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DISCUSSION PAPER SERIES

Number 64

The Determination of Poverty Band
in Thailand

by

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The Supply Response of Sugar Cane
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THE DETERMINATION OF POVERTY BAND IN THAILAND*

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By Medhi Krongkaew

Introduction

Generally speaking, one method for determining the minumum income level which is often referred to as the threshold line to poverty by a family is to identify the adequate nutritional requirement needed to support a life of a particular consumer and to convert it into monetary denominations or income required by such person. Once this is done, further computation of other necessities of life including clothing, lodging and medicine, is additional to the method. Another way out is to study the relationship between income and consumption or what is better known as consumption function which tell us the consumption levels of consumers in different income classes.

There are two major ways to approach this consumption pattern. One method is called "time series" approach. This is done by studying events within a given time span, say 10 years, and finding out major differences in the consumption pattern over the years under review, etc. Another approach is known as the "cross-section" analysis which focuses

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on studying events within a given period, in any one year, including the consumption patterns differentiated by consumers coming from different environmental backgrounds. Should we possess both sets of data, it would give us a solid basis for a more thorough study. Unfortunately, in Thailand, we could only approach our study through the "cross-section" method.

Data

Such data could be found in the "Report on the Socio-Economic Survey, B.E. 2511-2512"[1/] which was published by the National Statistical Office. This Report was the result of a survey, through random sampling, of the nature of incomes and expenses of families of various income brackets both within and outside the municipal area: throughout the Kingdom. Income here is defined as to include wages, salaries, overtime pays, commissions, bonuses, net profits arising from private business and other income sources. Expenses are classified into 9 categories, major ones of which include those on food, accommodation, clothing, education, entertainment, medications, transportation and others.

1/ At the time this paper was being revised in 1978, the result of another socio-economic survey became available in the form of the Report on Socio-Economic Survey, B.E. 2514-2516 also published by the NSO. However, the data on income and consumption from this survey were not as good as those from the 1968/69 survey. For example, there exists such inconsistencies as the average household expenditure on food in some region exceeds the average household income by the margin of almost three to one. As will be apparent later, this outlandish food expenditure to income ratio, if adopted, would ruin our method of study. So, we decided to base our study only for the period 1968/69 and adjust the result upward to the present time by the use of price indices.

Besides, the National Statistical Office has further subdivided the income level into 12 classes for those families within the municipality, and 11 classes for those outside. Families with annual income of less than 3,000 baht are classified in the lowest category for both divisions. However, families with largest annual income are nominated differently for each division, namely 60,000 baht and over for those within the municipality and 33,000 baht and over for those residing outside. The Report also tells us how each family, for each level of income in each division, spends its money on food and other types of consumption.

Methodology

For our purpose, we shall use certain assumptions which are generally accepted by economists, namely, those which state that the income earned by a family determines its consumption expenses. Thus, larger income implies larger consumption while smaller income means smaller consumption. This relationship could be expressed in the following equation: $C = f(Y)$ and $dC/dY > 0$. C here stands for consumption expenses while Y income. From above, one could compute the definite relationship between consumption and income in a simple regression equation of the form:

$$C_i = a + bY;$$

or in a more accurate logarithmic form:

$$\log C_i = \log a + b \log Y_i$$

where C and Y having the stated meanings; a and b are parameters with definite values by utilizing least-square methods; i stands for each category or group of families under review. (Here, we mean families with different incomes in each division as given by the relevant information); b is constant or in economics, it is known as the marginal propensity to consume which indicates the ratio of changes in consumption expenses as a result of income changes; a is the intercept of an equation. However, in economics, it is often believed to be the subsistence consumption needed by each family with or without any basic income.[2/]

Before we consider the effects of poverty which are our ultimate purpose, it is necessary to emphasize the basic differences between the identification of threshold lines from consumption function and of nutritional adequacy as well as other life-supporting necessities. The latter method tells us about the appropriate minimum level of a person of family necessary to pay for consumption as such. As for information on consumption function, we attempt to determine the expenses on food and necessities consumed by a representative family. We could not be certain that the volume of consumption, on the average, will be sufficient for the true physical needs since we have no definite knowledge, except

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2/ Here, however, we could not interpret it as subsistence consumption due to inadequate reasons. a is merely the intercept of the regression equation which varies according to the format of functions that we nominate. Nevertheless, we could assume a to be the subsistence consumption if we possess information covering both cross section and time series. Once historical comparisons over the years are made, a from each cross section would have similar values each year and has good "fit".

that we have to assume that most Thais, especially those residing in the rural areas, may not fully enjoy nutritional adequacy, but that the situation does not verge on malnutrition. However, the merit of this method relative to the nutritional adequacy method is that we do not have to decide for each person or family with different environmental background his own or his family's respective minimum food requirements.[3/]

Results of the Analysis

Results from computation of consumption function of the Thai families throughout the nation from B.E. 2511-12 are published in detail in the Appendix A. The benefits of such function, over and above the predictive consumption volume of each family in each region in the short run, include the determination of the equalizing point between expenses on consumption and incomes of each family, i.e., from the equation $C = a + by$, the point which equates incomes and expenses on consumption is $(a/1-b)$. We call this "break even" or "Wolf Point"[4/] The significance of this point is that the consumer has sufficient income to afford his

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[3/] For those interested in the levels of food adequacy for the Thais, please refer to Food Bureau, Public Health, Foods that the Thais Should Eat (October B.E. 2516) and Supanee Milindankura & Melvin M. Wagner, The Demand for Thai Agricultural Products: A Nutritional Approach (Faculty of Economics and Business Administration, Kasetsart University, March, 1969).

[4/] See Martin Bronfenbrenner, Income Distribution Theory (Chicago, Aldine, 1971) pp. 51-52. The actual computation of this consumption = income point, however, follows a logarithmic function shown earlier because it gives a better statistical fit.

consumption expenses according to his level without having to dissave or dispose of his existing possessions, or incur debts. Income below this point means that a family has overspent. It could be said therefore that this point indicates that a family is beginning to run into difficulty or poverty. Table 1 below shows the break-even point of families from each region both within and outside the municipality areas.

TABLE 1

THE BREAK-EVEN POINT OF A REPRESENTATIVE FAMILY MONTHLY AVERAGE, YEAR 2511-2512

Region	Municipality		Others	
	Break-even point	Average Members of family	Break-even point	Average Members of family
1. National	1399	5.8	831	5.7
2. North	1022	5.0	824	5.6
3. Central	1154	5.5	815	5.6
4. Northeast	1102	5.9	894	6.0
5. South	1316	5.6	844	5.3
6. Bangkok-Thonburi	1680	6.2	998	6.5

SOURCE: Appendix A.

Once coming to this point, the question arises as to whether or not we could regard this break-even point as the poverty line for families of each region. The answer seems to be positive since even in the U.S. and Japan, there are evidences of such adoption as poverty line yardstick.[5/] Nevertheless, we should bear in mind two important factors, namely:

a) If we examine carefully, we will see that this break-even point is the departure point from comfortable living by an average family but this has not yet reached a critical situation.

b) There are additional expenses other than on food, e.g., clothing, shelter, relaxation and entertainment, and so on. However, in the case of real poverty, the true necessity in terms of expenses is inevitably those on food. Since expenses are only incurred on food, real income levels must always lie below the break-even point.

Policy planners arrive at independent discretion whether or not to predicate their poverty index on break-even point and other relevant circumstantial evidences. The best proposition here is that "poverty band instead of having only a single poverty line or index, enables planning administration to be more flexible. Upper limits on income level are sets which indicate that families are beginning to experience certain inconveniences in meeting inadequate income as against expenditures. Lower limits are also set indicating families' minimum income levels for sheer survival. The government may have to select either of these two poverty approaches as best as it possibly can, for example, if the government has the capability to assist most of the poor, it will or tend to opt for the upper limit index whereas the lower limit index will be chosen if the government is short of resources. If the

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5/ Ibid., p. 42.

poverty point matches the minimum income level, only those who are really destitute will gain the assistance from the government.

In the case of Thailand, we could use the break-even point as the upper limit index. This will be elaborated further. Lower limit poverty line determination will be mentioned in the following section paper.

Upper Limit of Poverty Band

We now know, from Table 1,the break-even income of families in each region. However, these income figures are averages of families with different sizes, thus make the inter-regional comparison difficult. To rectify this, there are two methods. First, break-even point for one member of the family should be reached by dividing the break-even income of a family with the number of person in that family. From Table 1, for example, we have break-even income for each person in the municipality throughout the nation amounting to 1399 ÷ 5.8 = 241 baht and outside the municipality through the nation to 792 ÷ 5.7 = 139 baht. But such figures are only statistical averages and by no means imply that a person could well support his life with the stated income figures. Secondly, and it is believed to be superior to the first, the relationship between the size of family and expenditure volumes must be taken into account, for it is true that as the size of the family increases, the percentage increase in expenses should proportionately decline since economies of scale come into play. The fact that there is an additional increase in number of family members from 1 to 2 does not mean that expenses will double. In fact, the latter may increase by a mere 20-30%. Thus, it would be ideal if we could know the break-even income by different sizes of family, that is to say break-even income of a family of six, five, four, and so on. A table of such ready-made income figures would be very useful in understanding the spending behaviour of various households.

In Thailand, we do not have any basic study on comparative expenditure patterns for households of different sizes. For example, a man may spend so much on food, but how much more he has to spend if he has a wife? A wife with one child? A wife with more children? Thus we have to depend on the study in other countries. We select work done in 1965 by Mollie Orshansky, an official of the Social Security Administration of the U.S., as our reference. Orshansky has made considerable research work on expenditure budget of an average family consisting of different number of members,[6/] by starting with the search for the minimum level of income required by a family of two consisting of husband and wife in order to achieve an economy food plan. Adjustment of that income figure is then made to cover expenses in other categories. Then she goes on to study the magnitude of increase in expenses should the number of family members increases. As for family with only 1 member, Orshansky stipulates that 72% of food budget for family with 2 members is the needed figure. Using income level of one-person family as base,

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6/ Mollie Orshansky, "Counting the Poor: Another Look at the Poverty Profile," The Social Security Bulletin (January, 1965). Reprinted in Louis A. Ferman, et.al. Poverty in America (Ann Arbor: University of Michigan, 1965), pp. 67-115.

the increase in additional expenses for one and more members of the family is observed and shown in Table 2 below.

TABLE 2

ADDITIONAL EXPENSES INCURRED ON FAMILY WITH MORE THAN ONE MEMBER
(in percentages)

Number of Family Members	Non-Agrarian Families	Agrarian Families
1	-	-
2 Expenses increase	29.75	29.17
3 " "	55.43	46.88
4 " "	98.10	100.52
5 " "	133.23	130.21
6 " "	161.71	160.42
7 or more "	222.15	218.27

SOURCE: Mollie Orshansky, "Counting the Poor," p. 77.

