Agricultural pricing policies and demand patterns in Thailand

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Introduction and Summary

In the postwar period, the government of Thailand has exercised a range of policy instruments that have influenced the prices of agricultural goods. Policies towards the export of rice have been the most important, but a range of other goods, specifically sugar, rubber, maize, and vegetable oils have also been directly subject to government policy. The history and political economy of these policies has recently been well described by Siamwalla and Setboonsarng (1987), who also make estimates of the economic effects on domestic prices, on transfers of resources between agriculture and government, and on consumer welfare. In an earlier study of policies towards rice, Trairatvorakul (1984) makes an even more ambitious attempt to track the effects of rice policies, not only on government revenue and household welfare, but also as far as the influences on urban and rural real wages, and on the nutritional status of the population.

This report is less ambitious than either of these earlier studies, and focuses on only one part of the story, albeit a part that is important and that has been lightly researched in the earlier literature. I am concerned here with patterns of household demand and how knowledge of those patterns affects the assessment of pricing policies. There are two parts to the study, the first a good deal more complete and satisfactory than the second.

My first aim is to examine the effects of rice prices on the distribution of real incomes across different households. I do this by describing consumption and production patterns for rice with particular emphasis on the relationship between demand and household characteristics, particularly living standards and the geographical location of the household. Such description is important because it provides an easily comprehended "map" of the immediate effects of price changes, and although such maps contain a good deal less than everything that we should like to know, they are based on good data, and provide perhaps the only firm information we possess about the effects of changes in pricing policy. Using a household survey, the 1981-2 Socioeconomic Survey of the Whole Kingdom, as my data base, I find that higher rice prices can be expected to provide direct benefits to rural households at all levels of living, but that the main beneficiaries are neither the poorest households nor, more surprisingly, the richest households. The immediate effect of higher rice prices is to redistribute income towards households in the middle of the rural income distribution.

In the second part of the study, I attempt to estimate price elasticities of demand for rice and for several other items of food consumption. The basic idea is the same as in Trairatvorakul (1984), which is to link provincial price data to the household data from the Socioeconomic survey. My attempt meets with poor results; for rice, there is a negative correlation over space between the share of the budget devoted to the good and its price. Communities that have a high price of rice tend to have low shares of the budget devoted to rice and vice versa. If such a correlation is attributed to the effects of price on demand, then price elasticities must be greater than unity. While such a conclusion is not improbable for items like sugar that account for only a small share of the budget, it is quite implausible for rice, which is a major staple, which accounts for a third of the budget of poor households, and which has no obvious substitutes. Nevertheless, the correlations are real and require explanation.

The plan of the report is as follows. Section 1 provides a brief theoretical outline that motivates the empirical work. The material is standard, but is worth rehearsing since it is often misunderstood in the food policy literature. Section 2 presents the analysis of demand and supply patterns for rice and of the distributional consequences of alternative pricing schemes. Section 3 contains the material on price elasticities.

1. Demand patterns and pricing policy

Changes in an export tax like the Thai rice "premium" will generally have widespread and complex effects throughout the economy. The most immediate and obvious are the effects on government revenue and on household and farmer real incomes. For the latter, consider a farm or non-farm household that consumes rice, may or may not produce rice, and trades in other commodities and in the labor market. A simple representation of household living standards is given by the indirect utility function

$$u_h = \psi(wT+b+\pi, p) \tag{1}$$

where u_h is utility (or real income) of household h, w is the wage rate, T is the total time available, b is rental income, property income, or transfers, p is a price vector of commodities consumed, and π is the household's profits from farming or other family business. Since profits are maximized, we can think of π as the value of a profit function, $\pi(p,v,w)$, say, where v is a price vector of input prices, w is the wage rate (or a vector of wages), and p in this context is the vector of output prices for commodities, such as agricultural goods, that are produced by the household. A standard property of the profit function is that

$$\partial\pi/\partial p_i = y_i \tag{2}$$

where y_i is the (gross) production of good i by the household (or farm).

Given these functions, the effects of price changes on household real income are straightforward to derive. In particular, we have

$$\frac{\partial u_h}{\partial p_i} = \frac{\partial \psi}{\partial b}\frac{\partial \pi}{\partial p_i} + \frac{\partial \psi}{\partial p_i} = \frac{\partial \psi}{\partial b}(y_i - q_i) \tag{3}$$

where q_i is consumption of good i, and the last step in (3) comes from the use of Roy's identity, that demand is the derivative of utility with respect to price, scaled by (minus) the derivative with respect to income. Since the welfare of different households will generally weigh differently in the government's objectives, we can go from household to social welfare by writing, for social welfare W,

$$\partial W/\partial p_i = \Sigma_h \theta_h (y_{ih} - q_{ih}); \quad \theta_h = \partial W/\partial b_h = (\partial W/\partial u_h).(\partial u_h/\partial b_h) \tag{4}$$

so that θ_h is a weight that represents the social value of transferring one baht to household h. Note that (4) summarizes only the *direct* effect of the price change on household and social welfare; government revenue will also change, and the social value of this is not included in expression (4) and has to be taken account of separately.

Representative values of output and consumption levels, y_{ih} and q_{ih} in (4), can be obtained directly from a household survey such as the 1981 Socioeconomic Survey. The θ parameters are subjective, and represent the weights attached to changes in the real income of different households. It is therefore quite reasonable for the θ's to vary for different applications, and for different observers. For example, outside agencies may be more interested in the distributional consequences of pricing than is the price-setting ministry itself. It is therefore important not to specify the θ's in any empirical analysis, but rather to chart the ways in which consumption and production vary with the factors that determine the weights. The most important of these is likely to be household levels of living; much of the debate about pricing policy has concerned the effects on poverty and on nutrition among the poorest households. Regional, geographical, and sectoral factors also have an importance that is distinguishable from their correlation with living standards. In the next section, my main concern will be to present the joint distributions of consumption, production, location, and living standards. Armed with this, it is possible to look at the effects of pricing on welfare from a wide range of different viewpoints.

For the purposes of this report, it is convenient to work with a slightly different form of equation (3). Instead of looking at the change in welfare from a price change, we can ask how much money (positive or negative) that the household would require to maintain its previous level of living. If the price change is dp_i, and the required compensation is dB, then, from (3)

$$dB = (q_i - y_i)dp_i = p_i(q_i - y_i)d\ln p_i \tag{5}$$

so that, if dB is expressed as a fraction of household expenditure x, we have

$$(dB/x) = (w_i - p_i y_i/x)d\ln p_i \tag{6}$$

where $w_i = p_i q_i/x$ is the *budget share* of good i, and $p_i y_i/x$ is the value of production of i as a fraction of total household expenditure. Equation (6) is particularly convenient for empirical analysis since $w_i - p_i y_i/x$, which I shall call the *net consumption ratio*, is the elasticity of the cost of living with respect to the price of good *i*. For net producers of the good, the elasticity will be negative, and for net consumers positive. Further, the relationship between the net consumption ratio and any household characteristic determines the distributional effects of the price change with respect to that characteristic. For example, if the ratio is distributed independently of household living standards, or if it is the same on average in two different regions, then price changes will not affect the real distribution of income, or the distribution between the two regions. For this reason, it is the net consumption ratio that will be documented in the next section.

The proportional or elasticity formulation in (6) is also convenient because it automatically takes care of the fact that farmers produce, not rice, but paddy, while consumers consume rice. Suppose that there is a fixed rice yield, $\theta<1$, say, from each kilogram of paddy, so that if the price of rice is p_i, the price of paddy is θp_i. Farmers' profits depend on θp_i, while consumer costs depend directly on p_i. If p_i changes, with the paddy price moving proportionately, the compensation dB in (5), is now $(q_i - \theta y_i)dp_i$, since the producer benefit is proportional, not to y_i but to θy_i. As before, we can use the fact that $dp_i = p_i d\ln p_i$ to write dB as $p_i(q_i - \theta y_i)d\ln p_i$, which, since $\theta p_i y_i$ is just the value of sales of paddy, is purchases of rice less sales of paddy multiplied by $d\ln p_i$. In consequence, equation (6) is correct, provided that $p_i y_i$ is interpreted as the value of production.

For some purposes, it is useful to keep separate the production and consumption terms in (3) and (6). In the Thai context, sugar farmers would be an example. Farmers produce sugar cane, and sell it to the mills at one price, and they buy refined sugar at a different price. Given the complexities of Thai sugar policy, the two prices may not even move together. In these circumstances, it makes sense to consider production and consumption as disjoint activities, and to look at the separate effects of price changes on income generation on the one hand, and on the cost of living on the other. By contrast, for a subsistence paddy farmer who consumes much or all of what he produces, it would rarely be useful to make the distinction between the two effects.

Many of the effects of policy induced price changes depend, not only on the levels of consumption and production, but also on the way in which supply and demand respond to the price changes. Calculations of consumer surplus that are accurate for more than small changes require that we take into account the response of the consumer to the price change. But more seriously, even for "small" changes, price elasticities have a first order effect on the changes in revenue. Again, it is perhaps useful to give some examples in the Thai context. Suppose that the operation of the rice premium can be modeled in terms of a straightforward export tax, levied at (proportional) rate ρ. The simplest model would then have the form

$$p = p_w(X)(1-\rho) \tag{7}$$

$$X = Y(p) - Q(p) \tag{8}$$

where p and p_w are the domestic and world prices respectively, X is exports of rice from Thailand, and Y and Q are aggregate domestic production and consumption. The dependence of the world price on Thai exports reflects the market power exerted by Thailand as the world's largest exporter. Note that supply and consumption prices are identical; there is no significant policy wedge between farmer and consumer prices. The important elasticities here are the elasticity of foreign demand for Thai rice, ϵ_f, and the domestic *net* supply elasticity, ϵ_x. Consider for example, the effects of changes in the premium depend on the magnitude of the net supply elasticity. From (7) and (8) we have

$$\frac{\partial \ln p}{\partial \ln \rho} = \frac{-\rho/(1-\rho)}{1 - \epsilon_x/\epsilon_f} \tag{9}$$

so that while increases in the premium decrease the domestic price, the response will be less the *less* elastic is world demand, and the *greater* is the elasticity of net domestic supply. The traditional and official Thai position is that the premium is born by foreigners, presumably on the supposition that world demand is inelastic.

As a second example, the elasticity of government revenue to changes in the premium is given by

$$\frac{\partial \ln R}{\partial \ln \rho} = 1 - \frac{\rho \epsilon_x}{1-\rho} \left(\frac{1 + \epsilon_f}{\epsilon_x - \epsilon_f} \right) \tag{10}$$

so that, once again, we need to know ϵ_x to conduct an intelligent discussion of policy alternatives.

The net supply elasticity ϵ_x can be decomposed into its separate gross supply and demand components; in particular,

$$\epsilon_x = \frac{\epsilon_s - \sigma_c \epsilon_d}{(1-\sigma_c)} \tag{11}$$

where σ_c is the share of consumption in gross domestic production, and ϵ_s and ϵ_d are, respectively, the (gross) supply and demand elasticities. The supply elasticity of rice in Thailand has been estimated in many different studies; Siamwalla and Setboonsarng (1987, Table A14) list 34 different estimates of ϵ_s. Very much less is known about the demand elasticity ϵ_d.

2 Demand and supply patterns for rice in Thailand in 1981/2

In this section, I use data from the 1981/2 Socioeconomic Survey to describe patterns of demand and supply for rice. I shall be particularly concerned with how supply, demand, and living standards are related to one another, and how the relationships vary geographically. I begin with a brief description of the relevant parts of the household survey. It is from this that all the Tables and Charts in the report are constructed.

