paddy-dry farms

	Linear Size-participation Dummy Model				Linear Model		
	SFT	LFT	SPT	(SD)			(SD)
a P	-21697	-17450	-10093	(11887)	a⁺P	14656"	(5199)
M	387	442"	279	(88)	M	270"	(28)
F	116*	656"	338	(200)	F	153"	(54)
A	65.4*	42.5"	42.7	(9)	A	34.6"	(3)
b P	39301	-6700	88877*	(19532)	b P	28183"	(8702)
D	45595	14964	91252*	(18746)	D	7096	(9199)
M	178	229	-439	(125)	M	214"	(48)
F	212	613"	834	(216)	F	101	(109)
A	-45.1	11.6"	-12.1*	(5)	A	17.9"	(4)

* : significantly different from the large farmer group
" : significantly different from zero
⁺ : Linear model cannot be rejected (significance .05)

P : paddy land............official rental rate: 16634 NT$
D : dry land..............na
M : male labour...........average wage: 275 NT$
F : female labour.........average wage: 249 NT$
A : farm assets...........bank-market interest: 18.9-40.8%

Table E.24: MR: ESTIMATED SHADOW PRICES FOR SMALL FULL-TIME, LARGE FULL-TIME, SMALL PART-TIME FARMS

		Generalized linear model				
		SFT	LFT	SPT	(LFT) (SD)	SAMPLE AVER
a	P	21546*	45503"	56443	(9150)	44953
	M	306	266"	308*	(22)	299
	F	263	182"	77*	(50)	178
	A	10.0	.4	-8.2	(5.5)	-1.5
b+	P	-4860*	68131"	61207	(11846)	46172
	D	-32706*	-1872	9167	(8510)	-3372
	M	171	150"	352*	(54)	222
	F	169*	-112"	-62	(53)	-20
	A	75.6*	40.2"	22.3*	(7.7)	44.5

a: all paddy farms
b: paddy-dry farms

Linear size-participation Dummy model						Linear Model			
		SFT	LFT	SPT					(SD)
a	P	9064*	49224	47691	(16290)	a	P	41129"	(5858)
	M	346	235	369	(82)		M	292"	(32)
	F	253*	40	108	(99)		F	222"	(40)
	A	48.1*	24.0"	.3*	(9)		A	10.3"	(3)
b+	P	33761	66065	75887	(37027)	a+	P	76407"	(9441)
	D	-30157	-39107	56715	(32284)		D	10241	(10332)
	M	194	276"	-184*	(92)		M	141"	(41)
	F	117	99	76	(162)		F	31	(61)
	A	52.7	16.5	35.2	(24)		A	23.9"	(5)

* : significantly different from the large farm group
" : significantly different form zero
+ : Linear model cannot be rejected (significance .05)

P : paddy land.............official rental rate: 16634 NT$
D : Dry land...............na
M : Male labour............average wage: 275 NT$
F : Female labour..........average wage: 249 NT$
A : Farm assets............bank-market interest: 18.9-40.8%

Table E.25: SR: ESTIMATED SHADOW PRICES FOR SMALL FULL-TIME, LARGE FULL-TIME, SMALL PART-TIME FARMS

	Generalized linear model				
	SFT	LFT	SPT	(LFT) (SD)	SAMPLE AVER
a‡P	13791*	51651"	55031	(9493)	35609
M	326*	562"	-77*	(66)	183
F	316*	-396"	499*	(84)	227
A	48.5	51.6"	17.0*	(5.5)	35.6
b P	23470*	69052"	19308*	(10420)	36566
D	-70185	-47565"	11007*	(18445)	-35978
M	35	70"	97	(25)	96
F	197*	85"	156*	(17)	146
A	60.6*	38.6"	40.7	(3.7)	44.9

a: all paddy farms
b: paddy-dry farms

	Linear size-participation Dummy Model					Linear Model	
	SFT	LFT	SPT				(SD)
a P	6208	23506	32246	(16581)	a P	38800"	(8176)
M	404	833"	318	(85)	M	494"	(56)
F	185	-426	41	(226)	F	-89	(67)
A	21.5	37.3"	32.7	(12)	A	37.8"	(6)
b P	66200	113052"	69129	(15742)	b P	56758"	(8379)
D	-54443	7178	-69545	(24498)	D	9297	(12844)
M	351*	-73	414*	(128)	M	79	(51)
F	16	-274	246	(222)	F	181"	(61)
A	18.6	51.4"	21.5	(16)	A	51.6"	(6)

* : significantly different from large farmer group
" : significantly different from zero
‡ : Non constant returns to scale model

P : paddy land............official rental rate: 16634 NT$
D : Dry land..............na
M : Male labour...........average wage: 275 NT$
F : Female labour.........average wage: 249 NT$
A : Farm assets...........bank-market interest: 18.9-40.8%

Table E.26: SUG: ESTIMATED SHADOW PRICES FOR SMALL FULL-TIME, LARGE FULL-TIME, SMALL PART-TIME FARMS

	Generalized linear model				
	SFT	LFT	SPT	(LFT) (SD)	SAMPLE AVER
a⁺P	33551*	51332"	49004	(3626)	46948
M	-5	78	236*	(83)	139
F	168*	6	-79*	(28)	-3
A	60.9	58.0"	60.4	(4.0)	61.9
b P	43108*	53424"	61131*	(2228)	54905
D	77107*	59050"	59659	(4214)	59769
M	189	107"	129	(14)	141
F	9*	116"	132	(32)	111
A	28.1	28.8"	27.4	(4.0)	28.5
c D	-25695*	9454	54019*	(7820)	21785
M	423*	305"	-41*	(57)	198
F	-76	-68	-203	(105)	-129
A	99.4*	69.2"	58.5	(16.1)	74.7

Linear size-participation Dummy Model					Linear Model		
	SFT	LFT	SPT	(SD)			(SD)
a⁺P	56564	47015"	80992	(17311)	a⁺P	47866"	(6747)
M	-69	134	-162	(126)	M	81	(50)
F	105	-122	-16	(153)	F	2	(58)
A	101.1	76.0"	44.0	(20)	A	59.1"	(5)
b P	53635	63533"	53878	(10280)	b P	52257"	(6315)
D	67615	60356"	58900	(9228)	D	36942"	(6179)
M	124	68	-329	(89)	M	144"	(43)
F	57	88	409	(79)	F	85	(47)
A	31.6	19.8"	-12.7	(8)	A	26.8"	(4)
c D	57110*	-7643	112245*	(na)	c D	40936"	(10125)
M	-49*	450"	63	(na)	M	236"	(83)
F	-89	-91	17	(na)	F	-33	(79)
A	58.4	92.1"	-44.2*	(na)	A	41.7"	(10)

a: all-paddy farms b: paddy-dry farms c: all-dry farms
⁺: Linear model cannot be rejected (significance .05)