The following technique is used to compute the break-even income for one-person household. First, the average break-even income by region as shown in Table 1 is for households of different sizes. From Table 2 we know the rate of increase of expenditure by increasing sizes of household. We can then compare the average household size with the rate of increase in expenditure, and from there compute the level of income that will be needed for one-person household. For example, the average household size for Northern region is 5.0 members per household (see Table 1). The break-even income for this household which is 1022 baht, would represent a 133.23% increase in expenditure over the break-even income of household with only one person (see Table 2). The break-even income for the latter can then be computed by dividing the average regional break-even income with one plus the proportion increase or 1022 ÷ (1. + 1.3333), and the result is 438. Once this one-person income figure is known, it can be adjusted upward up to 7-person by using the rate of increase shown in Table 2. In the case where the average size of household does not exactly correspond with the rate of increase, some interpolations are made to either the average regional break-even income or the rate of increase of expenditure. The results are shown in Table 3.

Lower Limit of Poverty Band

It was mentioned earlier that the break-even income is that which a family has earned and is equal to the minimum expense figure. But the break-even expense figures include other not obsolutely necessary expense items, such as clothing, entertainment, household operations and decorations, wine, tobacco and others as well, which could be entirely omitted either temporarily or for a long period of time for really poor families. The only indispensable expense item, it seems, is that which is on food. Therefore, determination of minimum poverty line should be based only on food plan. But since our method of poverty determination

TABLE 3

BREAK-EVEN INCOME OR UPPER-LIMIT POVERTY LINE
(PER MONTH) 1968-1969 (BAHT)

Municipality Areas	National	North	Central	Northeast	South	Bangkok/ Thonburi
No. of Members in a family						
1	547	438	466	426	526	614
2	709	560	605	552	682	796
3	844	677	720	657	812	948
4	1083	868	924	843	1041	1215
5	1275	1022	1088	993	1226	1431
6	1430	1147	1220	1114	1376	1606
7 or more	1761	1411	1502	1371	1694	1952
Non-Municipality Areas						
No. of Members in a Family						
1	331	332	328	343	353	352
2	427	429	422	443	456	455
3	486	487	482	504	518	517
4	663	665	658	688	707	706
5	761	764	756	790	812	810
6	861	864	855	894	919	917
7 or more	1052	1056	1044	1092	1123	1120

SOURCE: From Tables 1-2. "Central" does not Include Bangkok/ Thonburi.

does not originate from the nutritional adequacy approach, but rather from consumption pattern, to adjust the upper income down to really reflect the subsistence level of income under which families are defined as poor, we use the ratio of food expenditure to income as the adjustor. Economists call this ratio "Engel Ratio" following the name of Ernst Engel, a German statistician who has initiated a study of expenditure patterns of families since the Nineteenth Century.[7/] Engel stated that expenses on food can reflect the income of a family, that is the ratio expenditure on food relative to income is higher for poorer families, while for wealthier families the reverse is true. In various studies on poverty of many nations, especially in the U.S., the nutritional adequacy approach (as that of Mollie Orshansky referred to earlier) is a case in point. After the investigator has determined the basic economy food plan, the plan will be converted into monetary terms and then multiply these with the inverse of Engel Ratio or Coefficient. The result is the poverty threshold. For example, if minimum expenses on food amount to $100 while the Coefficient is 1/3, the poverty income figure would be equal to $300 (100 times 3). This Coefficient figure is obtained from surveys conducted on families' incomes/expenses which vary considerably from time to time. For instance, from a survey conducted by the Ministry of Agriculture, U.S.A. in 1955 it was reported that for poorer families, the ratio of income spent on food is 27-33% depending on the number of

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[7/] For details, see S.J. Prais and H.S. Houthakker, The Analysis of Family Budgets (2nd abridged ed.), (Cambridge: The University Press, 1971), Chap. 7.

family members. Subsequently, the National Labor Statistical Society in the U.S. made a survey on the same matter in 1960-61 and found out that, an average family, irrespective of its size, would spend a quarter of its total income on food.[8/] Orshansky would give 1/3 to the Engel Coefficient for families with 3 or more members and 4/15 for those with 2 members.[9/] Selection of Coefficient values is most important because if they are high, the poverty threshold will be lower and thus families to be regarded as poor will be fewer.

In the case of Thailand, when we consider the relationship, between expenses on food and income earned from the Report on Socio-Economic Survey B.E. 2511-12 as displayed in Appendix B, it can be seen that they fit very well with the Engel law, namely that greater proportion of expenses incurred was on food for poorer families while the reverse is true for wealthier families. On average, these ratios are shown in Table 4.

Table 4 confirms the general understanding that families in the municipal area are better off than those residing outside, and secondly that Northeastern families are the poorest comparing with all the rest.

8/ See Martin Rein, "Problem in the Definition and Measurement of Poverty" in Peter Townsend (ed) The Concept of Poverty (London: Heinemann, 1970), pp. 46-47.

9/ Orshansky, op.cit., p. 74.

TABLE 4

FOOD EXPENSES RELATIVE TO AVERAGE INCOME, 1968-1969

Region	National	North	Central	Northeast	South	Bangkok/ Thonburi
Municipal Areas	52.06	53.46	54.26	54.33	51.91	50.60
Non-Municipal Area	58.71	58.20	55.81	60.85	58.20	55.61

SOURCE: Appendix B.

When adjustments of figures contained in Table 4 are integrated into the break-even income figures we have the lower limit poverty threshold. Adjusting method includes the designation of certain percentages for lower poverty limit threshold of each region out of certain upper limit income level of that region. For instance, lower limit income level of the North within municipal areas equal 53.46% of upper limit income levels, and those outside the municipal areas equal 58.20% of upper limit income levels, and so on.[10/] Table 5 indicates the lower limit income figures of families throughout each region on the average, while Table 6 indicates the lower limit poverty threshold according to the number of each family members in different regions.

[10/] Or $Ly = E_r \times B_y$ where Ly is lower limit income or poverty threshold, E_r is the food-income (Engel) ratio and B_y is the break-even or upper-limit income.

TABLE 5

MONTHLY INCOME INDICATING **LOWER**-LIMIT POVERTY LINE OF THE AVERAGE FAMILY **1968-1969 (BAHT)**

Region	Municipal Areas	Non-Municipal Areas
1. National	728	488
2. North	546	478
3. Central	626	455
4. Northeast	599	544
5. South	683	491
6. Bangkok/Thonburi	850	555

SOURCE: Tables 1 and 4.

TABLE 6

MONTHLY INCOME INDICATING LOWER-LIMIT POVERTY LINE OF FAMILY **1968-1969 (BAHT)**

Municipal Areas	National	North	Central	Northeast	South	Bangkok/ Thonburi
1 Member family	285	234	253	231	273	310
2	369	304	328	300	354	403
3	439	362	391	358	421	479
4	564	464	501	458	541	615
5	664	546	590	540	636	724
6	745	613	662	606	714	812
7 or more	917	754	815	745	879	1000

TABLE 6 --(continued)

Non-Municipal	National	North	Central	Northeast	South	Bangkok/Thonburi
1 member family	194	192	183	209	205	196
2	251	249	237	270	265	253
3	285	283	269	307	301	288
4	389	386	367	419	411	393
5	447	443	422	481	472	451
6	506	501	514	544	534	510
7 or more	618	613	583	665	653	623

SOURCE: Table 1,2 and 4.

Adjustment of Poverty Band by Using Price Index

It would be quite misleading to use upper-lower poverty limits based on incomes figures during 1968-69 and apply them for the year 1978 since inflation has taken its toll during these past several years, especially in the year 1974. It is therefore necessary to use appropriate price index to make adjustments for both limits. Such index appears below.

TABLE 7

RETAIL PRICE INDEX, AVERAGES OF JANUARY-APRIL 1978
(1969 = 100)

National	North	Central	Northeast	South	Bangkok/Thonburi
187.5	204.5	191.5	170.8	190.6	183.3

SOURCE: Bank of Thailand, Monthly Bulletin, May, 1978.

After price index has been properly adjusted, we will arrive at figures indicating poverty levels at present both within and outside the municipal areas. Table 8 below depicts the lower and upper limits of poverty threshold of the average family while Table 9 illustrates poverty threshold of families according to their respective sizes.

TABLE 8

INCOME INDICATING LOWER-LIMIT POVERTY LINE OF THE AVERAGE FAMILY JANUARY-JULY, 1978 (BAHT)

Region	Municipal Areas	Non-Municipal Areas
1. National		
Upper Limit	2595	1558
Lower Limit	1351	915
2. North		
Upper Limit	2090	1685
Lower Limit	1117	981
3. Central		
Upper Limit	2209	1560
Lower Limit	1235	871
4. Northeast		
Upper Limit	1882	1527
Lower Limit	1022	929
5. South		
Upper Limit	2508	1608
Lower Limit	1302	936
6. Bangkok/Thonburi		
Upper Limit	3080	1829
Lower Limit	1558	1017

SOURCE: Tables 1, 2 and 7

TABLE 9-1

AVERAGE MONTHLY INCOME INDICATIVE OF LOWER-UPPER POVERTY LINE OF FAMILIES WITH DIFFERENT SIZES WITH ADJUSTMENTS OF AVERAGE PRICE INDEX, JANUARY-JULY, 1978

Municipal Areas

Families Sizes	National	North	Central	Northeast	South	Bangkok/ Thonburi
1 member family						
Upper	1036	896	893	727	1002	1125
Lower	528	479	484	395	520	569
2 member family						
Upper	1315	1146	1158	943	1300	1459
Lower	685	622	628	512	675	738
3 member family						
Upper	1565	1384	1379	1123	1547	1737
Lower	815	740	748	610	803	879
4 member family						
Upper	2008	1775	1768	1440	1985	2228
Lower	479	949	960	782	1030	1127
5 member family						
Upper	2364	2090	2082	1696	2336	2623
Lower	1231	1117	1130	921	1213	1327
6 member family						
Upper	2653	2345	2336	1903	2622	2944
Lower	1381	1254	1268	1034	1361	1489
7 or more member						
Upper	3265	2887	2876	2342	3227	3579
Lower	1700	1543	1560	1272	1675	1833

TABLE 9-2

AVERAGE MONTHLY INCOME INDICATIVE OF LOWER-UPPER POVERTY LINE OF FAMILIES WITH DIFFERENT SIZES, JANUARY-APRIL, 1978

Non-Municipal Areas

Families Sizes	National	North	Central	Northeast	South	Bangkok/Thonburi
1. member family						
Upper	620	679	628	586	672	645
Lower	364	395	351	357	391	359
2. member family						
Upper	801	877	811	757	880	833
Lower	470	510	453	461	505	463
3. member family						
Upper	910	997	923	861	987	948
Lower	534	580	515	524	575	527
4. member family						
Upper	1243	1361	1260	1176	1348	1294
Lower	730	792	703	715	784	719
5. member family						
Upper	1427	1562	1446	1350	1547	1485
Lower	883	909	807	821	901	826
6. member family						
Upper	1614	1767	1636	1527	1750	1680
Lower	948	1029	913	929	1019	934
7. member family						
Upper	1972	2160	1999	1866	2139	2053
Lower	1158	1257	1116	1135	1245	1142

SOURCE: Table 3, 6, and 7.