Table 1 shows the numbers of survey households and their distribution over the kingdom. There are 11,893 survey households used in this study; these are distributed as shown over the three sectors, municipal areas (urban), sanitary districts (semi-urban), and villages (rural). The survey is designed to give each household an equal probability of inclusion within each of the three sectors, but not between them. Households in municipal areas are less expensive to sample and are over-represented and those in villages are correspondingly under-represented. In order to avoid having to make weighting corrections, and because the sectoral division is itself inherently interesting, I shall keep the three sectors separate throughout the analysis. There are five standard regions, North, North-East, Center, South, and Bangkok, all of which are represented in each of the sectors. These can be further divided into the twelve regions shown in the Table, all of which, apart from the center of Bangkok, have some households in each sector of the survey. I shall use both the broad and fine regional breakdown; for rice in particular, cropping and consumption patterns of glutinous

Table 1: Structure of the Sample

	Community Types								
	Municipal Areas			Sanitary Districts			Villages		
	hh	am	blx	hh	am	blx	hh	am	blx
Regions:									
North Upper	313	4	27	326	13	38	598	17	99
North Lower	259	6	23	137	11	22	628	19	106
North East Upper	272	3	24	310	13	40	1015	17	169
North East Lower	303	4	27	243	13	32	977	20	163
Central West	120	3	11	167	7	21	293	9	49
Central Middle	172	6	15	280	11	37	547	12	93
Central East	141	5	13	31	4	4	321	10	54
South Upper	393	10	34	147	7	19	494	21	83
South Lower	207	4	18	22	3	3	146	8	25
Bangkok Central	1533	8	136	0	0	0	0	0	0
Bangkok Suburbs	403	3	36	172	1	22	116	1	19
Bangkok Fringe	43	1	4	63	1	8	701	4	118
Totals	4159	57	368	1898	84	246	5836	138	978

hh–households, am–amphoes, blx–blocks or villages

Block sizes are designed to have 12 households in municipal areas, 8 households in sanitary districts, and 6 households in villages.

Source: 1981/2 Socioeconomic Survey, author's calculations.

versus non-glutinous rice are quite different in the two parts of each of the North and North-Eastern regions.

Table 1 also shows the numbers of amphoes and blocks in each of the subregions. The amphoe and block structure of the survey will be used repeatedly below, so that it is worth explaining it at the outset. The amphoes are (official administrative) regions rather smaller than the seventy or so provinces of the country, and were chosen, not at random, but to match the amphoes in the previous (1975-6) socioeconomic survey. Within each amphoe, a number of blocks were randomly selected, the number being such as to ensure that, with a fixed block size, each household had an equal probability of selection. The design was for 12 households per block in municipal areas, 8 in sanitary districts, and 6 in villages; in practice there are minor deviations from the intent. The importance of the block structure is that households in the same block live in close geographical proximity to one another, and that all households in the block were interviewed over the same two week period. In consequence, geographical or seasonal factors will be the same for all households in the same block, so that block fixed effects can be used to control for such factors without having to specify their precise nature.

Table 2 presents sample means for the main variables of interest. Throughout this study, I use total household expenditure per head (*xpc*) as my preferred measure of household living standards; it is measured here as total household expenditure on non-durables per month divided by the number of persons in the household. Judging by this criterion, and ignoring any price differences, households in municipal areas have higher living standards than those in sanitary districts, who in turn are better off than

Table 2: Summary Data

Municipal Areas	All	N Up	N Lw	NE Up	NE Lw	Center	South	B'kok
Characteristics:								
family size	4.1	3.6	3.9	4.4	4.1	4.1	4.1	4.2
head's age	42.2	44.7	41.7	42.0	39.5	45.0	41.8	41.8
exp per head	1516	1394	1562	1171	1172	1497	1361	1680
Production value:								
rice	202	0	1559	0	110	399	219	49
glutinous rice	32	314	46	49	32	0	3	0
sugar cane	33	0	489	0	0	0	15	0
Expenditures:								
rice	208	146	251	125	189	244	227	213
glutinous rice	35	180	10	173	87	3	7	3
Budget shares:								
rice	4.51	3.05	6.70	2.82	4.82	5.66	5.89	3.97
glutinous rice	1.08	5.75	0.33	5.36	2.86	0.06	0.17	0.08
sugar	0.25	0.17	0.24	0.16	0.11	0.28	0.56	0.20

Sanitary Districts	All	N Up	N Lw	NE Up	NE Lw	Center	South	B'kok
Characteristics:								
family size	4.2	3.9	4.2	4.9	4.4	4.2	3.9	4.0
head's age	45.1	43.8	45.4	43.5	44.2	49.2	48.1	39.2
exp per head	902	779	754	710	767	993	1002	1292
Production value:								
rice	3693	928	11385	575	2867	8294	1255	407
glutinous rice	1484	3554	296	4200	1289	6	0	0
sugar cane	261	59	0	706	0	526	0	22
Expenditures:								
rice	199	31	289	52	241	318	235	265
glutinous rice	142	338	11	400	104	6	20	8
Budget shares:								
rice	6.88	0.98	12.35	1.66	9.99	11.01	8.47	6.03
glutinous rice	6.51	16.73	0.48	16.88	5.68	0.18	0.55	0.20
sugar	0.37	0.19	0.61	0.20	0.31	0.47	0.81	0.25

Villages	All	N Up	N Lw	NE Up	NE Lw	Center	South	B'kok
Characteristics:								
family size	4.6	4.1	4.3	5.2	5.1	4.3	4.5	4.4
head's age	45.4	44.0	43.6	44.1	44.9	48.1	45.7	46.0
exp per head	675	560	647	472	441	862	712	1021
Production value:								
rice	8790	672	16611	578	6018	14100	4345	18171
glutinous rice	2125	4446	1042	6382	2513	93	46	18
sugar cane	767	62	1072	445	17	2819	4	28
Expenditures:								
rice	233	20	337	15	292	360	303	277
glutinous rice	155	357	40	454	176	14	21	8
Budget shares:								
rice	10.39	1.08	17.38	0.69	17.14	13.77	13.68	8.41
glutinous rice	8.31	20.69	2.06	23.95	9.64	0.44	0.70	0.18
sugar	0.46	0.13	0.65	0.29	0.18	0.51	1.23	0.42

Notes: Expenditure per head (xpc) is total household expenditure (in baht) on non-durable goods per month divided by the number of persons in the household. Married children living with their parents are treated as separate households, even if they share the same food and kitchen. Production values are one twelfth of the annual value of crops; the mean is taken over all households whether or not they produce anything. Expenditures are also baht per month per household (not per person.) Budget shares are percentages of total household expenditure on non-durables.

N Up and N Lw are Upper and Lower North, similarly for NE Up and NE Lw; B'kok is Bangkok.

Source: 1981/2 Socioeconomic Survey, author's calculations village households. There are very marked regional disparities in these means. The average *xpc* of households in Municipal Areas is more than twice the average *xpc* in villages households, while the discrepancy between an average urban household in Bangkok and an average village household in the North East is closer to four to one. Overall, northern and particularly north-eastern rural households are the poorest, with central and southern areas in the middle of the distribution, and Bangkok at the top. I shall return to the distributions within these averages below. Note also that urban households tend to be headed by somewhat younger people, and that rural household sizes are larger. Again, the North-East is the outlier; household sizes are on average a full person larger than in municipal areas as a whole.

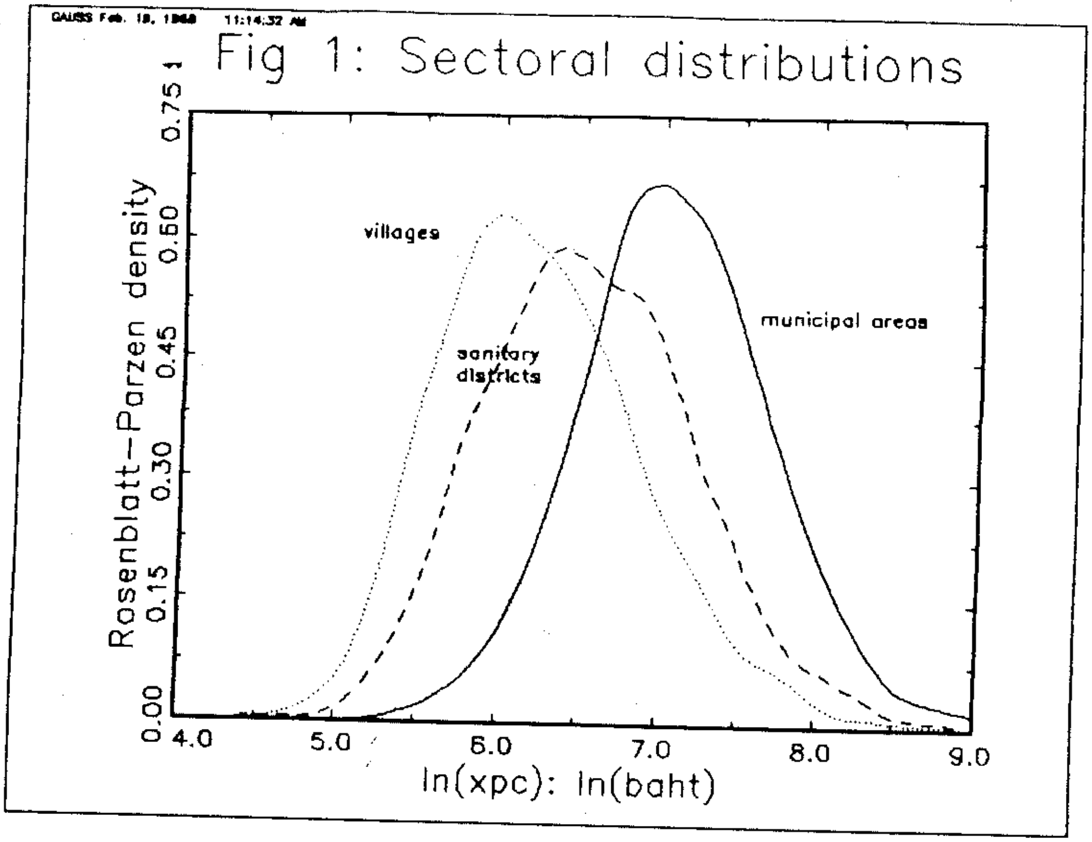
The second panel of Table 2 shows the regional distribution of the crops that are most affected by the food pricing policies. Note that while I have converted the annual production values to a monthly basis, the figures are given on a household and not on an individual basis and therefore should not be compared with the values of *xpc* in the first panel. Although there is a good deal of production by sanitary district and municipal area households, I shall focus on the much more important rural population in the third part of the table.

On average, village households produced 10,915 baht worth of rice (glutinous or non-glutinous) per month, a figure that is about three and a half times average household expenditure on all goods, and more than 28 times the value of their total consumption of rice. Clearly, rice pricing policy is capable of transferring very significant resources in and out of the sector as a whole. The major rice producing regions are the (very wide) rural Fringe Area around Bangkok, the Lower North and the Center, with the Lower North East also important. At any specific location, production is either rice or glutinous rice, with consumption patterns following production. The Upper North and North East regions produce and consume glutinous rice, while the Lower North, Center, and South produce and consume non-glutinous rice. The North East Lower region contains both glutinous and non-glutinous rice growing areas. Sugar cane is grown by households in the Center (mostly in the Western Region) and in the Lower North.

The final two panels of the Table show consumption patterns for the same commodities. The split between glutinous and non-glutinous rice follows the same geographical pattern as does production, with households typically consuming one or the other but not both. Even if the budget shares of glutinous and non-glutinous rice are combined, there remains a great deal of variation in the importance of rice in the budget, and thus in the extent to which households benefit from artificially low prices. The *average* rural household in the upper part of the North-East devotes nearly a quarter of its budget to (glutinous) rice, whereas, at the other extreme, the average urban household in Bangkok spends on rice only four percent of a budget that is nearly four times as large. Expenditure on sugar is nowhere a large component of the budget. On average, Thai households spend less than half of one percent of their budgets on sugar; consumption is a good deal higher in the South.

When we are interested in issues of poverty and distribution, averages such as those in Table 2 conceal as much as they reveal. The broad inter-regional patterns of distribution tells us which areas benefit and which lose from different pricing strategies. But there are rich and poor households in all of the regions, and production and consumption patterns are far from being independent of household resources. If it is true that the "exports" of rice come from the better-off households, while poor households produce less than their own needs, then the direct effects of higher prices, while bringing more money into the region as a whole, might well be to worsen the distribution of real income. Figure 1 shows estimates of the distribution of living standards across households in the three sectors. The graphs show the estimated density functions of the logarithm of household per capita expenditure for the three regions. The logarithmic transformation is chosen because the distribution of *xpc* itself, like that of income, is strongly positively skewed, and taking logs induces something closer to symmetry. The density functions are estimated by kernel smoothing, a technique which is described in the Appendix. Readers unfamiliar with the technique can treat these graphs as if they were (smoothed-out) histograms.

The most obvious feature of Figure 1 is the relative positions of the three sectors; the modal urban household is very well off indeed by village standards. Perhaps less obvious is the size of the disparities. A difference of 2 on a logarithmic scale corresponds to scale factor of 7.4 and a difference of 1 to a scale factor of 2.7. The distribution in the villages, even after the logarithmic transformation, has a long upper tail; there are very rich households in the rural areas in spite of the very low mode. Rice shares at each point of these distributions are estimated and plotted in Figure 2. Once again, the technical details are confined to the Appendix, but these graphs should be thought of as non-parametric regressions, so that at each point in the ln(*xpc*) distribution, the graph shows the average value


GAUSS Feb. 18, 1988 11:14:32 AM
Fig 1: Sectoral distributions
Rosenblatt–Parzen density
0.00
0.15
0.30
0.45
0.60
0.75
4.0
5.0
6.0
7.0
8.0
9.0
ln(xpc): ln(baht)
villages
sanitary districts
municipal areas

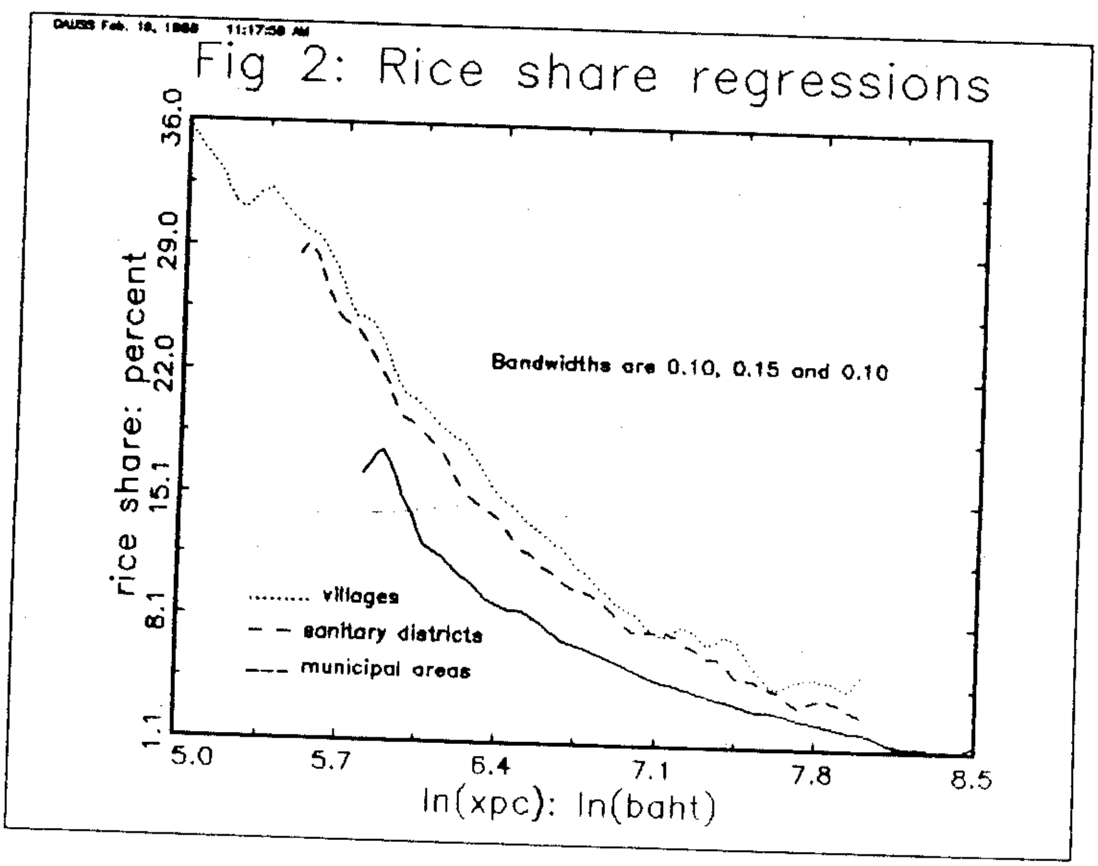


Fig 2: Rice share regressions
rice share: percent
1.1
8.1
15.1
22.0
29.0
36.0
5.0
5.7
6.4
7.1
7.8
8.5
ln(xpc): ln(baht)
Bandwidths are 0.10, 0.15 and 0.10
villages
sanitary districts
municipal areas

of the budget share on rice conditional on that value of *xpc*. Plots of estimated regressions would look rather similar, but the advantage of the technique used here is that the data are allowed to choose the shape of the function, and there is nothing that forces the points to lie along a straight line, or along a low-order polynomial.

The fact that the curves in Figure 2 slope down is no more than a confirmation of Engel's Law, or its rice equivalent; the share of the budget spent on rice declines as living standards rise. At the very bottom of the expenditure distribution, among poor village households, more than a third of the budget goes on rice, while among the richest, the share is less than one percent. The regressions for villages and for sanitary districts are very close to one another, but it is clear that village households spend more on rice, even when we control for the size of the budget. The shift is magnified for urban households; not only are they richer on average, but at the same level of living they spend less on rice. Of course, the regressions do not tell us what is responsible for the difference, whether it is lower prices, or less tangible factors associated with urbanization itself. Over a considerable range of levels of living, the association between the rice share and ln(xpc) is approximately linear, though over the whole distribution, the curve is steeper at low levels of living and flattens out among the rich. The total expenditure elasticity of rice is given by the formula

$$\eta = 1 - \beta/w \qquad (12)$$

where β is (minus) the slope of the regression line, and w, as before, is the share of rice in the budget. Differentiating with respect to lnx, we have

$$\frac{\partial \eta}{\partial \ln x} = -\frac{1}{w}\frac{\partial \beta}{\partial \ln x} - \frac{\beta^2}{w^2} \qquad (13)$$

By inspection of the graph, the first term on the right hand side is positive, while the second must be negative; for the values shown here, the second term dominates, and we have the traditional result that the expenditure elasticity is lower for better-off households. For the data in Figure 2, the total expenditure elasticity falls from 0.5 or so for the poorest households to approximately zero at the top of the distribution.

Budget share Engel curves such as those in Figure 2 describe the *average* welfare effects of price changes that operate through consumption. If all farmers were to continue to receive the same price for production, but the consumer price were to increase by ten percent, the poorest households would suffer a 3.6% fall in living standards and the richest only 0.1%. These figures could be rather different if the possible response of the budget shares to the price change were taken into account, but there is no reason to suppose that the response would vary much by level of living, so that the distributional consequences of the price change would not be much affected. Apart from the obvious omission of the production side, which I shall deal with next, the curves in Figure 2 can also be faulted for giving no impression of the *variability* in consumption patterns at each level of *xpc*. Poor consumers spend a third of their budgets on rice on average, but the effects of pricing policy on poverty depend on whether such an average is typical, or whether there are significant numbers of poor households which spend much more. At the other end of the distribution, significant numbers of rich households with large rice budgets will generate a powerful lobby for low prices.

Figures 3 through 6 provide the additional information. Each graph presents estimates of the joint density of the logarithm of *xpc* and the share of the budget devoted to rice. Again, such graphs can be thought of as smoothed histograms, but this time in three dimensions; the height of the histogram represents the fraction of households at the levels of *xpc* and rice share represented by the co-ordinates along the base. Figures 3 to 5 are contour maps; points linked by a contour have the same density, and the contours are equally spaced. Figure 6, which is a different representation of the same data given in Figure 5, gives a visual impression of the surface of the joint density; although such graphics conceal some of the information given in the contour plots, they give a clearer impression of relative heights. These diagrams fill out the skeletal information in the regression functions in Figure 2. The contour plot for the villages shows great diversity in rice budgeting patterns, a diversity which is greater the poorer are the households concerned. For example, for households with ln(xpc) around 5.3, i.e. with 200 baht per head per month, the mean rice share is close to a third, see Figure 2 or Figure 3, but there is an enormous range of behavior; there are households with shares of 10% and those with shares of 50%. As we move towards richer households, the regression line flattens out, and the variance around it is sharply reduced. Essentially no rich households spend more than 10% of their budget on rice.

Expenditure patterns are also more homogeneous in sanitary districts and municipal areas than in rural areas. In Figure 4 the contour lines are closely bunched near the mode, and although the pattern of decreasing

Fig 3: Villages

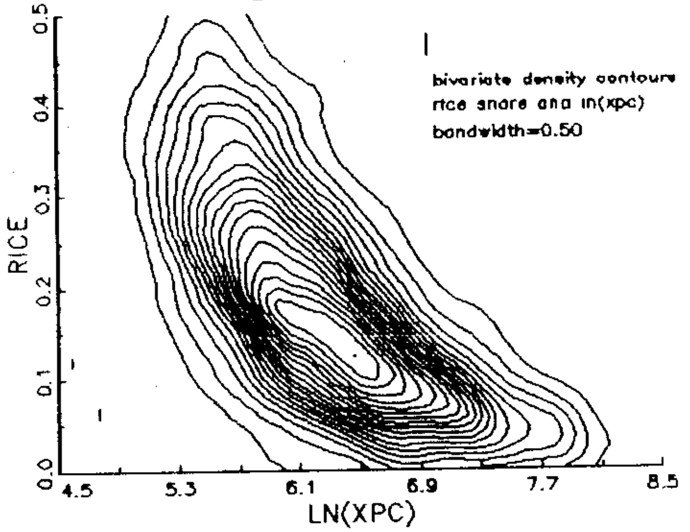


Fig 4: Sanitary Districts

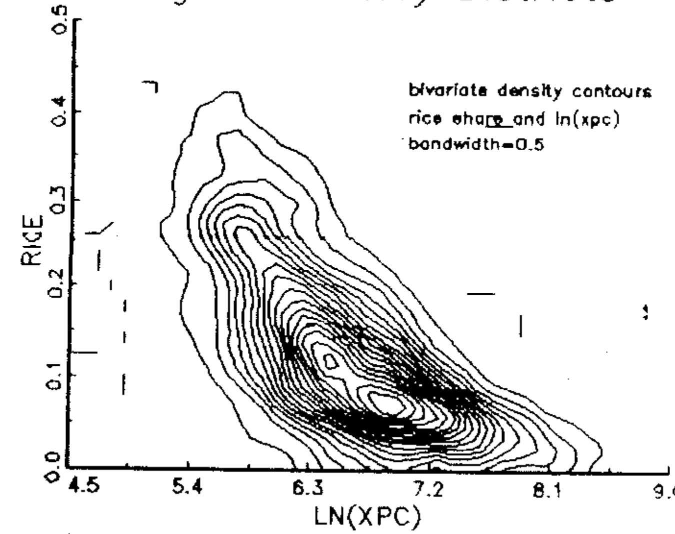


Fig 5: Municipal Areas

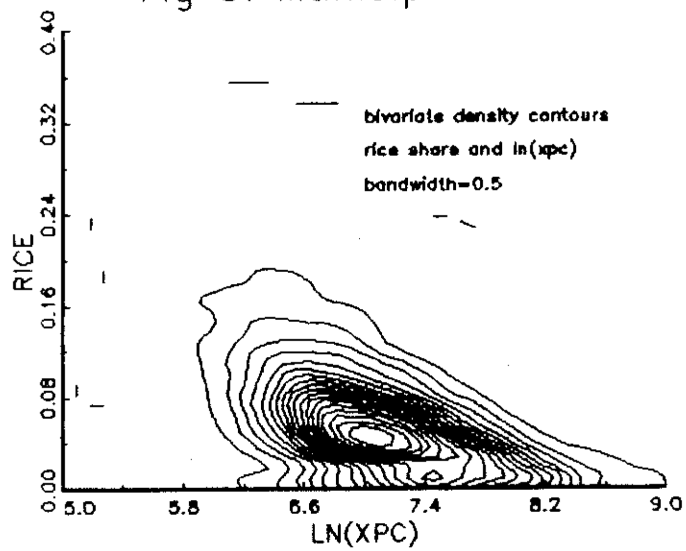
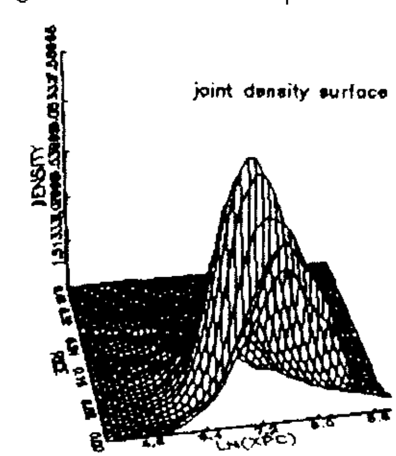