Some Observations on Attained Results.

1) The poverty band obtained in each region pertain more or less exclusively to that region, and does not lend itself to comparison with other regions. This is because the upper and lower income limits are computed from the average patterns of income and expenditure in that region only, not the pattern for the entire nation. A given amount of income, say 500 baht, may have different meanings to households in different regions. The figure of national poverty band, therefore, is only an approximate indication of poverty situation for the whole country. In order to have figures that are compatible across regions, one must be able to know the amount of income in each region that will buy the same "basket" of goods and services. The income of one region can then be used as a numeraire by which relative income index for each region can be computed. In this way, the regionally compatible poverty band will be possible.[11/]

2) It is classic case of **understatement** of real income once income in kind is not translated into monetary terms. However, the exclusion of income in kind does not affect the illustrated income levels

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11/ One such attempt to find out the relative income and price indices across the five regions of Thailand can be found in Oey Astra Meesook, "Regional Consumer Price Indices for Thailand, 1970" Faculty of Economics, Thammasat University, Discussion Paper No. 49, January, 1976, and "Impact of Price Increases on Different Income Group," Thai Economic Journal, 10 (September-December, 1977), pp. 47-60. However, we did not make use of these studies because we are still doubtful about some of the major results such as when the average cost of living in the Southern region is found to be about 14% higher than that in Bangkok Metropolitan Areas, which we find difficult to accept.

which reflect the poverty threshold of both limits in this study since we use the break-even point of both income and cash expense as our basis. If any one family has considerable income-in-kind, other income sources will be correspondingly less while cash expenses will also be less. In this case, the break-even points between income and expense should be less accentuated than found in other families. This causes the lower limit calculated money income to be less than other methods. On the other hand, it would be easier to differentiate between the well-to-do and the poor once we base our analysis on money income because no conversion of income-in-kind into money income is called for.

3) If we abide by the lower limit income level of families in each region as the basis for measuring poverty in Thailand, we could arrive at the number of families having income equal to or below that base line. The Report of the Socio-Economic Survey, B.E. 2511-12 and the Report on Housing Cansus B.E. 2513 give us some insights into the number of poor families in each region as illustrated in Table 10.

It is obvious that the number of poor families living in the rural or non-municipal areas far surpassed those living in the municipal areas by the ratio of some 39:1. Three-quarters of families in non-municipal areas of the Northeast are very poor while those in the municipal areas of Bangkok/Thonburi rate highest in number in terms of poverty. However, if measured in terms of poor families out of the total number of families in each region, the South has the largest number (17.2%). It is also interesting to note that while families in non-municipal areas

TABLE 10

NUMBER OF POOR FAMILIES, 1968/69

	Municipal Areas		Non-Municipal Areas	
	Number	% of Areas	Number	% of Areas
1. National	87,641	11.5	2,663,294	51.8
2. North	17,833	15.0	761,152	49.3
3. Central	12,041	9.9	251,222	21.9
4. Northeast	6,703	8.7	1,314,479	75.3
5. South	18,220	17.2	325,223	52.4
6. Bangkok/Thonburi	32,844	9.7	11,218	12.6
Total Number of Families, Poor and Non-poor	762,081	12.90	5,146,392	87.10

SOURCE: Report on Socio-Economic Survey, B.E. 2511-12; and Report on Housing Census, B.E. 2513.

of the Northeast rate highest in terms of the number of destitutes, the number of poor families within the municipal areas of the same region rates lower than in any other regions. This shows that the differences of income distribution between families in the municipal vis-à-vis the non-municipal areas are most marked in the Northeast. When we take into consideration the figures on a national basis, families falling into the "poor" category amount to some 46.6% for both municipal and non-municipal areas combined. (11.5% of households in municipal areas are classified as poor; and 51.8% of households in the non-municipal areas or also poor) However, it is worth noting that if we use the upper limit income level as our basis for measuring poverty, the number of poor families would have correspondingly increased more so than by using the lower limit income level as the basis for poverty determination.

4) The concept of poverty band can be very useful in designing a negative income tax system where public direct transfer (or negative income tax) in paid to a person or household whose income is less than a certain, predetermined level. As the payment may be made first to lift the income level of a poor person to a designated minimum level, then the additional payment is gradually reduced as such person is earning higher income until he reaches that predetermined point also called break-even point where the negative income tax stops and positive income tax begins. Our upper income limit will serve as the break-even point and lower income limit as the minimum income level. The existence of both lower and upper income limits will also determine the rate of negative income tax for each region.[12/]

Studies of Other Types of Poverty

There are many research scholars in Thailand who adopt different techniques in their work on income and poverty at present. For instance:

12/ See Medhi Krongkaew, "Potential Use of Negative Income Tax in Thailand", Journal of Social Science, (in Thai), forthcoming.

1) In determining the basic wage issue in January 2517, the Sub-Committee of the Prime Minister's Council of Economic Advisors adopted the nutritional adequacy approach with certain cost of living adjustment to arrive at the decision as to the daily minimum living wage level which an employee ought to be able to earn to support himself and two additional members in his family. Such wage level of each region could likewise be used as the general guideline for determining poverty.[13/]

2) Dr. Oey Meesook of the Economics Faculty, Thammasat University, has studied the characteristics and situation of the poor by employing the basic minimum income of 1,000 baht per person per year in 1974 as the basis for determining family's poverty threshold.

3) In 1971 the National Statistical Office conducted a public opinion poll of families earning low income who live within municipal areas through out the nation.[14/] Those families earning income less than 800 baht per month are regarded by the office as "poor".

4) During 1971-1972, two research projects on the economic and social conditions of the slum-dwellers were conducted. The first project on the slums in the Klong Toey Port Authority area was conducted

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13/ The Report by the Sub-Committee on their minimum living wage determination, August, 2517: See also an article by Trairong Suwankiri and associates published in Warasarn Thammasat, (Thammasat University Journal), Thammasat University, (June-Sept., 2518).

14/ The National Statistical Office: Report on the Survey on Public Opinion of Families Earning Low Income, B.E. 2514, in the National Municipal Areas (2514).

by the Social Administration Faculty, Thammasat University.15/ The second project studies other 5 slum areas in Bangkok and undertaken by Miss Chuanpis Nualprink who submitted her research work as partial fulfilment of her Master of Economics' Degree, Economics Faculty, Thammasat University.16/

5) Besides, there have been other academic activities relating to poverty and social problems in Thailand, e.g., seminar on "Population Problem and Poverty" arranged by the Social Science Association of Thailand in 2516, a conference on the policy to eliminate poverty arranged by ECAFE in December 1973, and other works done by Population Study Institute, Chulalongkorn University, etc.

When we compare our own research work with those which have just been cited, we find that there are remarkable similarities in some cases, while considerable differences exist in others. For example, the appropriate basic or minimum living wage which the Sub-committee proposed was 27.88 baht per day in the Bangkok metropolitan area in 1974 for a worker with two members in his family.17/ However, if we use the lower

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15/ The Social Administration Faculty, Thammasat University, Report on the Social Survey of Families Living in the Klong Toey Port Authority Slum Areas, Bangkok, (Bangkok-May, 2514).

16/ Chuanpis Nualprink, Nature of the Economic and Social Conditions of the Slum Areas and Developmental Planning. A Thesis to be submitted as partial fulfilment of the Master of Economics, Economics Faculty, Thammasat University (2515), Bangkok.

17/ Assuming that worker works 6 days a week or 26 days a month, the figure is then adjusted with the relevant price index.

limit income figure for a 3-member family from our study as the basis for determining basic living wage per day, we get 27.41 baht in the Bangkok metropolitan area which is only slightly less than that of the Sub-committee's, but for all practical purposes could be considered the same.[18/] In August 1978 the minimum wage in Bangkok Metropolitan Areas was again raised to 35 baht per day. Adjust the relevant lower income limit from our study by using appropriate **April** price index, the result would be 34 baht which is again very close to the actual minimum wage in force. For other regions as of **April,** 1978 the corresponding threshold income would be 29 baht for Northern and Central regions, 24 baht for Northeastern region, and 31 baht for Southern region.

However, statutory living wage level as a determinant of poverty may, in fact, not be a completely reliable instrument, since, as was the case in the past, the minimum living wage was not computed on the needs basis of the employee, after certain adjustments for the cost of living are made, similar to that done by the Sub-committee. Rather, the whole paraphernalia of political, economic and employers' acceptance factors are taken into consideration, exclusive of the "needs" criterion, which in turn, does not reflect the real poverty. As for the method of using median income of the nation's average families to determine poverty in Thailand as was done by the National Statistical Office, this is plausible

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18/ This is one of the most exciting, and interesting aspects of the result of this research in the sense that two researches with entirely different methods of study could produce virtually the same answer.

in a general situation. A drawback however is that our country will always come up with just about half of the nation's total families to be branded "poor" each time. And if most of our families' status has improved, we will then have a peculiar situation when one family possessing two cars, a home and a black-white television set would fall into the "poor" bandwagon since more than half of the nation's families own 3 cars, 2 houses and one colour TV. set!

From the analysis of the two projects on the slum areas, the average income of the slum-area families amounted to some 1,225 baht per month in 1971 (a 6-member family, on the average).[19/] As for other five slum areas under analysis, the average income per month was 1,337 baht in 1972 (6.5 member family, on the average).[20/] When adjustments of higher price index and number of family members were made, income level earned by both areas was very much the same. Meanwhile, from our method, the mid point of the range between the upper and lower income limit in the Bangkok metropolitan area amounted to 1,265 baht per month during 1968/69 and once adjustments were made up to the year 1971/72 we have figures which are fairly close to those cited by the two studies. This indicates that our method presents a fairly realistic picture.

19/ See footnote 12.

20/ See footnote 13.

Conclusion

We have attempted to reach an income level the results of which eventuate into the upper and lower limits of poverty threshold by using the consumption (expenditure) pattern and income level of the average family of the nation as the basis. From this poverty band result, greater flexibility and usefulness in the overall national poverty planning may indeed be achieved since the state could now find a determining line to measure poverty. Our research is concentrated solely on one aspect of the economic problem of poverty; that is to say, we only decide on which particular index of determinant of poverty we should use in Thailand. If the general income level we propose is accepted, the next task is to study the nature or characteristics of the social and economic environments of family members of various regions below our designated poverty threshold e.g., the age of the breadwinner, the nature of his job, work force in his family, and so on. Full information on the incidence of poverty could then be most useful to enable us to know how to differentiate between the most critical issues and the least. Also, the study of which sex does the breadwinner belong to and its proportion, etc., is worth pursuing. The distribution of poor families in terms of region contained in Table 10 is merely one aspect of the overall characteristics of poverty which we have just attempted to study.

Practically speaking, the main question is how best we could apply this poverty threshold index in real life. We are not able to give a satisfactory answer in this article since the subject matter itself is quite substantial and deserves a separate treatment from our present subject of designation certain income levels which are regarded as "poor". However, we have two suggestions to make regarding the application of our work. First, it is the easiest and most practical thing to use the income level as the measuring rod of poverty of families in our nation. The government simply has to take care of the authenticity of the reported income earned by these families who indeed deserve our assistance, and understatement of income must be discouraged. Once we have sufficient poverty profile as stated earlier, we could then investigate which particular family gives false statements. For example, the better educated breadwinner with a small number of children who are also working would generally be classified into the "less needy" category than the family with an uneducated breadwinner with big family or who has retired. Those welfare officers who have been assigned to perform such duties must be most efficient here in order to be effective in their work.

Secondly, we could give a proper weight to items or characteristics other than income, such as the number of children in the family sex, education, age, and so on. If such factors lead to critical poverty, additional weight should be attached. Once adding up, we arrive at the weighting of each family, and appropriate selection of families deserving which kind of assistance could then be determined and implemented. Such methodology would enable us to benefit from administration of social works. The most intractable problem, however, is the criteria of how to apply weightings or marks to each item or thing.

Finally, all methods have one basic objective, namely to determine how best to eliminate poverty or environmental poverty in Thailand. We must not forget that it is only a short-term solution for us to sustain or alleviate poor families through our income maintenance scheme or other similar social works. The longer-term solution to the problem of poverty is our rightful emphasis on full employment of the persons and families throughout the nation.

APPENDIX A

CONSUMPTION FUNCTION, 1968/69

Equation: $\ln C = \ln a + b \ln Y$

Region	a	b	R^2
Municipal Areas			
1. National	3.9326	0.8110	0.9936
2. North	5.1412	0.7637	0.9773
3. Central	6.1850	0.7416	0.9934
4. Northeast	5.3274	0.7612	0.9825
5. South	3.8913	0.8108	0.9906
6. Bangkok/Thonburi	3.6439	0.8259	0.9932
Non-Municipal Areas			
1. National	5.1007	0.7576	0.9811
2. North	3.3576	0.8196	0.9920
3. Central	6.3719	0.7237	0.9771
4. Northeast	5.4604	0.7502	0.9823
5. South	4.6874	0.7707	0.9742
6. Bangkok/Thonburi	3.8029	0.8066	0.9874

SOURCE: Computed from Report on Socio-Economic Survey, B.E. 2511-2512.

APPENDIX B

RATIO OF FOOD EXPENDITURE TO HOUSEHOLD INCOME, 1968/69

Municipal Areas

Income Class	Whole Kingdom	North	Central	Northeast	South	Bangkok
Under 3,000	85.75	84.77	107.80	98.54	84.79	70.65
3,000- 5,999	76.23	73.00	86.03	82.93	71.46	71.99
6,000- 8,999	69.14	74.06	68.96	66.79	67.04	68.52
9,000-11,999	65.02	60.62	65.62	64.24	60.43	68.14
12,000-14,999	59.80	53.58	61.91	60.59	56.27	60.66
15,000-17,999	57.20	50.88	59.08	58.10	52.34	58.60
18,000-23,999	51.15	45.76	50.91	53.74	45.19	52.57
24,000-29,999	47.40	43.52	44.83	46.85	41.66	49.60
30,000-35,999	44.70	37.92	38.42	45.96	45.04	46.83
36,000-47,999	39.86	33.14	36.45	41.94	38.90	41.77
48,000-59,999	36.57	29.66	34.19	37.50	32.02	32.62
60,000 and over	22.35	21.30	22.46	21.42	21.28	22.78
Weighted Average	52.05	53.46	54.26	54.33	51.91	50.60

Non-Municipal Areas

Income Class	Whole Kingdom	North	Central	Northeast	South	Bangkok
Under 3,000	75.64	81.62	94.11	72.83	72.83	82.43
3,000- 4,499	59.27	63.89	70.63	48.52	66.04	72.08
4,500- 5,999	58.19	59.07	54.83	52.12	57.12	72.82
6,000- 7,499	55.00	52.72	59.71	50.78	56.58	67.12
7,500- 8,999	54.72	50.39	60.70	53.01	51.87	67.36
9,000-10,499	54.51	48.38	60.55	52.29	49.40	66.63
10,500-11,999	52.03	46.87	57.77	50.83	48.17	65.00
12,000-14,999	48.22	43.63	50.31	49.48	46.55	61.35
15,000-17,999	45.38	41.22	46.25	44.98	47.61	56.52
18,000-32,999	40.32	39.00	39.08	40.25	43.77	50.98
33,000 and over	21.49	23.40	20.28	19.54	23.13	29.12
Weighted Average	58.71	58.20	55.81	60.85	58.20	55.01

SOURCE: Computed from Report on Socio-Economic Survey, B.E.2511-2512

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The Supply Response of Sugar Cane in Thailand*

by

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THE SUPPLY RESPONSE OF SUGAR CANE IN THAILAND*

J.M. Dowling and Phitsanes Jessadachatr

*This Paper was written while the senior author was a Fulbright Professor at Thammasat University, Bangkok, Thailand. The National Statistical Office in Bangkok provided computer assistance for the project, and Ammar Siamwalla made numerous valuable comments. Any errors remain our responsibility.

I. INTRODUCTION

Recent wide fluctuations in the price of agricultural commodities such as sugar, coffee and grains have sparked renewed interest in the mechanism of agricultural supply response as well as suggestions for modification and extension of the basic Nerlovian adjustment model (2,4,6,13). Models have been developed for perennial crops using capital stock adjustment along with a vintage productions function and dynamic profit maximization. They have been relatively successful in describing the supply response pattern of perennial tree crops where there are gestation lags and the useful economic life of the tree is long. For annual crops the perennial model usually converges to a variant of the standard Nerlove model, either with additional variables or utilizing different lags and/or estimating techniques (4).

An interesting crop category which lies somewhere between the annual and perennial model includes sugar cane.[1] Since sugar cane ratoons grow for several seasons, planting decisions for sugar cane depend upon the expected future profit stream for more than one harvest. However, there are also distinct similarities with annual crops; yields tend to fall from the outset, the gestation period is short and the lifespan of the ratoon crop is only a few years. Thus the supply response of sugar cane includes features of annual and perennial crop models. Furthermore the standard reduced form supply response model may have to be augmented to reflect demand factors. Sunk investment in extensive sugar milling equipment may lead to irreversibilities in sugar production when demand is slack, while millers and middlemen may

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1 Livestock and field crops like asparagus may also fall into this category.

exert pressure on farmers to increase planted area in anticipation of buoyant demand.

In this paper a model of sugar cane supply response is formulated and tested for Thailand. Insignificant only 10 years ago Thailand is now the fifth leading sugar exporter after the Philippines, Australia, Brazil and Cuba. After a short historical summary of the growth of the sugar industry a supply response model is formulated and tested using postwar data. Regional differences in response are examined and the impact of government policy considered. The statistical results are contrasted with previous estimates and some tentative conclusions are drawn in the final section.

II. Historical Review[2]

Thailand's rise to the ranks of the worlds leading sugar exporters has been accomplished in an amazingly short period of time. Her export quota from the International Sugar Organization rose from a paltry 36.0 thousand tons in 1971 to 1.2 million tons in the agreement being negotiated in early 1978, and total production of sugar cane from 6.5 million tons in 1971 to over 26 million tons in 1977. This phenomenal growth was achieved mainly through increases in planted area, taken from virgin land in the east and central regions of the country coupled with increases in sugar milling capacity. Between 1971 and 1977 daily cane crushing capacity increased from 42 thousand tons

2 This section draws heavily on P. Jessadachatr (8) and K. Kirakul(9)

per day to nearly 200 thousand tons, while the number of sugar mills nearly doubled. At the same time planted area went from 860 thousand rai to over 3 million rai.

Thai agriculture is dominated by the small holder and sugar cane is no exception. To obtain a stable supply of raw sugar cane most millers must negotiate with numerous small holders.[3] This is facilitated by quotamen (middlemen) who distribute "ngoen keaw" loans from the millers to the cane growers in their district. These loans serve as a kind of foreward payment and help to defer cane planting costs. Cane farmers in turn make forward contracts to sell their harvested cane to a particular mill. These foreward contracts are normally negotiated in June for cane to be harvested five to nine months later. These contracts are for quantity only. Prices are determined much later, just before the cutting season begins in November. Operating through quotamen, who are themselves usually larger cane growers, helps guarantee reliable cane supply. Often bonuses are paid to the quotamen if 80% of contracted quantities are delivered. For the sugar miller the quotaman system avoids the difficulties associated with dealing with a large number of individual farmers, and facilitates delivery scheduling during the crushing season. The later point is important since sugar yield from the raw cane declines drastically if there are long delays between cutting

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3 The potential for exploitation exists to the extent that poor farmers may be squeezed during periods of slack demand, high interest rate are changed for "ngoen keaw" loans and transportation charges can be manipulated by monopolistic sellers.

and crushing. Quotamen also may provide small loans to other farmers and often help with cane transportation for the poorer farmer.[4] Until the late 1960's farmers were unorganized and somewhat at the mercy of the millers. After the formation of farmers organizations in the central and eastern regions in'64 and'69 respectively, features of collective bargaining began to emerge in price negotiations. There are now nine farmers associations and they annually gather into a union of farmers associations to bargain on cane prices.