Fig 6: Municipal Areas

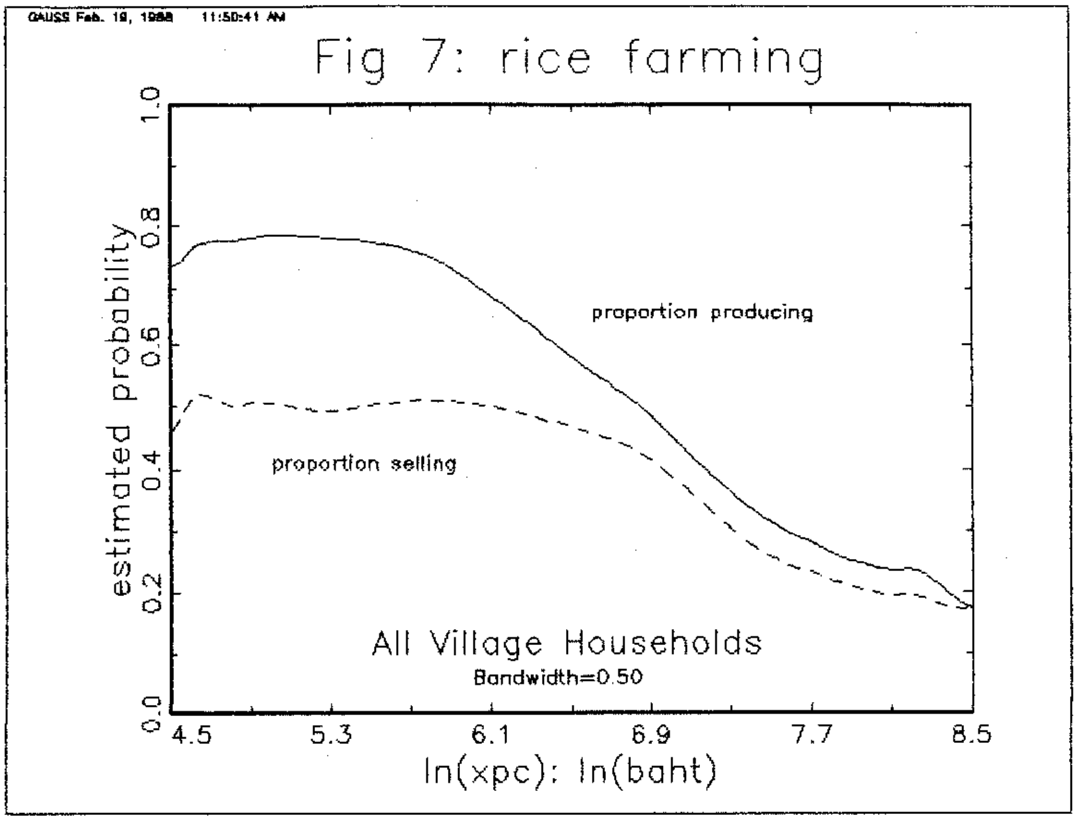


diversity with rising income is repeated, the whole distribution is much more concentrated than in the villages. The process of homogenization is carried furthest in the municipal areas where the density falls away very sharply from the mode. Note also that Figure 5 is drawn on a larger scale than either Figures 3 or 4. There are no rich urban households who spend more than a few percent of their budget on rice. Note also that the density in the urban areas does not fall to zero as the rice share goes to zero; there are substantial numbers of urban households who record no purchases of rice. Figure 6, with its open "hole" or "cave" is perhaps the best illustration. Some of this will reflect the fact that not all households buy rice over the survey period, but more important is probably the purchase of meals rather than food by urban residents, particularly in Bangkok. Unfortunately we cannot directly allow for this, since we have no data on the proportion of pre-cooked meals that is accounted for by rice. A more detailed analysis would have to make some allowance for this in assessing the impact of food prices on urban residents. Note finally that in all three of Figures 3 through 5 there are short line segments detached from the main contours. These are genuine contour segments that result from the presence of observations that are "outliers" with respect to the main distribution.

The next step is to bring production into the picture and to look at the net effects of price changes on different households. Clearly, the issue is one for the village sector; as we shall see there is not enough production in either of the other two sectors to significantly change the welfare effects that are generated on the consumption side. Figure 7 shows estimates of the proportion of village households that produce rice as a function of $\ln(xpc)$. The broken line, which must lie below the solid line, is the proportion of households for whom the value of rice produced is greater than the value of rice consumed. While such households may both buy and sell rice, for example at different times of year, or because they sell paddy and buy rice, I shall use this definition of net sellers as a guide to the direction of the welfare effects of a price change. Figures 8 and 9 show two subregions; between them the three regressions can be used to discuss all eleven of the rural subregions.

As shown in Figure 7, the proportion of households that produce rice generally falls with the level of *xpc*, while conditional on being a producer, the probability of being a net seller increases with *xpc*. High income farmers are almost all net sellers of rice, presumably because they typically farm on a larger scale. What is more surprising is that the (unconditional) probability of being a net seller is a declining function of *xpc*, at least for rural areas as a whole. This finding means that the fraction of households that benefits from a price increase is as high or higher among the poor as it is among the rich. It is not true, as is often the case, that price increases directly benefit only a few large farmers while poor households have to rely on labor market or other indirect trickle-down effects, if indeed they benefit at all.

Although the data in Figure 7 apply to much of the sector, there is, as usual, a good deal of regional variation. Figure 8 illustrates for the Upper North, which is the most extreme case of its type. Here almost all poor households grow rice, though only 20% are net sellers. Even here, however, about 30% of households are net sellers of rice over a wide range of living standards. Figure 9 shows the situation in the Lower North, where a good deal more rice is produced, and where more than half of the house-


GAUSS Feb. 19, 1998 11:50:41 AM
Fig 7: rice farming
estimated probability
proportion producing
proportion selling
All Village Households
Bandwidth=0.50
ln(xpc): ln(baht)

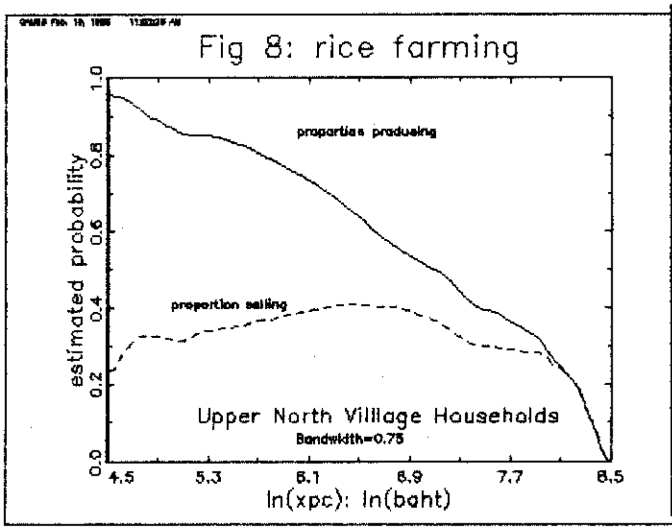


Fig 8: rice farming
estimated probability
proportion producing
proportion selling
Upper North Village Households
Bandwidth=0.75
ln(xpc): ln(baht)

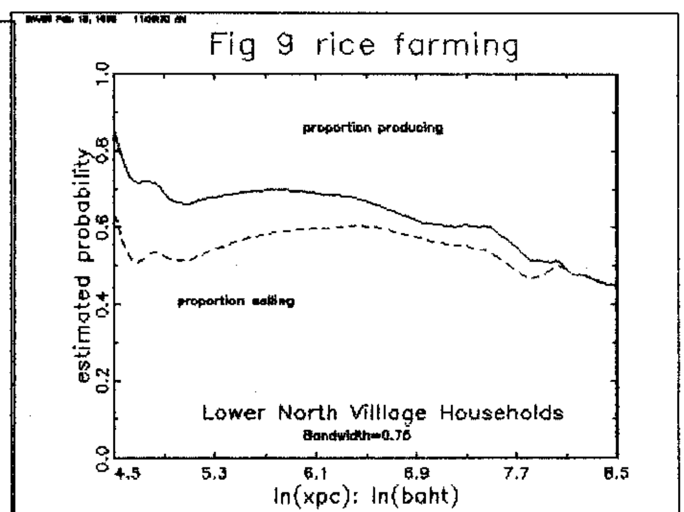
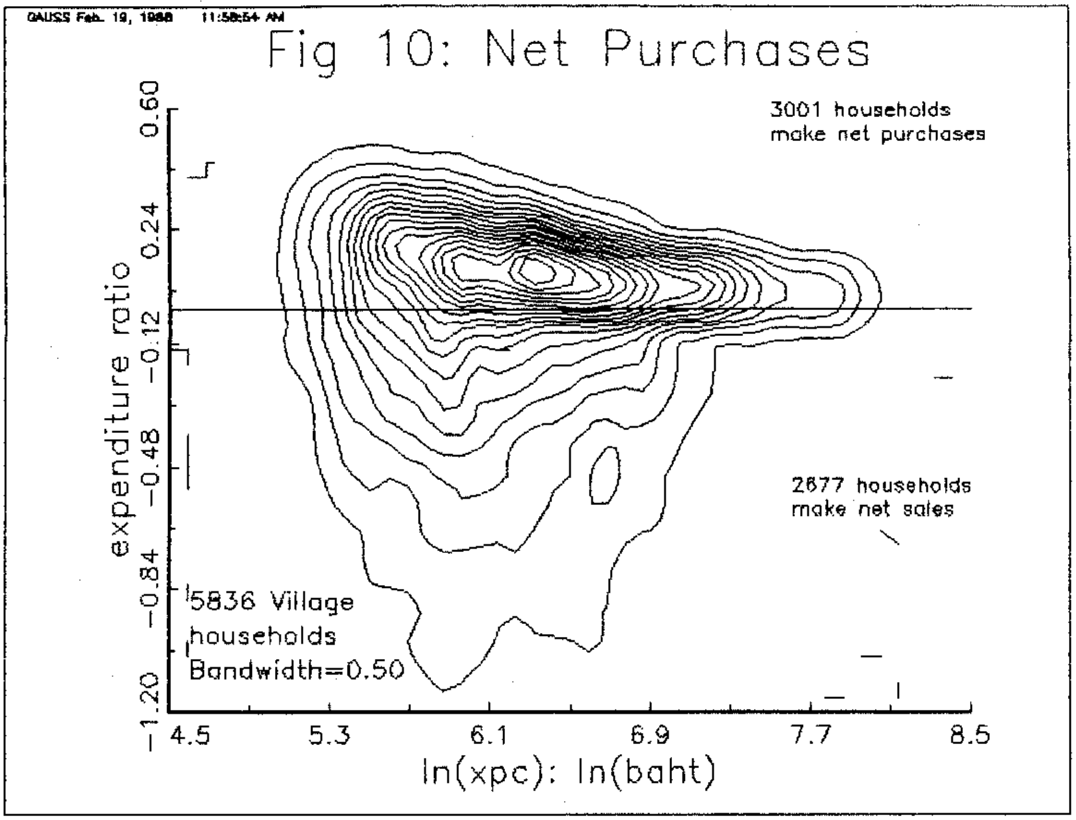


Fig 9 rice farming
estimated probability
proportion producing
proportion selling
Lower North Village Households
Bandwidth=0.75
ln(xpc): ln(baht)

holds are net sellers, a fraction that once again does not vary very much with living standards. Comparable graphs for the other regions are given in the Graphical Appendix: the Central region generates a regression that looks very like that for the Lower North, although both curves dip more sharply towards the upper end of the distribution. The South and the North East regions look very like the overall sectoral picture in Figure 7. Rural households on the fringes of Bangkok also produce a great deal of rice. About 45% of such households are producers, and essentially all are net sellers.