Historically Thai Government sugar policy has evolved on a rather ad hoc basis. The only consistent long run objective has been to stabilize fluctuations in the domestic sugar price relative to the external price while maintaining a protectionist barrier against foreign competition. Figure 1 shows that over the years this policy has been relatively successful.[4a] The government has also sporadically pursued a policy of export subsidy and import substitution. However, this policy has been abandoned when costs became prohibitive or when high export prices threatened to drive up domestic prices. Before 1957 domestic production fell short of total domestic needs and import substitution was encouraged. By 1957 production exceeded domestic demand but milled sugar was not competitive in the world market, and a sugar cess on total production was introduced to finance an export subsidy. However, production continued to grow and the cess ceased to be

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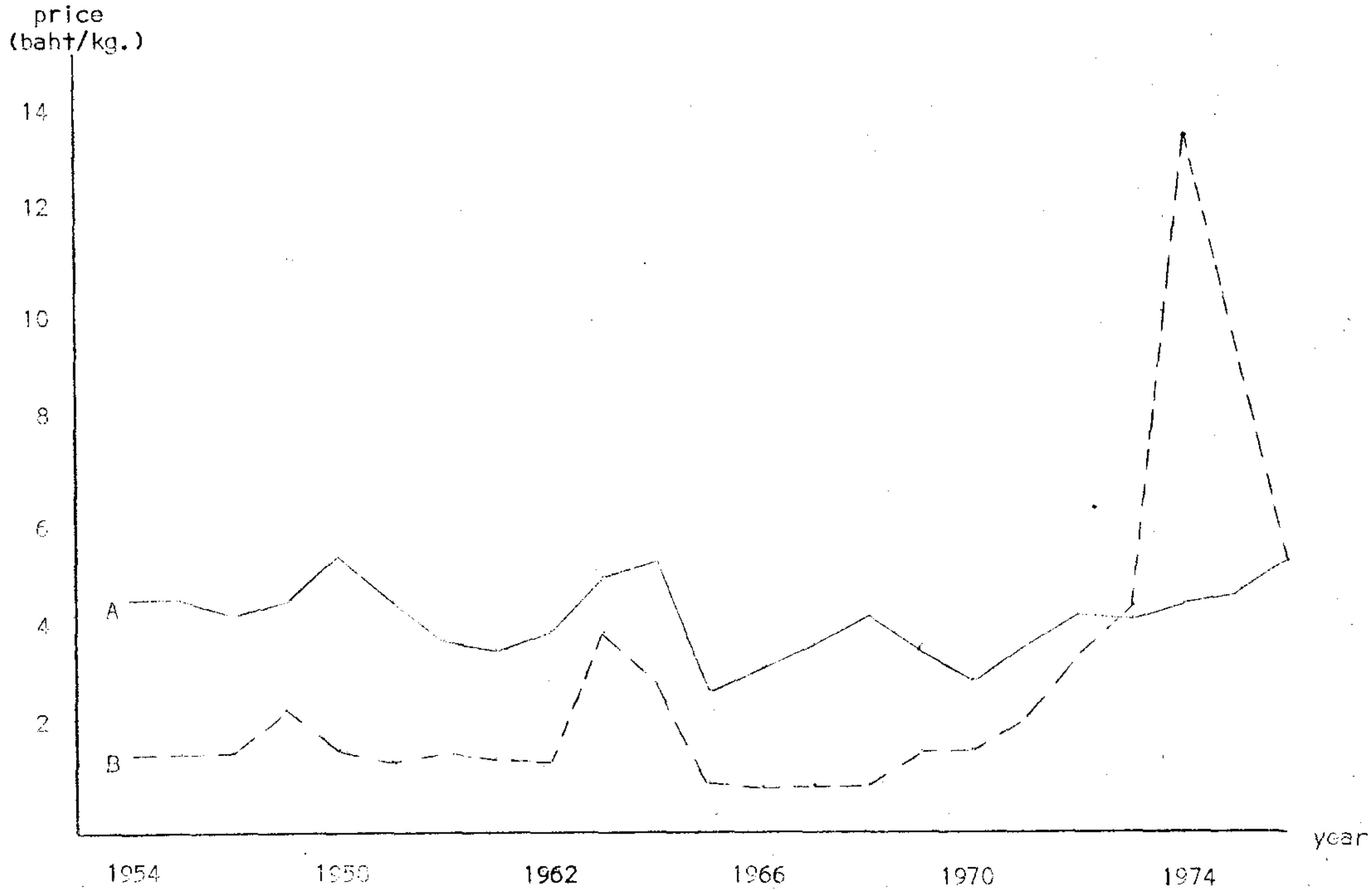
4 While some millers own their own farms, they are in the minority.
4a Coefficients of variation in the two series are similar if the years 1973-1976 are excluded. It is only when they are added that the domestic Thai price shows much greater stability than the world price.

Figure 1



A: Wholesale price of plantation white sugar, Bangkok (baht/kg.)

B: Raw sugar price, f.o.b. and stowed, New York (baht/kg.) using exchange rates for J.C Ingram, <u>Economic Change in Thailand</u>, 1850-1970 and Bank of Thailand an adequate revenue source by 1966. From 1967 to 1971 the policy shifted to improving millers efficiency thereby lowering domestic production costs. New sugar mill construction was curtailed and export quotas were introduced. Government policy was aided during this period by a drought in 1968 and U.S. purchases of excess production. Thailand also joined the International Sugar Organization in 1970. However, world prices were not high enough for exporters to make a profit until the world sugar crisis of 1972-75. Then exports skyrocketed as Thailand took advantage of the shortfall in world production. The ban on sugar mill expansion was lifted and a tax was imposed to soak up excess profits. Attempts were also made to keep the domestic sugar price down, but shortages and smuggling resulted nonetheless. Since 1974 a quota system for domestic production and exports has been enforced to insure that domestic needs are met and to keep domestic prices from rising to the same level as the world price. As the world price came down in 1976 the government tried to help the sugar cane farmer by fixing the ex factory cane price at 300 ฿ per ton, while at the same time raising ceiling domestic sugar prices, and subsidizing domestic sugar production with the proceeds of the export premium collected in 1974-75. This provided continued buoyancy for sugar cane production up to 1978, current production costs being just above the world price.

If we focus simply on the growth of the sugar industry in Thailand, the import substitution, export subsidization policy which has been followed sporadically over the past twenty years must be judged an unqualified success; a success due in large part to the responsiveness of sugar cane and sugar output to market forces. It is to a model of this supply response which we now turn.

III. A Post Nerlovian Supply Response Model for Sugar Cane

The standard Nerlovian supply response model is specified as either an area planted or output response model. In its most general form, potential output (Q^*) [or sometimes planned planted area (A^*)] is a function of expected price (P^*).

$$Q_t^* = \alpha + \beta P_t^e \tag{1}$$

Observed values are introduced through two adjustment equations.

$$Q_t - Q_{t-1} = \lambda (Q_t^* - Q_{t-1}) \tag{2}$$

$$P_t^e - P_{t-1}^e = \delta (P_t - P_{t-1}^e) \tag{3}$$

and the reduced form is obtained by substitution

$$Q_t = \alpha\lambda\delta + \beta\lambda\delta \; P_t + [2 - \lambda - \delta] \; Q_{t-1} \quad (1-\lambda)(1-\delta) \; Q_{t-2} \tag{4}$$

When applied to annual field crops where adjustment and gestation lags are short, the Nerlovian model serves as a reasonable standard for supply response behavior. However, there are circumstances when alternative assumptions are required. In perennial crop models developed in the past few years (4, 13) there are three structural equations. A vintage production is constructed where potential output depends only upon the number (area) and yield of different age plants. Investment takes place until the cost of planting just equals the discounted expected future profit stream, and a short run output determination equation allows for excess capacity (unharvested crops, untapped trees, or uncollected fruit) and short run output adjustments based on price. The detailed specifications of these structural equations differ from model to model, but the reduced form equations bear many similarities, actual output depending upon lagged output, lagged prices and weather variables.

It is quite easy to adapt the perennial model to sugar cane. Allowing for two ratoon crops, the vintage production function is

$$Q^*_t = \sum_{i=0}^{2} \delta(i,t)\, I_{t-i} \qquad (5)$$

where Q^*_t is potential output, I_{ti} is the area planted in year t-i which survives until t, and $\delta(i,t)$ is the appropriate yield. Time t is included in the yield function to reflect technical progress.[5] I_t is determined from the investment function

$$A_t - A_{t-1} = a_0 + a_1 P_t^* + a_2 A_{t-1} \qquad (6)$$

where $A_t - A_{t-1} = I_t$ the investment in new planting, P^*_t is the expected cane sugar price and A_{t-1} is lagged total area planted. This reduces to

$$A_t = a_0 + a_1 \sum_{i=1}^{n} b_i P_{t-i} + (a_2+1)\, A_{t-1} \qquad (7)$$

---

5 For some tree crops like rubber, depreciation, measured as the difference between area planted in t-i and I_{t-1}, is a continuous function of time (11). Introduction of depreciation introduces complications in the derivation of the reduced form and is often ignored or assumed to be random(4,13). Since sugar cane has only a three or four year usable life it is not unrealistic to assume that all depreciation takes place at the end and that there is no difference between I_{t-1} and area planted in t-i.

when a weighted average of past prices replaces P_t^*. In a more formal presentation Wickens and Greenfield (13) maximize discounted future expected profits [equation (8)] subject to the production function constraint [equation (5)]

$$v = \sum (1-r)^t \quad (P_t^* - S_t^*)\ Q_t^* - F_t - f(I_t) \qquad (8)$$

where S_t^* is expected cost of harvesting, F_t are fixed costs, $f(I)$ is a non linear planting cost function and r is the discount rate. If $\partial f/\partial I_t > 0$, $\partial^2 f/\partial I_t^2 > 0$ and $\delta(t,i) = \delta(i)$,

then the first order condition yields

$$\frac{\partial f}{\partial I} = \sum (1+r)^{-i} \quad (P_{t+1}^* - S_{t+i}^*)\delta(i). \qquad (9)$$

Investment is continued until the marginal cost of investing equals discounted expected future profits. If $f(I_t)$ is quadratic, then

$$I_t = b_0 + b_1 R_t^* \qquad (10)$$

where R_t^* equals the right hard side of (9). Wickens-Greenfield suggest a distributed lag proxy for (9).

$$A_t = \alpha_0 + \sum_{i=1}^{m} \alpha_i \ A_{t-i} + \sum_{i=1}^{m} \beta_i \ P_{t-i} \qquad (11)$$

which they found collapses to

$$I_t = a_0 + a_1 I_{t-1} + bP_t \qquad (12)$$

for Brazilian coffee. Dowling (4) suggests a similar approach.

$$I_t = a_0 + \sum W_i P_{t-i} \qquad (13)$$

and if $W_i = \beta \phi^i$ $\qquad 0 < \phi < 1$

$$I_t = a_0^* + \beta P_t + \phi \ I_{t-1} \qquad (14)$$

Surprisingly (7), (12) and (14) are close to the Nerlovian model. Replacing Q_t with A_t in (4) and noting that $A_t - A_{t-1} = I_t$ we have

$$I_t = d_0 + d_1 P_t + d_2 I_{t-1} + d_3 A_{t-2} \qquad (4a)$$

where $d_0 = \alpha \lambda \delta$, $d_1 = \beta \delta \lambda$, $d_2 = 1 - \delta - \lambda$, $d_3 = -\delta \lambda$

Since sugar cane in Thailand is replaced about every three years, current gross investment will probably depend upon gross investment lagged three years as well as past prices. Adjusting (14) accordingly we have

$$I_t = a + bP_{t-1} + cI_{t-1} + dI_{t-3} \qquad (15)$$

Assuming that there is no excess capacity, i.e. all sugar planted is harvested. ($Q^*_t = Q_t$) we can dispense with further consideration of the short run simply response function[6] relating potential and actual output. Combining (5) and (15) gives.

$$Q_t = \delta(o,t)\, bP_{t-1} + \delta(1,t)\, bP_{t-2} + \delta(2,t)\, bP_{t-3} + cQ_{t-1}$$
$$+ d\, Q_{t-3} + \text{constant} \qquad (16)$$

The yield profile for sugar declines so we would expect the coefficients on Pt-i to decline as i increases.