These results suggest that increases in the rice price would have direct benefits to the rural sector that extend to households at all income levels. But direction of an effect is not the same thing as size, and it is necessary to look at the pattern of net sales in relation to the distribution of living standards. Figures 10 and 11 show, for the village sector, the joint density of the net expenditure ratio for rice and the logarithm of *xpc*. The contours in Figure 10 are as before, and the horizontal line is the zero net purchase line that divides net buyers (51%) and net sellers (46%); three percent of households are on the line. Although it makes little difference, these households are not included when estimating the density. Figure 11 contains the same information as Figure 10, from a three dimensional perspective observed from above the right hand side of the zero line shown in Figure 10. I have not included the corresponding estimates for sanitary districts and municipal areas. For the latter, and apart from a scattering of outliers, the net purchase contours look like the consumption contours in Figure 5; there is little rice production in urban areas. For sanitary districts, the shape of the density is much the same as in Figure 10, but


GAUSS Feb. 19, 1988 11:58:54 AM
Fig 10: Net Purchases
3001 households
make net purchases
2677 households
make net sales
5836 Village
households
Bandwidth=0.50
expenditure ratio
0.60
0.24
-0.12
-0.48
-0.84
-1.20
4.5
5.3
6.1
6.9
7.7
8.5
ln(xpc): ln(baht)

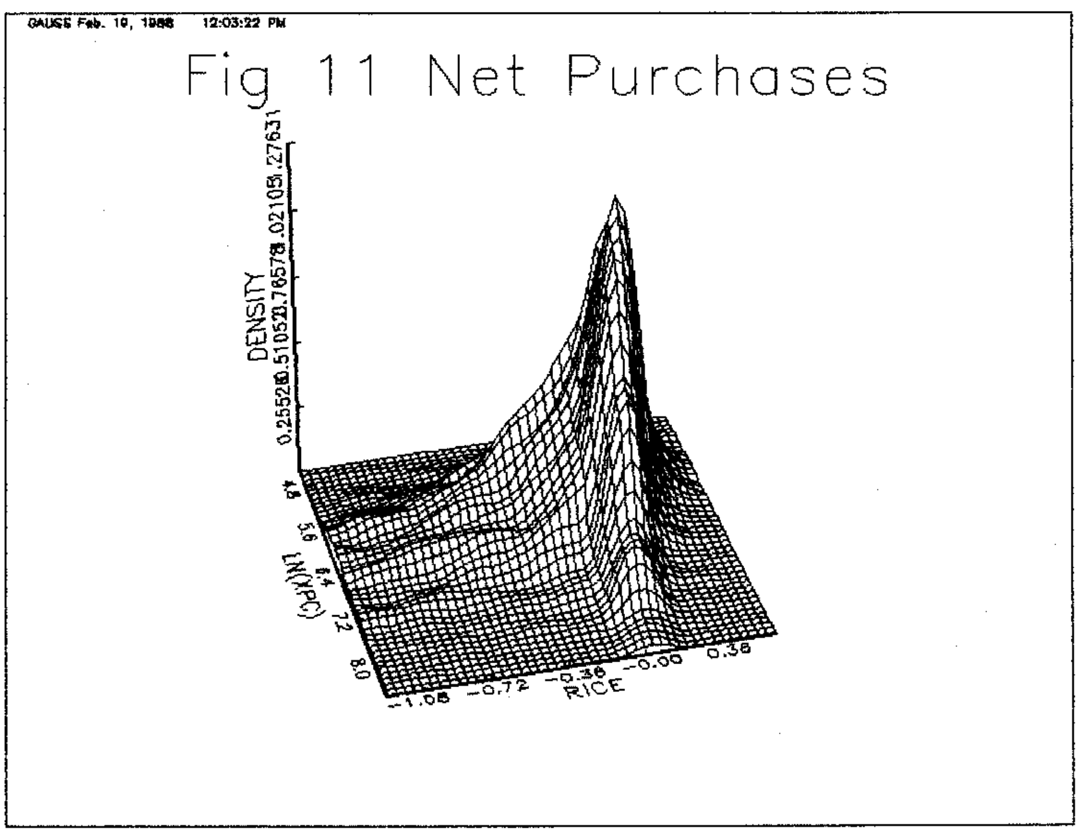

GAUSS Feb. 19, 1988 12:03:22 PM
Fig 11 Net Purchases
DENSITY
LN(XPC)
RICE

Fig 12: Welfare Effects

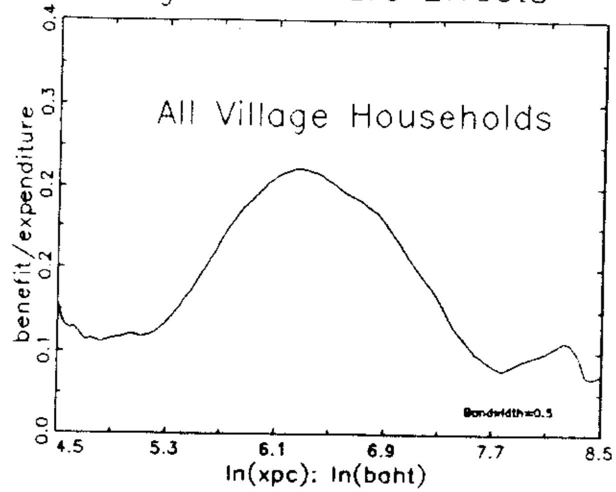


Fig 13: Welfare Effects

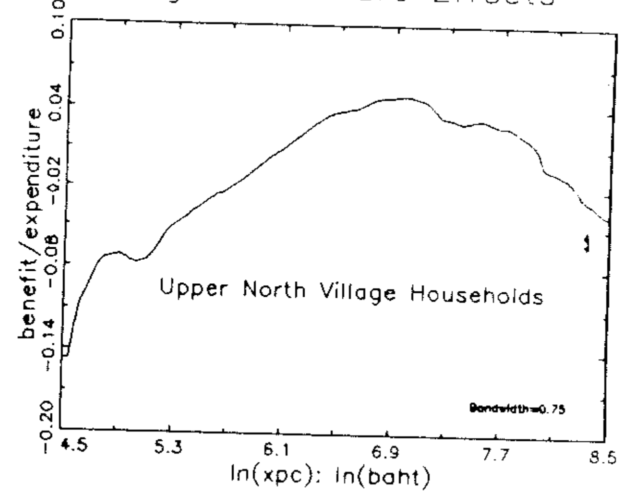


Fig 14: Welfare Effects

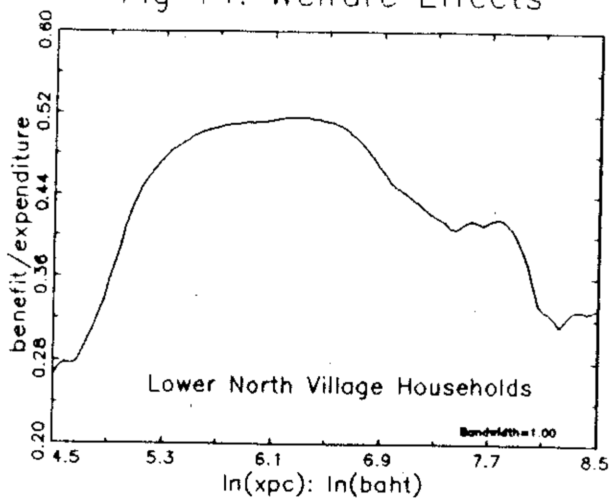
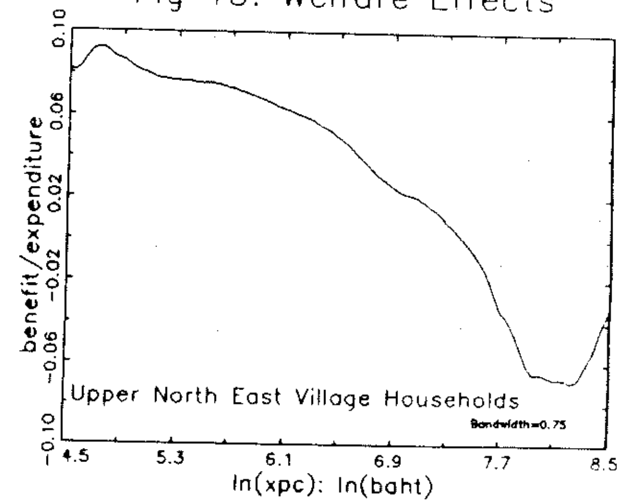


Fig 15: Welfare Effects



the lower half of the graph is much foreshortened, and only a quarter of households are net sellers of rice.

The remarkable feature of these figures, and of the others like them (included in the Graphical Appendix), is the lack of association between the two variables; the costs and benefits of changes in the price of rice are of different signs and different magnitudes for different households, but there is no systematic pattern whereby benefits go differentially to rich or poor. This is not at all what I had expected to find, based on reading of the earlier literature. While it is true that the better off rice farmers produce more and sell more than do smaller, poorer farmers, and while it is also true that, among rice farmers, the richer, (and presumably larger) farmers are more likely to be net sellers of rice, it is nevertheless *not* the case that increases in rice prices tip the distribution of real income towards the rich. Part of the reason is that there are relatively few rice farmers among the rich, so that the fractions of households who are net sellers of rice does not increase with income, but it is also true that the ratio of net sales to household income is largest, not among the rich who produce relatively more, but among the middle income farmers whose net sales are largest relative to their incomes. As both Figures 10 and 11 show, the part of the density that corresponds to net sales is mostly in the middle of the expenditure distribution. Figure 12, which is the estimated regression function from Figures 10 and 11, (with the sign changed, so that benefits show up as positive) makes this even more clear (but note the larger scale). The regression line is always above the axis, so that, on average, rural households at all *xpc* levels benefit from higher rice prices. But the major beneficiaries are households in the middle of the income distribution, with

Fig 16: Welfare Effects

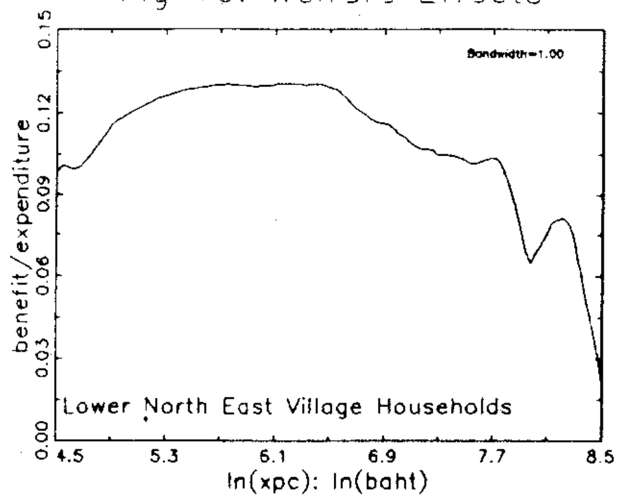


Fig 17: Welfare Effects

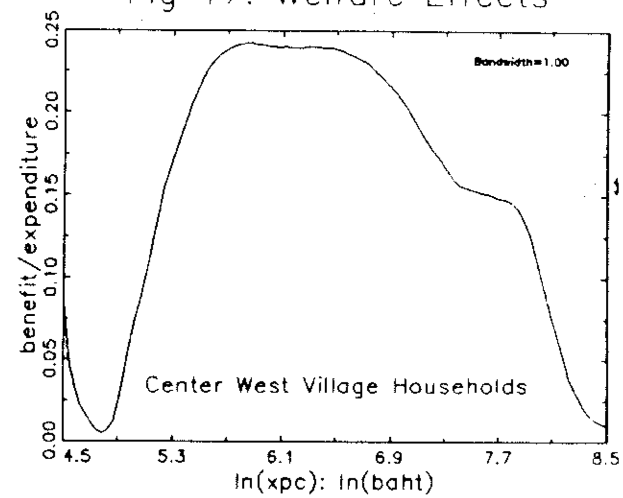


Fig 18: Welfare Effects

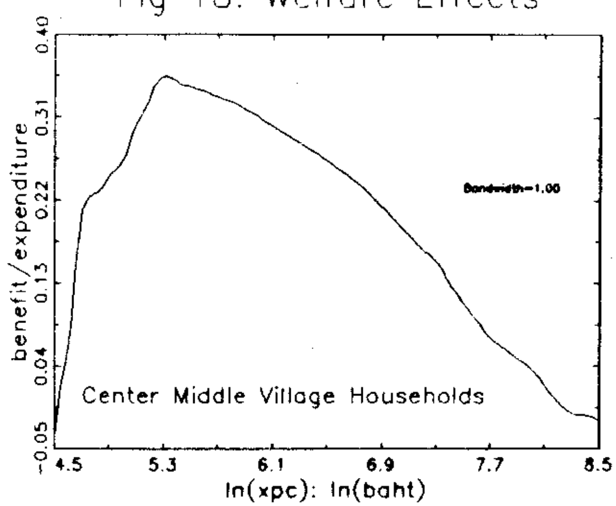


Fig 19: Welfare Effects

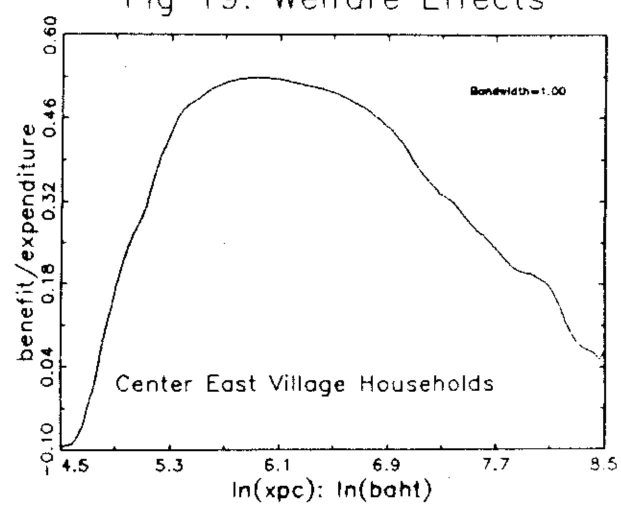


Fig 20: Welfare Effects

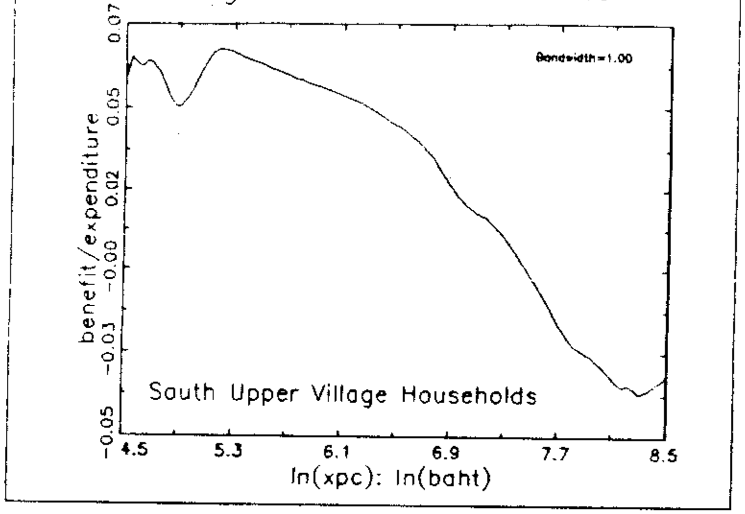


Fig 21: Welfare Effects

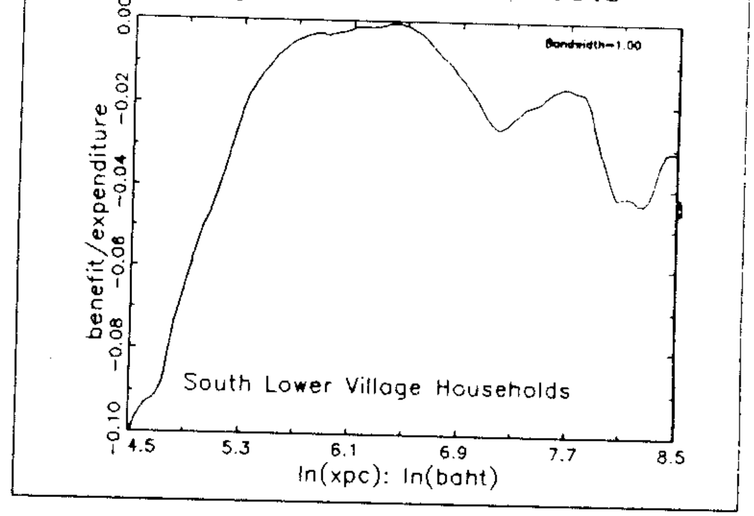
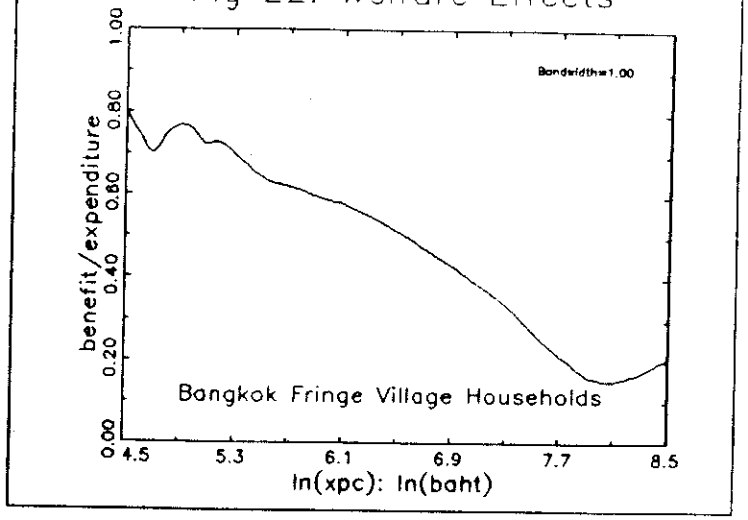


Fig 22: Welfare Effects



poor and rich households benefitting much less. Given this, changes in rice prices will have little effect on the distributional of income between rich and poor; the gainers and losers are the rural middle class.

Figures 13 through 22 show the corresponding net welfare effects for the ten subregions; these are included because of the diversity of patterns across the regions. Note not only the difference in patterns, but also the difference in scales. For example, the effects of rice price changes are much smaller in the Upper North, Figure 13, than in the Bangkok Fringe, Figure 22, where a one percent increase in the price of rice generates a benefit that is 0.8% of household income. In the Bangkok Fringe, the size of the benefits falls with levels of living, from an elasticity of 0.8 to 0.2 among the best off households, but again this pattern in not uniform across regions.

In the light of this evidence, there is no *prima facie* case in favor of cheap rice that is based on considerations of rural income distribution. A more comprehensive analysis seems unlikely to reverse this conclusion. Higher rice prices are likely to generate higher wages in the countryside and to have some benefits even for those who are not net producers of rice. The complications to the consumer surplus calculations that permit the study of large price changes will only affect the distributional outcome if it is thought that price elasticities of demand and supply differ sharply by income level. There is, of course, no empirical evidence for such a phenomenon in Thailand (or anywhere else) and even if there is a difference it seems unlikely to be important enough to make a difference. Finally the intersectoral arguments also provide no support for keeping prices artificially low. Although urban households are made worse off by higher prices, there are many fewer of them than there are rural households, even the poorest among them spend quite a small fraction of their budgets on rice, and their incomes tend to be very much higher than those in the rural sector.

3 Estimation of price elasticities

The consumption data from the 1981/2 Socioeconomic survey do not contain any useful price data. Although the questionnaire contains items on both quantities and expenditures for certain goods, such data were not in fact collected, so that it is impossible to use the sort of model proposed in Deaton (1988). However, monthly data are available on the prices of a number of commodities at the province level, although not for all provinces. Using these data, and given the location of the household and the month in which it was interviewed, it is possible to assign prices to households, at least in some cases. Table 3 gives the details; prices can be assigned for 81% of households in municipal areas, 58% of households in sanitary districts, and 54% of households in villages. The procedure is as follows. Provinces are not part of the sampling design, so that each amphoe in the survey is allocated to a province, and if we have a price for that province, the price is assumed to apply to that amphoe. For each block within the amphoe, households are assigned a price depending on the month in which they were interviewed. It is important to note that, within each block, all households are assigned the same price. Even if the price data used are a good deal less than perfect, and even if provincial prices are in some cases a poor guide to amphoe or block prices, households in the same block do in

Table 3: Provinces with price data and survey households in each

Province:	MA's	SD's	Villages
	numbers of households		
Bangkok	1979	235	817
Central:			
Chanthaburi	-	-	-
Chonburi	22	-	71
Prachin Buri	10	-	71
Phra Nakhon Si Ayutthaya	11	135	103
Lop Buri	48	39	151
Ratchaburi	23	88	60
Suphanburi	32	31	65
North East:			
Khon Kaen	134	29	102
Nakhon Ratchasima	72	80	220
Roi Et	58	56	247
Surin	-	24	150
Nong Khai	80	8	126
Ubon Ratchathani	115	31	121
North:			
Chiang Rai	-	64	78
Chiang Mai	186	89	178
Tak	56	8	101
Nakhon Sawan	34	15	145
Phrae	-	16	48
Uttaradit	45	-	36
South:			
Trang	45	8	47
Nakhon Si Thammarat	60	-	-
Yala	126	8	36
Songkhla	158	31	126
Surat Thani	60	100	29
Total households	3354	1095	3128
Percent of sample	80.6	57.7	53.6

Note: All households in Bangkok core, suburbs or fringe are included in Bangkok, whether or not they are technically located in Bangkok province.

Source: 1981/2 Socioeconomic Survey, and author's calculations.

fact face the same price, even if we only have an imperfect indication of the level of that price.

The non-parametric methods of the previous section cannot be used in the same way here. These techniques work well when there is a single important variable, such as per capita household expenditure, against which we wish to compare joint distributions and regression functions. But price is only one among a multitude of influences on demand patterns, and since it is unlikely to be even the most important, other variables must be taken into account. And while multivariate non-parametric estimation is straightforward in theory, its practical application requires both huge data sets and very heavy computation. I therefore fall back on standard regression analysis, leaving for future analysis the sort of mixed or semi-parametric techniques discussed, for example, by Robinson (1988). Of course, the estimated densities and regression functions of the previous section can be used as guides for choice of functional form.

Consider first a regression equation of the form:

$$w_{ic} = x_{ic}\beta + \ln p_c \alpha + v \tag{14}$$

where w_{ic} is the share of the budget devoted to rice by household i living in cluster (block) c, and x_{ic} is a vector of explanatory variables, including per capita total expenditure, household demographics, educational variables and other measures of household characteristics. The logarithm of price is indexed only on the cluster, and is singled out for special attention. The parameters β and α are to be estimated and v is a stochastic term. If (14) is estimated directly, it is possible to include only those observations for which prices are available, and a substantial fraction of the sample information will be lost. Consider instead the more general model

$$w_{ic} = x_{ic}\beta + z_c\theta + \ln p_c\alpha + f_c + u_i \tag{15}$$

where z_c is a vector of variables that do not vary within the cluster, and f_c is a fixed-effect associated with the cluster c to which household i belongs.

I estimate the price response in equation (15) in two stages. At the first, the "within" estimator of β, $\hat{\beta}_w$, is calculated by estimating (15) by ordinary least squares after subtracting cluster means from the shares and the x variables. This regression is calculated using the complete sample; subtracting the cluster means removes all the variables that do not vary within the cluster, including the prices, so that the fact that some price data are missing is of no consequence. At the second stage, which uses only data for those clusters with prices, the residuals from the first stage are averaged by cluster and the results regressed on the prices together with an assortment of the z-variables. At a minimum, the second stage regression includes the logarithm of price and the cluster means of the first stage explanatory variables. This allows for the possibility that cluster means of these variables have an effect of their own, as when, for example, there are emulation effects so that household behavior depends on neighbors' as well as on own income. I shall also examine the effects of including regional and mensal dummies on the supposition that regional demand patterns may be determined by something different from temporal patterns.