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6 Including a short run adjustment equation would not change the reduced form substantially, other than to intruduce greater flexibility in the estimation of the coefficients of the lag distribution on price.

IV. Estimation of Area Planted and Output Response Functions

(15) was estimated from 1959 to 1976 for the entire Kingdom and from 1962 to 1976 on a regional basis. Data for I were not available in raw form. However, by assuming two ratoon crops and area planted before 1931 is negligible, a Kingdom wide series for It was generated using the total area planted identity

$$At = I_t + I_{t-1} + I_{t-2} \qquad (17)$$

The regional time series were derived assuming unchanged regional weights for the two years before the start of the sample.[7] Thus we assume that none of the area planted is damaged and that all depreciation occurs at the end of the second ratoon crop, when uprooting and replanting occur.[8] The price series were derived from a weighted average of ex factory sugar cane prices paid to farmers, the weights being sugar production by the mill. Being ex factory, the price index overstates the farm gate price. It may be reasonable to assume constant transportation costs in the short run in which case the error would appear in the regression intercept.

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7 See the Appendix for details.
8 While it is difficult to measure the reliability of the generated series a rough and ready check was made by comparing it with some selected independent field survey estimates of ratoon and newly planted area. In 1965 (17) did not hold unless I_t was negative, implying premature uprooting of some ratoon acreage. To make the identity hold we let $I_t = 0$ and reduced I_{t-2} for that year only.

The results of the least squares estimates of (15) are displayed in Tables I and II. An inspection of the residuals from the model revealed rather consistent over prediction of area planted for the years since 1973. This surge of planting was reinforced by several factors which were mentioned above and which have heretofore not been included in the model. They include removal of restrictions on the construction of new sugar mills and an extremely favorable world price. We experimented with several additional explanatory variables to reflect these events such as export prices, cane crushing capacity, millers effective sugar prices and the number of sugar mills. However, none of these variables performed satisfactorily in the model and we finally settled for a dummy variable (D) which is zero before 1973 and one otherwise. These regressions are also shown in Tables I and II. The results are satisfactory with all variables but I_{t-1} being statistically significant in most cases. For the Kingdom, mean short run price elasticities of investment response range from .57 to .196, averaging 1.1 for the six reported regressions. However, the coefficient of I_{t-3} is somewhat greater than one, suggesting an explosive long run solution. While generally unacceptable, this is clearly compatible with the recent rapid expansion of sugar cane planting and the apparent short run absence of an upper bound total land constraint on new-area planted.

Table I - Kingdomwide Determinants of

Area Planted in Sugar Cane - 1957 - 76*

Equation number	Constant	I_{t-1}	I_{t-3}	P_{t-1}	D	R^2	short run price elasticity	D-W
1	-309.2	.069		3.91		.56	1.9	1.84
	(-2.09)	(.29)		(3.24)				
2	-248.6		1.22	2.20		.86	1.1	1.65
	(-3.18)		(5.92)	(3.66)				
3	-235.0	.054	1.22	2.02		.86	1.0	1.76
	(-2.67)	(.38)	(5.76)	(2.59)				
4	-136.5	-.20		2.65	375	.72	1.3	2.50**
	(-2.75)	(-.94)		(2.47)	(3.03)			
5	-112.6		1.07	1.13	225	.92	.5	2.24**
	(-1.60)		(6.61)	(2.06)	(3.64)			
6	-126.0	-.13	1.06	1.41	258	.93	.7	2.09
	(-1.79)	(-1.14)	(6.53)	(2.37)	(3.81)			

t values are in parentheses.

** indicates test is inconclusive. In other cases null hypothesis of no auto-correlation is accepted at the 5% level of significance. Durbin's H (5) was also computed since D-W is biased when lagged endogenous variables are included in the model. The null hypothesis of no auto correlation was rejected in the case of equatinns 4 and 5. In these cases we performed a Cochrane - Orcutt autoregressive tranformation to obtain a model with unautocorrelated residuals. The results differed only marginally form these reported.

* Data Series are from P. Jessadachatr (8). We tried both absolute and relative sugar cane prices the later using Bangkok 5% white rice prices as the denominator. The absolute price series performed better in every case. While we are convinced that Thai farmers are aware of and react to relative prices we are not surprised that the relative price formulation was inferior since virgin land clearing has accounted for most of the recent additions to sugar cane planted area.

Table II - Determinants of Sugar Cane

Area Planted by Region, 1965 - 1976

Equation Region	Constant	I_{t-1}	I_{t-3}	P_{t-1}	D	R^2	D-W*
1.North	-58.3		.94	.57		.63	1.33
	(-2.23)		(1.00)	(3.70)			
2.N. East	-21.3		.40	.29		.53	1.88
	(-1.32)		(1.02)	(2.77)			
3.Central	-107.83		1.69	.77		.92	1.72
	(-1.72)		(7.88)	(1.96)			
4.East	-66.93		.78	.62		.76	1.49
	(-1.89)		(3.83)	(3.31)			
5.North	-33.87		1.38	.22	52.29	.85	2.32
	(-1.76)		(2.13)	(1.48)	(3.38)		
6.N. East	-11.71		.56	.15	22.11	.72	2.82
	(.86)		(1.73)	(1.44)	(2.35)		
7.Central	-70.93		1.52	.54	64.54	.93	1.56
	(-1.06)		(6.34)	(1.28)	(1.29)		
8.East	-48.92		.78	.45	32.15	.81	1.60
	(-1.37)		(4.04)	(2.13)	(1.43)		
9.North	-40.32	.45	1.19	.32		.68	1.46
	(-1.37)	(1.22)	(1.27)	(1.24)			
10.North	-24.81	.27	1.50	.09	48.68	.87	2.49
	(-1.17)	(1.02)	(2.28)	(.49)	(3.07)		
11.Central	-110.21	-.02	1.69	.81		.92	1.66
	(-1.64)	(-.19)	(7.33)	(1.78)			

Table II - Continued

Equation Region	Constant	I_{t-1}	I_{t-3}	P_{t-1}	D	R^2	D-W
12. Central	-69.89	-.11	1.52	.62	85.15	.94	1.23
	(-1.02)	(-.84)	(6.17)	(1.41)	(1.50)		
13. East	-65.28	-.05	.75	.65		.76	1.42
	(-1.71)	(-.21)	(3.02)	(2.75)			
14. East	-43.28	-.12	.71	.50	34.99	.81	1.54
	(-1.11)	(.54)	(3.03)	(2.08)	(1.45)		
15. N. East	-16/12	.058	.46	.24		.55	2.11
	(1.01)	(.11)	(1.02)	(1.30)			
16. N. East	-5.47	.08	.63	.08	22.07	.69	2.69
	(-.36)	(.18)	(1.53)	(.46)	(1.82)		

* The Durbin-Watson statistic can only be suggestive of auto-correlation in cases where there are limited degrees of freedom. Durbin's H appears to have good small sample properties but is also apt to lose power for extremely small samples such as those encountered in this regional regression analysis. Furthermore, in a recent monte carlo study Maesiro (10) concludes that use of autoregressive or first difference transforms when we have trending independent variables and autocorrelated residuals may lead to a loss in efficiency rather than an improvement over least squares. For these reasons we have not attempted any transformations to remove suspected residual autocorrelation where sample sizes are less than fifteen.

TABLE III

Regional Mean Short Run Price Elasticities

of Sugar Investment From Table II Regression

Region	Equation	Elasticity	Equation	Elasticity	Equation	Elasticity	equation	Elasti -city
North	1	2.40	5	.46	9	1.21	10	.38
N. East	2	1.60	6	.84	15	1.24	16	.41
Central	3	.81	7	.35	11	1.56	12	.40
East	4	1.10	8	.81	13	1.17	14	.90

The model would have to be modified to include a trend or a ceiling constraint on area planted if it were to be used for long run analysis.[8a]

The results of the regional breakdown are somewhat less satisfactory This is partially a consequence of a sizeable reduction in degrees of freedom and the presence of multicollinearity within the set of independent variables. Nevertheless they support the general results of the aggregate analysis. P_{t-1}, I_{t-3}, and D are statistically significant in most instances. Surprisingly investment is only mildly responsive to price changes in the rapidly growing central region where new planting has been almost exclusively on newly cleared virgin land and more strongly responsive in the older more established eastern region.[9]

If the coefficient for I_{t-1} is insignificant, as the results of Tables I and II suggest, then c in the output response function (16) is also zero. We fitted (16) with and without this restriction both by least squares and using an Almon lag with a low level polynomial constraining the lag coefficients. There was little difference between the two sets of results, for reasons of space we report the least squares results only.

If we maintain the assumption that technical progress influences yield, i.e. δ is a function of i <u>and</u> t, then the price parameters in (16)

8a Experiments with a double log form of the model reduced the explosive nature of the long run solution. Results for the log form of the reduced output determination equation (16) are shown below.
9 Together the north and northeast are still relatively minor sugar cane growers, handling less than fifteen percent of total output for most of the study period.

are not fixed. While it is possible to estimate varying parameter models (7,12) the procedure uses up valuable degrees of freedom. Hence we assume $\delta(i,t) = \delta(i)$.[10]

The regressions for kingdom and region are displayed in Table IV and V. As we observed in the case of area planted, the model tends to underpredict for the last few years of the sample. Therefore we again introduce D as an explanatory variable.[11] Overprediction was also noted in 1968 and 1972. Harvests were low in these years because of drought conditions during the previous planting season, so we included total accumulated rainfall from June to September of the previous year as a final explanatory variable (R_{t-1}). Proper specification of the rainfall variable is complicated by the geographic differences in rainfall accumala tion. We decided upon single station accumulation in the sugar growing section of each of the four regions. For the kingdom analysis these were averaged, the weights being regional share of total sugar production.

The regression results for the kingdom are encouraging. Aside from rainfall, the regression coefficients are usually significant with correct a priori signs. Price is statistically significant in most cases and a decline in the size of the regression coefficient with increasing lag is also observed in some cases, although there is also some evidence of an inverted V shape in a few equations. Q_{t-1} has the more significant lagged output coefficient, a contrast with the fit of the investment function.

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10 Recall that the derivation of the investment function also depends on this assumption.

11 This could also be accomplished by introducing D into (15) but would result in two additional lagged dummy variables. This does not make much sense in terms of the overall specification of the model.

TABLE IV

Kingdomwide Determinants of Sugar Cane Output 1957-1976

Equation No.	Constant	q_{t-1}	q_{t-3}	P_{t-1}	P_{t-2}	P_{t-3}	D	$RAIN_{t-1}$	R^2	Short run price elasticity (P_{t-1})	Long run price elasticity
1	-2756	.63		29.50			3453	.61	.97	.85	2.3
	(-3.44)	(4.47)		(4.30)			(3.45)	(.65)			
2	-6361	.35	-.03	34.68	.63	31.80	4563	-.30	.99	1.01	2.8
	(-5.04)	(2.37)	(-.11)	(3.42)	(.06)	(3.43)	(4.67)	(-.35)			
3	-2671	.62	.05	28.38			3358	.55	.98	.82	2.4
	(-2.70)	(3.94)	(.16)	(2.80)			(2.80)	(.53)			
4	-3335	.52	.26	21.30	12.45		3233	.11	.98	.62	4.4
	(-2.74)	(2.76)	(.63)	(1.68)	(.94)		(2.67)	(.10)			
5	-2705		.57	30.22			5313	1.71	.95	.87	2.0 *
	(-1.95)		(1.26)	(2.13)			(3.47)	(1.22)			
6	-3130	.99		29.61				-.66	.96	.86	86 *
	(-3.04)	(8.34)		(3.33)				(-.59			

* Denotes residual auto-correlation using Durbins H.

TABLE IV (Continued)

Kingdomwide Determinants of Sugar Cane Output 1957-1976-Log Form*

Equation No.	Constant	q_{t-1}	q_{t-3}	P_{t-1}	P_{t-2}	P_{t-3}	D	R^2	Longrun price elasticity
1	-1.49	.74		.73			.22	.94	2.8
	(-1.23	(7.24)		(2.60)			(1.14)		
2	-3.44	.58		.71	.27	.40	.30	.95	1.7
	-1.73	(3.39)		(2.21)	(.65)	(.93)	(1.47)		
3	-3.73	.72		.82	.21	.21		.94	2.9
	(-1.81)	(4.86)		(2.49)	(.47)	(.50)			
4	-1.23	.67	.12	.62			.22	.95	1.9
	(.94)	(4.02)	(.59)	(1.82)		(1.14)			

* None of the regression residuals was significantly autocorrelated using Durbins H.

The mean shortrun price elasticities of output response are quite stable, clustering between .8 and .9 in most instances For the long run the coefficients are between two and five time the short run response except in the case of equation 6 in TableIV where D is excluded and the coefficient on Q_{t-1} is very close to one.

An alternative model was constructed using a double log transformation of the variables. This transformation seemed appropriate because of recent rapid (nonlinear) changes in output and prices as well as the significance of D in the linear model. These regression are displayed in the lower half of Table IV. The results are supportive of the conclusions drawn from the linear model. As we would have guessed D is no longer statistically significant. The long and short run price elasticities are still quite high, although somewhat lower than those implied by the linear model. For the short run, elasticities can be read as the coefficient on P_{t-1} while the long run elasticities are shown in the final column of the table.

Turning to the regional results we find certain similarities with the aggregate regressions. Rainfall is unimportant, the pattern of declining price coefficients is again observed and D is statistically significant with few exceptions. However, there are several distinct differences. First, the price elasticities are not nearly so stable or statistically significant. They vary widely between regions and for different models within a region. In the northeast, price is highly significant but falls to marginal significance in the eastern and central regions. Similarly, the coefficients for lagged output are erratic and in several instances when D is excluded imply explosive behavior. No doubt one reason for the sensitivity of the regional models is the limited sample size combined with collinearity in the set of independent variables. For these reasons we cannot give as much weight to them as they perhaps deserve. Furthermore, it is difficult to envision an alternative estimation model which can break the multicollinearity deadlock without additional sample observations. We did construct a pooled cross-section time series model for the four regions over the 1965-1976 period. Intercept dummies for each region were included (DC DNE DN DE) and a common slope coefficient was assumed. Analysis of this pooled model (Table VI) reveals two disturbing features. The residuals appear to be heteroscedastic and the lagged output coefficient is greater than one, suggesting explosive long run behavior. The problem of heteroscedasticity results from scale difference among the different regions; the central region supplying a disproportionaly large volume of output and consequently having very large residuals. The explosive nature of the long run solution has been noted above and is probably a consequence of rapid nonlinear regional growth in sugar output since the world commodities crisis of 1973. In the light of these problems a double log transformation again seemed appropriate.[12]

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12 Such a transformation is desirable only if it makes the model more nearly linear and if the errors more closely conform to the least squares assumptions. While the log transformation clearly reduces hetereoscedasticity it is difficult to judge which functional form gives a better fit. R^2 comparisons are not valid and the comparison suggested by Box and Cox (3) is not strictly applicable when the model includes lagged values of the dependent variable.

TABLE V

Regional Determinants of Sugar Cane Output:1965-1976

Region	Constant	q_{t-1}	q_{t-3}	P_{t-1}	P_{t-2}	P_{t-3}	D	$RAIN_{t-1}$	R^2	D-W
North	-91.1	.82		.45			420	.07	.94	2.48
	(-.30)	(2.53)		(.19)			(2.84)	(.36)		
North	131.5	.80	.28	.56	1.13	-3.37	456	.09	.948	2.69
	(.10)	(1.56)	(.19)	(.15)	(.11)	(-.50)	(2.09)	(.28)		
North	-137	.79	.25	.17	.47		436	.10	.944	2.50
	(-.34)	(1.67)	(.18)	(.05)	(.05)		(2.46)	.34		
North	-489		-.82	9.66				-.20	.797	1.47
	-1.00		(-.53)	(4.85)				(-.56)		
North	-745		.58	4.88			554	.23	.895	2.22
	(1.93)		(.45)	(2.02)			(2.57)	(.75)		
North	58[illegible]	1.05		1.67				-.19	.879	1.56
	(.14)	(2.44)		(.51)				(-.75)		
North	-186	.79	.25	.176	.475		434.6	.096	.944	2.50
	(-.18)	(1.67)	(.18)	(.05)	(.05)		(2.2)	(.34)		
North	-22	.84		.49			396.8		.943	2.51
	(.098)	(2.80)		(.21)			(3.18)			
N.East	-106	.64		2.51			84.62	-.12	.990	2.07
	(1.96)	(4.20)		(8.44)			(2.50)	(-2.16)		
N.East	-72	.37	-.35	3.02	.58	-.62	130.9	-.07	.997	2.64
	(-.76)	(2.11)	(-2.40)	(8.81)	(1.12)	(-1.27)	(5.34)	(1.83)		
N.East	-51	.41	-.44	3.24			116.8	-.11	.993	2.58
	(-1.17)	(2.89)	(-2.61)	(9.09)			(4.18)	(-2.82)		
N.East	-155	.25	-.41	3.24	.84		132	-.83	.996	2.36
	(2.11)	(1.59)	(-2.74)	(10.40)	(1.69)		(5.08)	(-2.16)		

TABLE V (Continued)

Region	Constant	q_{t-1}	q_{t-3}	P_{t-1}	P_{t-2}	P_{t-3}	D	$RAIN_{t-1}$	R^2	D-W
N. East	-48		-.81	5.13				-.13	.875	.80
	(-.28)		(-1.61	(6.40)				(-1.15)		
N. East	-50		-.74	4.00			178.5	-.04	.98	2.77
	(-.77)		(-3.86)	(11.54)			(6.90)	(-1.00)		
N. East	-72	.37	-.35	3.02	.58	-.62	130.9	-.07	.997	2.64
	(-.77)	(2.11)	(-2.40)	(8.81)	(1.12)	(-1.28)	(5.34)	(-1.83)		
East	-1375	-.06	.20	4.5	5.51	3.09	1024	1.04	.930	1.50
	(-1.37)	(-.18)	(.43)	(1.34)	(1.04)	(.74)	(2.22)	(1.34)		
East	-1114	.04	.21	4.26	5.53		959	1.18	.92	1.61
	(-1.24)	(.13)	(.48)	(1.33)	(1.10)		(2.22)	(1.63)		
East	-863	.66		7.98				.42	.81	1.89
	(-1.14)	(3.35)		(2.90)				(.52)		
East	-517	.26		6.13			885	.99	.90	1.42
	(-.87)	(1.22)		(2.75)			(2.56)	(1.50)		
East	-475	.26	-.06	6.31			923	.98	.90	1.42
	(-.68)	(1.13)	(-.16)	(2.38)			(2.10)	(1.37)		
East	-923		.79	6.95				.90	.67	1.41
	(-.91)		(1.86)	(1.68)				(.83)		
East	-266		-.06	6.39			1226	1.17	.88	1.16
	(-.39)		(-.16)	(2.37)			(3.45)	(1.65)		
Central	-6033	.29	.20	19.81	1.93	34.94	3322	-1.82	.988	2.04
	(-2.94)	(1.14)	(.32)	(1.58)	(.17)	(2.47)	(2.81)	(-.39)		
Central	-4085	.26	.97	6.04	11.25		1724	4.64	.970	2.20
	(1.51)	(.72)	(1.23)	(.38)	(.77)		(1.22)	(.86)		

TABLE V (Continued)

Region	Constant	q_{t-1}	q_{t-3}	P_{t-1}	P_{t-2}	P_{t-3}	D	$RAIN_{t-1}$	R^2	D-W
Central	-3560	1.03		19.47				2.53	.933	2.73
	(-1.19)	(4.92)		(1.92)				(.47)		
Central	-4918	.54		22.69			2614	6.31	.961	2.12
	(1.95)	(1.94)		(2.70)			(2.23)	(1.34)		
Central	-4173	.33	.71	13.78			1965	6.47	.966	2.05
	(-1.60)	(.97)	(1.03)	(1.14)			(1.48)	(1.39)		

TABLE VI

Pooled Results of Regional Determinants of Sugar Cane Output: 1965--1976

C	q_{t-1}	P_{t-1}	P_{t-2}	P_{t-3}	DC	DNE	DE	DN	D	R^2	D-W
-304	1.24	5.12	-2.36	-1.31						.941	2.52
(-.47)	(19.72)	(2.09)	(-.52)	(-.31)							
-687	1.22	4.47								.940	2.46
(-2.19)	(22.32)	(2.13)									
	1.20	5.54	-1.35	.17	-480	-652	-897	-592		.944	2.57
	(14.80)	(2.20)	(-.29)	(.04)	(-.64)	(-.92)	(-1.13)	(-.86)			
	1.20	5.20			-590	-756	-1017	-693		.944	2.57
	(15.56)	(2.39)			(-1.51)	(-2.11)	(-2.67)	(-1.98)			
-336	1.18	4.96	-1.41	.034		-249	-450	-191	146	.944	2.51
(.42)	(13.06)	(1.79)	(-.30)	(.007)		(-.63)	(-1.38)	(-.49)	(.53)		
-471	1.18	4.61				-242	-463	-179	143	.944	2.52
(-1.04)	(13.89)	(1.88)				(-.63)	(-1.48)	(-.47)	(.54)		

TABLE VI (continued)

Pooled Results of Regional Determinants of Sugar Cane Output: 1965-1976, Double Log Form of the Model

Equation	C	q_{t-1}	P_{t-1}	P_{t-2}	P_{t-3}	DC	DNE	DE	DN	D	R^2	D-W
1	-3.14	.900	.787								.945	1.82
	(-3.92)	(21.03)	(4.33)									
2	-.85	.499	.692	.309	-.037		-1.09	-.42	-1.00	.419	.964	1.63
	(-.49)	(4.01)	(3.49)	(1.08)	(-.127)		(-4.07)	(-3.17)	(-3.82)	(3.43)		
3	-1.21	.950	.754	-.039	-.386						.947	1.89
	(-.67)	(16.03)	(3.72)	(-.124)	(-1.23)							
4	-.21	.548	.760				-1.01	-.386	-.93	.401	.963	1.62
	(-.21)	(5.89)	(4.21)				(-4.28)	(-3.24)	(-3.96)	(3.36)		

(Table VI bottom). Heteroscedasticity is reduced and the long run relationship is stable, price elasticity of supply is large and significant while the coefficient distribution for price exhibits the anticipated declining lag shape. In the short run the price elasticity of supply is between .69 and .78 and in the long run between 1.4 and 15. The long run estimates are sensitive to the inclusion of the intercept dummy variables, the more realistic values being obtained when the intercept dummies are included. Analysis of the dummy coefficients suggests that the eastern and central regions have greater output responsiveness, to price changes, ceteris paribus. This is consistent with the specialization patterns of the regions suggested earlier.