Tables 4 and 5 show the parameter estimates for the rice Engel curves for the three sectors; Table 4 gives the whole sample estimates, while Table 5 shows the within-block estimates. These provide a good deal more information about rice demand than comes out of the non-parametric estimates in Section 2 above. The first set of variables in the Tables relates to household welfare and demographic structure. The coefficients on the logarithm of *xpc* and its square reflect the shape of the Engel curve revealed in the non-parametric regressions. While it is comforting that the addition of other variables does not radically alter the shape of the Engel curve, the finding reflects the dominant role of *xpc* in explaining rice consumption patterns. The inclusion of the logarithm of household size allows for the possibility that demand patterns may change with additional individuals, even when per capita total expenditure is held constant. The positive coefficients in all three sectors show that, even at the same level of *xpc*, larger families spend a larger share of their budgets on rice. The age variables, the age of the household head and its square, show that rice consumption rises with age until about 50 years of age and thereafter declines. The demographic composition variables M1 through F3 are numbers of people in various age and sex categories as a ratio of household size, and so are unaffected by changes in the scale of the household. The patterns here are consistent across sectors, although are much the strongest in the villages; children consume less rice than adults, and smaller children less than older children. There is no evidence of differential rice consumption by sex or between old and younger adults. But the differences between adults and children are large, particularly in the villages; replacing a male adult with a male baby is predicted to reduce household consumption by more than 11.5% of total household expenditure. Independently of household composition, living standards, and age, the education of the household

Table 4: Rice demand regressions: Whole sample

	Municipal Areas		Sanitary Districts		Villages	
Observations		4159		1898		5836
D.f.		4120		1860		5798
R-squared		0.449		0.537		0.538
S e e		0.039		0.069		0.069
mean(lnxpc)		7.1110		6.5685		6.2583
coeff at mean		-0.0487		-0.0955		-0.1141
dep mean		0.0559		0.1340		0.1870
elas at mean		0.1283		0.2868		0.3897
CONSTANT	1.2886	24.1	1.8684	15.2	1.8272	25.9
LNXPC	-0.3083	-21.1	-0.4450	-12.4	-0.4263	-20.3
LNPCXSQ	0.0183	18.2	0.0266	10.0	0.0249	15.6
LNN	0.5057	3.5	0.7529	1.7	0.9933	3.3
HDAGE	0.1056	4.6	0.1324	2.3	0.1057	2.5
HDAGES	-0.0009	-3.7	-0.0016	-2.5	-0.0012	-2.7
M1	-3.9754	-4.6	-9.3070	-4.0	-10.9083	-7.3
M2	-1.3599	-2.0	-4.5872	-2.7	-4.3414	-3.9
M3	-0.2944	-0.6	-0.1383	-0.1	0.7370	0.8
M4	-0.5365	-0.8	-1.3537	-0.8	0.3751	0.4
F1	-2.9666	-3.4	-7.3510	-3.4	-10.8222	-7.2
F2	-2.1527	-3.1	-4.9085	-2.9	-3.4700	-3.1
F3	-0.7626	-1.5	-0.5413	-0.4	-1.5021	-1.8
HDEDEL	-0.1148	-0.6	-1.0009	-1.9	-0.6367	-1.9
HDEDSEC	-0.4599	-1.9	-3.1404	-4.0	-2.1839	-3.1
HDEDUN	-0.9981	-2.9	-4.7231	-3.4	-2.7548	-1.7
HDEDVOC	-0.5527	-2.0	-3.4961	-3.5	-3.0319	-3.4
HDEDQ	-0.9423	-1.2	0.1995	0.1	1.9971	1.0
N-UP	3.8402	15.5	5.8189	8.2	6.0344	7.0
N-LOW	1.7800	6.6	1.4823	1.8	4.0578	4.8
NE-UP	2.2787	8.7	6.5355	9.3	7.1880	8.6
NE-LOW	1.9030	7.5	3.7906	5.1	8.6014	10.3
CW	0.7571	2.0	1.9659	2.5	2.9482	3.3
CMID	0.9877	3.1	2.3618	3.4	2.5175	3.0
CE	0.7644	2.2	2.9808	2.1	3.0408	3.4
S-UP	0.5190	2.3	0.9242	1.1	1.3433	1.6
S-LOW	0.8792	3.0	-1.5650	-1.0	-1.2112	-1.2
BK-SUB	0.2446	1.1	-	-	-	-
BK-FR	0.1368	0.2	2.2430	2.2	-0.7564	-0.9
FEB	-0.2155	-0.7	-3.3773	-4.5	-1.5351	-2.9
MAR	0.3295	1.1	-2.3330	-3.0	-2.1525	-4.1
APR	-0.3848	-1.2	-0.9866	-1.3	-1.5792	-3.0
MAY	0.3718	1.3	-1.2459	-1.7	-2.1069	-4.0
JUN	-0.2388	-0.8	-0.6585	-0.8	-1.2764	-2.5
JUL	0.0423	0.1	-0.2961	-0.4	-0.1021	-0.2
AUG	0.1971	0.7	1.5958	2.0	0.3661	0.7
SEP	0.5973	2.0	0.7330	1.0	-0.8150	-1.6
OCT	-0.3730	-1.3	-1.5205	-2.0	-1.4786	-2.8
NOV	-0.3752	-1.3	-0.3695	-0.5	-0.8023	-1.5
DEC	0.0218	0.1	-0.7136	-0.9	-1.5019	-2.8

Notes: See Table 5 below

head also affects rice consumption, with higher education tending to reduce rice consumption. Once again, the effects are strongest in the villages, and most attenuated in the municipal areas. The regional effects follow the patterns delineated in Section 1; consumption of rice is highest in the North and North-East, high in the Center, low in the South, and lowest in Bangkok. Note that these effects are in addition to the total expenditure effects, so that the high rice consumption in the North and North East is only partly explained by the relative poverty of those areas. A number of the mensual dummies are individually significant but there is no very obvious pattern to the monthly effects. Note also that with data from twelve successive months, there is no way to separate seasonal from secular effects.

Table 5 repeats the regressions with the block means removed, so that there are now neither regional nor mensal dummies. The cluster effects are significant at any conventional level. Even though the F-statistics may not look very large, the sample sizes are so large that the associated p-values are all less than 10^{-9}. However, the F's are less than the logarithms of the sample size, so that, for example, Schwartz's Bayesian test would accept the lower dimensional model without the cluster effects. Furthermore, the parameter estimates in Table 5 are remarkably similar to those in Table 4, so that whatever the role of the cluster effects, they are not strongly related to the other included variables.

Table 6 presents the estimates of the price response parameter from equations (22) in which the estimated cluster fixed effects are used to infer a price response. The left-hand side of the Table shows the calculated α-parameters under alternative assumptions about the determinants of

Table 5: Rice demand regressions: Within blocks

	Municipal Areas		Sanitary Districts		Villages	
Observations:		4159		1898		5836
D.f. :		3774		1635		4841
No of blocks:		368		246		978
R-squared :		0.341		0.357		0.347
S e e :		0.035		0.059		0.065
F-test :		2.243		2.318		2.207
df1, df2 :		346,4120		225,1860		957,5798
ln(#obs) :		8.333		7.548		8.672
coeff at mean		-0.0436		-0.0843		-0.1046
elas at mean		0.2200		0.3660		0.4405
Variable	Coef	t	Coef	t	Coef	t
LNXPC	-0.2655	-18.1	-0.3812	-10.3	-0.3938	-20.3
LNPCXSQ	0.0156	15.5	0.0226	8.2	0.0231	15.8
LNN	0.7089	5.0	0.7264	1.7	1.2231	4.6
HDAGE	0.1046	4.6	0.1551	2.7	0.1299	3.6
HDAGES	-0.0009	-3.8	-0.0017	-2.8	-0.0013	-3.4
M1	-3.9122	-4.6	-9.1064	-4.1	-9.9887	-7.6
M2	-1.5767	-2.4	-4.3929	-2.7	-3.6342	-3.7
M3	-0.4289	-0.8	-1.0265	-0.8	-0.0015	-0.0
M4	-0.2786	-0.4	-2.1704	-1.4	0.2867	0.3
F1	-3.2858	-3.8	-8.1601	-3.9	-9.7505	-7.4
F2	-2.2938	-3.4	-5.0128	-3.1	-2.7855	-2.8
F3	-0.6817	-1.3	-1.3813	-1.2	-1.3266	-1.8
HDEDEL	-0.2935	-1.5	-0.3221	-0.6	-0.4273	-1.4
HDEDSEC	-0.4934	-2.0	-2.3595	-3.1	-2.1993	-3.5
HDEDUN	-1.2776	-3.6	-3.9084	-2.8	-1.5701	-1.1
HDEDVOC	-0.7720	-2.7	-2.8671	-3.0	-3.0204	-3.7
HDEDQ	-0.6307	-0.8	-0.4335	-0.2	1.5994	0.9

Notes: The dependent variable is the percentage share of the budget spent on glutinous and non-glutinous rice. The constant term and the parameters for ln(xpc) and its square are divided by 100. The variables are as follows. LNXPC is the logarithm of household per capita total expenditure, and LNXPCS is its square. LNN is the logarithm of household size. M1 through F3 are variables representing the demographic composition of the household; M1 is the ratio of numbers of males ages 0-4 to total household size, M2 the ratio for males 5-14, M3 males 15-65, M4 males over 65, while F1 through F3 are the same ratios for females. Since the sum of M1 through F4 is unity, F4 is omitted. HDEDEL, HDEDSEC, HDEDUN, HDEDVOC, and HDEDQ are dummies for head's education at elementary, secondary, university, vocational, and unknown levels; the omitted category are uneducated heads. The regional and mensual variables in Table 4 are self-explanatory; Bangkok Core is omitted for municipal areas, Bangkok Suburbs for the other two sectors. January 1982 is the omitted month. The F-statistics above are the tests for the block effects beyond the regional and mensual dummies in Table 4.

Source: 1981/2 Socioeconomic Survey and author's calculations.

regional and temporal demand patterns; the right-hand side shows the corresponding estimates of the price elasticity calculated at the sample mean budget share. The parameter α is the coefficient of the logarithm of price in the equation for the budget share so that the price elasticity can be calculated as $-1+\alpha/w$ for any value of the budget share w. Row 0 of the Table corresponds to the projection of the cluster effects on log prices alone; this corresponds to the assumption that all regional and temporal variations in demand should be attributed to price variations. Row 1 projects the fixed effects on log price and on the 11 or 12 regional dummies (depending on sector). Such a model does not seek to explain the broad spatial variations in rice demand, but calls on prices to explain seasonal variation as well as variation within the regions, to the rather small extent that there are several provincial prices within the region. Row 2 makes the projection on month dummies but not on regional dummies, so that prices are asked to account for spatial but not temporal patterns. Finally, row 3 takes out both seasonal and regional effects, leaving prices to explain what is essentially the interaction between them.

The estimates in Table 6 do not generate plausible estimates of the price elasticity. In all three sectors, there is a negative correlation between the cluster effects and the logarithm of the price. Apart from the sanitary districts, the correlation is robust to the inclusion of other variables in the regression. Since the cluster effects come from a budget share equation, the negative correlation means a price elasticity in excess of unity, a result that is quite implausible for a commodity that is a basic staple, that composes a third of the budget of poor households, and that has no obvious substitute. The provincial price data suggest that prices are

Table 6: Price parameters for rice

	Alpha parameters			Price elasticities		
	M A	S D	V	M A	S D	V
0.	-0.0665 (0.0124)	-0.0604 (0.0359)	-0.1152 (0.0237)	-2.19	-1.45	-1.62
1.	-0.0288 (0.0156)	0.0534 (0.0427)	-0.0237 (0.0264)	-1.52	-0.60	-1.22
2.	-0.0816 (0.0140)	-0.0900 (0.0378)	-0.1502 (0.0261)	-2.46	-1.67	-1.80
3.	-0.0428 (0.0206)	0.0349 (0.0504)	-0.0752 (0.0304)	-1.77	-0.74	-1.40

Notes: Rows are as follows: 0: only log price explaining the cluster effects; 1: log price and regional dummies; 2: log price and mensual dummies; 3: log price, regional and mensual dummies.