The pooled regional regressions are quite stable and are consistent both with a priori reasoning and with the kingdom wide results reported above. This is in sharp contrast with the individual region results which we found to be quite volatile and generally unreliable. Part of the reason for enhanced stability of the regression results through pooling lies with the increased number of sample observations. This is obtained at the expense of a restriction on slope coefficients varying among regions. If this restriction is incorrect the pooled results cannot be interpreted in a straightforeward way. Fortunately an F test for slope homogeneity was not rejected.

V. Comparison with Other Researches

Most of the postwar estimates for sugar cane supply resposne have been conducted for India, although a few other countries have been studied.

The results of many of these researches have been conveniently summarized by Askri and Cummings (1). Our estimates of Kingdomwide supply elasticity are on the average somewhat higher than those reported in the literature. One reason for this relates to the choice of the dependent variable. Many investigations have used area planted rather than output as the dependent variable. Output may vary because of variations in yield, some of which may be random, while area planted reflects "committed" farmers intentions. For the perennial crop model we have tried to circumvent this problem by measuring output response and by dividing the planted area into different vintages, each associated with a different yield profile. Random variations in yield due to weather and other exogenous factors are assumed to be small or else reflected by independent weather variables like rainfall. Gross yields, averaged over all vintages, are modified by changes in the age distribution of plants. As Askari has noted,[13] the market response of farmers involves both acreage planted adjustments and yield adjustments. Models which do not recognize the later underestimate the actual price response of farmers.

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13 Askari also notes the possibility of irreversibilities in sugar production which make output relatively insensitive to price declines. Irreversibilities occur when there is regional concentration in sugar production and because of high fixed costs in milling equipment require a steady thruput. Although we have not formulated any rigorous tests of this proposition we have not observed any pronounced downward insensitivity of price reductions in our data set. Casual observation of residuals in both output and area planted adjustment equations do not suggest any such assymetries nor do the usual tests of residual autocorrelation. Furthermore in the 1966 sugar slump total cane area and output dropped 31 and 17 percent respectively in response to a 24 percent price decline. At the same time seven sugar mills with nearly 10 percent of total cane crushing capacity closed down.

Unfortunately it is difficult to construct a reliable test of this proposition. International comparisons are subject to well known comparability limitations and data problems inhibit analysis for Thailand alone. Nevertheless a rough regional comparison between the rapidly growing central region and the more established eastern region is instructive. As we observed above the results are not favorable to the growth hypothesis. New planting investment is only mildly price responsive in the central region where much newly cleared virgin land has been planted in sugar cane; whereas in the eastern region where cassava and sugar often compete for the same land, planting is more highly responsive to price changes. At the same time output is not particularly price responsive in either region, although the eastern region does register a few significant price coefficients in the results presented in Table V.

On the other hand the results of the pooled regional regressions give at least partial support to the hypothesis to the extent that the dummy variable intercept for the central region is the largest, followed by the eastern region. This may mean that other factors beside price such as industrial organization and specialization may be important in analyzing regional differences in output responsiveness. We would need to go beyond a simple supply response model to specify behavior on such a detailed regional level.

V. Conclusions

A theoretical model has been developed demonstrating that field crops with both annual and perennial characteristics can be fruitfully analyzed using theory developed for perennial crops. Such a supply adjustment model has been successfully fitted for Thai sugar cane. Aggregate kingdom findings suggest significant and elastic output responsiveness to price changes. Regional results are less conclusive perhaps because of data limitations. However, a pooled model of regional output determination performed well and suggested conclusions in keeping with those for the kingdom as a whole.

A protective government policy which has kept domestic prices above world prices for most of the study period has also been a contributing factor in the rapid growth of the sugar and sugar cane industries. This policy has also helped to smooth out world price fluctuations which could have a potentially harmful effect on the stability of domestic prices. Growth has been further reinforced by the availability of cheap and fertile virgin land for crop expansion and a highly favorable world price from 1973 to 1975-76. Sugar cane and sugar in Thailand thus seem to provide some support for infant industry protection. Certainly this could be argued simply from the standpoint of the growth and viability of the industry over the last twenty years. This is not to say that the overall economic impact of government policy can be judged by this criteria alone. A careful analysis of the dead weight loss implied by price supports as well as the benefits from economic growth and price stabilization needs to be made before the complete welfare impact of Thai government sugar policy can be clearly evaluated.

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APPENDIX

A consistent time series for total area planted (A_t) in sugar cane is available from the Sugar Institute, Ministry of Industry beginning in 1962. These figures are somewhat lower than those reported by the Ministry of Agriculture since cane planted for noncentrifugal sugar production is excluded. Between 1954 and 196 Amnuay Patise, Economics of Sugar Trading, Roong Ruang Press, Bangkok, 1974, has estimated area figures which are reasonably consistent with the Sugar Institute's definition. In order to determine new area planted (I_t) from 1954 on we must make estimates of new area planted beginning in 1952. To do this we began in 1938, just after the first centrifugal sugar milling equipment was installed in Thailand. Based on some approximations about sugar yield per ton of cane and cane yield per rai of land we were able to arrive at some rough estimates of new and total area planted from 1938 to 1940 based on sugar production of the Thai Lampang Sugar Mill. During WWII sugar production data were insufficient to continue using this method. Instead we extended Amnuay's figures back to 1941 using Ministry of Agriculture figures on area planted as a base. Once a yearly total area series is derived, new planting from 1938 on is obtained by using (17) and the initial values of new planting in 1936 and 1937. These series are displayed in Appendix Table 1.

Because of the uncertainty of figures for the early years an alternative series was derived for new planting by assuming that I_{1952}, I_{1953} and I_{1954} were each 1/3 of A_{1954}. The series for I_t derived in this way was not substantially different from that shown in Appendix Table 1 aside from the starting up problem for 1954-1958. This suggests that the derivation of the new planting series is not particularly sensitive to the initial conditions on I_{t-1} and I_{t-2} so long as we begin with some tenable assumptions.

To further establish the reliability of the artificially generated new planting series we compared our estimates with independent survey estimates of ratoon and new planting made by the Sugar Institute for selected years and regions. In most instances the two values were fairly close (within 20 %) and we observed no systematic differences between the estimates. Excepting 1971 the disparities between the two sets of estimates are smallest for the central region and largest for the eastern region and the overall kingdom.

Regional new area planted totals from 1962-1977 were generated using regional total areas from 1962 on, under the assumption that the regional distribution of area planted in 1960 and 1961 was unchanged from 1962. In 1967 where total area figures implied that some area was uprooted, the oldest ratoon (I_{t-2}) was debited. The regional series are shown in Appendix Table II.

Appendix Table I

YEAR	TOTAL AREA(A_t) (,000 RAI)	NEW PLANTING (,000 RAI) I_t	I_{t-1}	I_{t-2}
1938	21	8	8	5
1939	23	7	8	8
1940	25	10	7	8
1941	28	11	10	7
1942	31	10	10	10
1943	36	15	10	10
1944	41	16	15	10
1945	46	15	16	15
1946	51	21	15	15
1947	56	20	21	15
1948	62	21	20	21
1949	67	26	21	20
1950	78	31	26	21
1951	102	45	31	26
1952	106	30	45	31
1953	120	45	30	45
1954	143	68	45	30
1955	153	40	68	45
1956	173	65	40	68
1957	208	103	65	40
1958	175	7	103	65
1959	233	123	7	103
1960	315	185	123	7
1961	343	35	185	123
1962	441	221	35	185
1963	345	89	221	35
1964	452	142	89	221
1965	532	301	142	89

Appendix Table I (continued)

YEAR	TOTAL AREA(A_t) (,000 RAI)	NEW PLANTING (,000RAI) I_t	I_{t-1}	I_{t-2}
1966	524	81	301	142
1967	361	0	81	280*
1968	448	367	0	81
1969	646	279	367	0
1970	739	93	279	367
1971	862	490(244)	93	279
1972	872	289	490	93
1973	1133	354	289	490
1974	1616	973(856)	354	289
1975	1935	608(627)	973	354
1976	2348	767(684)	608	973
1977	3119	1744	767	608

* 21,000 rai were uprooted

Source: A_{1954} - A_{1977}; P. Jessadachatr /̅ 8 ,Appendix Tables F.16,F.17/̲
A_{1940} - A_{1953}; Derived from P. Jessadachatr /̅ 8 ,Appendix TableF16/̲ using proportions developed by Amnuay Patise.

A_{1938} - A_{1939} & I_{1937}, I_{1936} ; Derived from sugar production of Thai Lampang Sugar Mill reported in P. Jessadachatr /̅ 8 , Appendix Table F.24/̲. Figures in parentheses are independent survey estimates made by the Sugar Institute.

Appendix Table II

YEAR	TOTAL NEW PLANTING(I_t) (,000 Rai)	REGIONAL NEW PLANTING (,000 RAI) Central	East	North	Northeast
1960	185	65	72	24	24
1961	35	12	31	5	5
1962	221	76	82	32	31
1963	89	35	34	16	4
1964	142	52	56	7	27
1965	301	122	132	24	23
1966	81	29	20	19	13
1967	0	0	0	0	0
1968	367	173	143	16	35
1969	279	(276) { 142	(144) 92	17	28
1970	93	78 }	10	5	0
1971	490 (244)(144)	325	(100) 122 { (157)	22	21
1972	289	(412) { 170	(114) { 76 }	15	28
1973	354	217 }	92 } (134)	20	25
1974	973 (856)	642 (617)	184 (238)	109	38
1975	(1026) 608 (627)	319	114	96	79
1976	767 (684)	453	157	101	56
1977	1744	1370	166	126	82

Source: Appendix Table I and P. Jessadachatr [8], Appendix Table 17.
Regional new plantings must add to total area planted using (17).
Figures in parentheses are independent survey estimates made by the Sugar Institute. Bracketed figures refer to the sum of two years. One and two years estimates are not always consistent.