Source: 1981/2 Socioeconomic Survey, author's calculations

Table 7: Estimated price elasticities for other goods

	MA	SD	V	MA	SD	V
	lean pork			freshwater fish		
0.	-3.67	-1.55	-3.91	-0.77	-1.19	-1.09
1.	-6.17	-0.16	-8.74	-1.03	-1.20	-1.04
2.	-3.55	-1.27	-3.89	-0.50	-1.37	-1.21
3.	-5.96	-0.06	-8.91	-1.14	-1.68	-1.44
	chicken			beef		
0.	-0.44	-1.47	-1.52	-0.50	-0.83	-1.61
1.	-0.42	-0.96	-1.27	-0.81	-2.59	-3.25
2.	-0.61	-1.21	-1.66	-0.19	-1.55	-1.27
3.	-0.88	-0.67	-1.36	+1.55	-3.35	-3.17

Note: See Table 6 for row definitions and source.

highest in areas like Bangkok where rice budget shares are low, even after allowing for income and other factors, so that the cross-spatial comparison generates the negative slope. Now it can perhaps be argued that the broad geographical variation in rice demand is not really determined by market prices, but rather by long-standing (and inexplicable?) taste differences. If this is allowed by the inclusion of regional dummies, the negative correlation is attenuated, see row 1 of Table 6, but apart from the case where regional dummies are included in the sanitary districts, the negative correlation remains. In row 2 of the Table, seasonal dummies are allowed but these do not play a very important part in the story and the negative correlation between the rice share and the rice price is slightly more negative than in row 0. Similarly, row 3 looks very much like row 1. It is the treatment of the regional effects that is important, not that of the seasonals.

It is difficult to know what to make of these numbers. Trairatvorakul (1984) uses the earlier 1975/6 Socioeconomic Survey to estimate price elasticities of between -0.6 and -0.7. The methodology is essentially (a simpler) version of that used here, and indeed my primary motivation here was to try to refine and update Trairatvorakul's estimates. Siamwalla and Setboonsarng (1987, page 187), backing their own judgment, choose a value of -0.12, and their guess seems an eminently reasonable one. One obvious possibility is errors of measurement in the provincial price series. It is unclear exactly how these are compiled, and even if done so perfectly, the provincial averages would still not be correct at the level of amphoes or individual villages. But such errors in variables, though undoubtedly present, can hardly explain why the relationship between budget shares and prices is negative not positive. For example, if recorded prices are averages of prices over a large number of villages, the coefficient on price will be inefficiently estimated, but it will not be biased. More general measurement error typically biases the coefficient towards zero, but once again, this is not what appears to happen; the problem here is not an attenuated estimated but one with the wrong sign. The geographical negative correlation really exists, and if it does not reflect a high demand elasticity, then it must be explained by something else.

Finally, in Table 7, I show estimated price elasticities for a range of other foodstuffs. As is the case for rice, most goods in most sectors display a negative association over space between the budget share and the price, so that estimated elasticities are (absolutely) larger than unity. While such large numbers are less implausible for commodities that occupy only a small share of the budget, there is no independent evidence to support the figures in the Table, and some of them appear implausible in any case, e.g.those for pork in the Villages. Indeed, it is entirely possible that whatever is causing the difficulties with rice is also present in these numbers. Once again, the spatial correlations appear to exist, but it is hazardous to interpret them in terms of demand responses to price.

4. Appendix 1: Non-parametric estimation of regressions and densities

The techniques described here are standard in the statistical literature, and excellent discussions can be found in Silverman (1986), for density estimation, and Hardle (1987), for regression. My aim here is give only a brief explanation of what was done to generate the figures used in the main text and hence to make this report reasonably self-contained.

One simple non-parametric regression technique that is familiar to everyone is the smoothing of a time-series by calculation of a moving average. For example, if data are available on daily stock returns, some of the noisiness of the series could be removed by plotting for each day, not its own return, but the average of the returns for the k previous days, the day itself, and the k succeeding days. The bigger is k, the smoother will be the resulting plot. Exactly the same idea can be applied to the Engel curves estimated here, even though there is no natural ordering of observations, and in spite of the unequal spacing of observations. Consider, for example, the construction of the rice share Engel curves illustrated in Figure 2. At each point along the x(ln*xpc*)-axis, there will be some nearby households, and an estimate of the Engel curve is computed by taking the average of their rice budget shares. There are various ways of deciding which households to include, and how to calculate the average, but the same principles of smoothing that applied to the simple moving average also apply here. In particular, the more households included in the average, the smoother will be the regression.

In this report, I have used what are known as "kernel" estimators. These are conceptually straightforward, easily (although not necessarily inexpensively) computed, and can be applied to both density and regression function estimation. The idea is to set a "bandwidth" parameter that determines how near observations have to be in order to contribute to the average at each point. In the context of Figure 2, the simplest kernel estimator would be to set some bandwidth, say 0.20, and at each value of ln(*xpc*) to calculate the average of the rice shares for households whose ln(*xpc*) is within 0.20 of the value. Such an estimator can be improved on by calculating a weighted average that gives greater weight to households the closer is their value of ln(*xpc*) to the value that is being considered. Formally, the estimate of the regression corresponding to a point X, $\tilde{m}(X)$, say, is

$$\tilde{m}(X) = \Sigma w_i(X,X_i)Y_i \tag{A1}$$

where n is the sample size, X_i and Y_i are a the x and y values for observation i, and i runs over the whole sample. In the method described above, the (non-negative) weights w_i will be zero for X_i far enough away from X, though it also possible to allow all observations to contribute and simply let the weights decline with the distance between X and X_i.

The estimator (A1) is a very general one, and is described as a kernel estimator when the weights take the specific form

$$w_i(X,X_i) = K_h(X-X_i)/\Sigma K_h(X-X_j) \tag{A2}$$

where K_h is the kernel, and h is the bandwidth. In the calculations here I have used the Epanechnikov kernel which is defined by

$$K_h(X-X_i) = \frac{3}{4h}\{1 - \left(\frac{X-X_i}{h}\right)^2\} \, I(|X-X_i| \le h) \tag{A3}$$

where I is an indicator function such that I=1 if X and X_i are within h of one another, and otherwise I=0. The $3/4h$ is irrelevant for the purposes of calculating the weights in (A2), but its presence has the effect that the integral of $K_h(X-X_i)$ over the range of its argument will be unity, a property that turns out to be convenient later.

The formulae (A1) through (A3) are used for all of the nonparametric regressions discussed in the main text, and illustrated in Figures 2, 7 through 9, and 12. In Figures 2 and 12, the dependent variable y is either the rice share or the net consumption ratio of rice, while in Figures 7 through 9, where I am estimating probabilities, the dependent variable is simply one or zero depending on whether the household does or does not grow and sell rice. The graphs are constructed by calculating (A1) for 100 equally spaced values of ln(*xpc*) and plotting the result. All calculations were programmed in GAUSS on a 386-series PC and were plotted using GAUSS graphics. The regression estimates are inexpensive to calculate, requiring about one minute of computation time. I selected bandwidths by trial and error, using screen plots to choose a value of h that appeared to give enough smoothness without obscuring detail. While there exist techniques for automatic bandwidth selection (see Silverman or Hardle), they tend to be computationally expensive, and early experiments with one such (cross-validation) showed that the informal methods were unlikely to be misleading, at least for the purposes of this report.

Non-parametric estimates of density functions such as those in Figure 1 follow very much the same principles. At each point on the x-axis, a count is made of how many households are nearby, and if this is expressed as a ratio of the sample size, an estimate of the density is obtained. Again, it is a good idea to give closer households greater weight, and a kernel function can be used to achieve this. Indeed, one of the great advantages of kernel regression estimation is that it automatically yields a density estimate as a by-product. This is the estimate $\tilde{f}_h(X)$ given by, cf (A2),

$$\tilde{f}_h(X) = n^{-1}\Sigma K_h(X_i - X) \qquad \text{(A4)}$$

where n is the sample size, and the fact that $K_h(.)$ integrates to unity is now required in order to generate a proper estimate of the density. This formula is used to produce the univariate densities in Figure 1, and the results calculated at the same time as the regressions in Figure 2.

The bivariate densities in Figures 3 through 6 and in Figures 10 and 11 are calculated according to the same general principles. A grid is constructed over the range of the two variables, and at each point on the grid, a (weighted) count is made of the observations within a neighborhood of the point. The fineness of the grid determines the definition of the contour and surface plots; here I used an 89 by 89 grid, which is the largest that can be handled by the GAUSS graphics routines. Since a complete pass through the sample has to made for every point on the grid, these calculations are much more expensive than those for the non-parametric regressions, requiring some 120 minutes of 386 machine time for the village sector which has 5836 observations. A kernel weighting function is again used. The bivariate Epanechnikov kernel is given by, see Silverman (1986 p76),

$$K(d_i) = (2/\pi h^2)(1-d_i'd_i)\mathrm{I}(d_i'd_i \le 1) \qquad \text{(A5)}$$

where d_i is a two element vector of deviations of X_i-X and Y_i-Y_i each divided by the bandwidth h. Note that this kernel counts observations if they are within a circular region centered at the current point and with radius h. This is not likely to be very useful if the two variables are measured in very different units or if the distribution of the two variables is highly correlated, both of which are true in the current context. The natural way around the problem is to use the sample covariance matrix of the two variables as a metric, or equivalently to transform the units and axes so that the units are the same and the variables orthogonal. The density estimate at the point $Z=(X,Y)'$ is then given by, see Silverman, equation (4.7),

$$\tilde{f}_h(Z) = \frac{(\det S)^{-1/2}}{nh^2}\Sigma k\{h^{-2}(Z-Z_i)'S^{-1}(Z-Z_i)\} \quad \text{(A6)}$$

where $k(d'd)=K(d)$, where S is the sample variance covariance matrix of the two variables.

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APPENDIX 2: Additional Graphical Material

Figures A1 through A8 correspond to Figures 7 through 9 in the text. They show proportions of households producing and selling rice for the following regions: Upper North East, Lower North East, Central West, Central East, Central Middle, Upper South, Lower South and Bangkok Fringe. Figures A9 through A28 are the regional versions of Figures 10 and 11 in the text. They show the joint distributions of the net rice consumption ratio and the logarithm of household per capita expenditure for the Upper and Lower North followed by the ten regions listed above.

Fig A1: rice farming

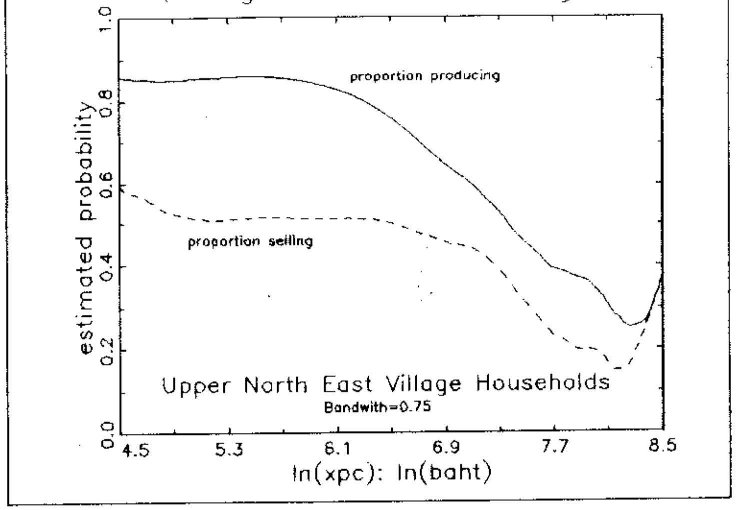


Fig A2: rice farming

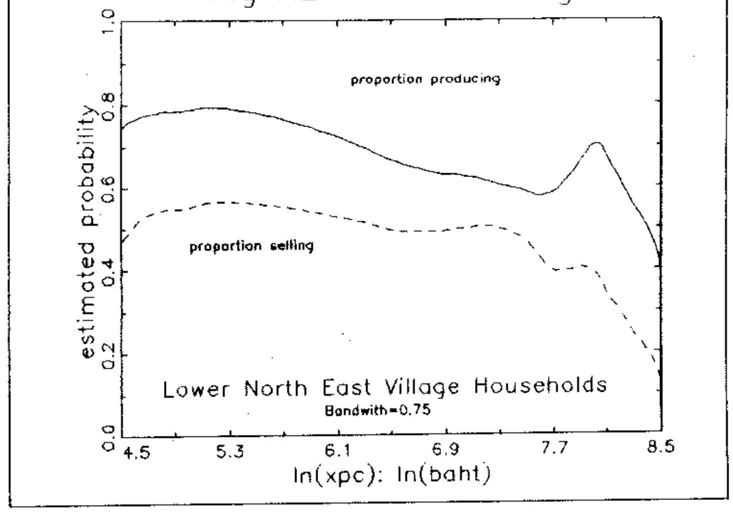


Fig A3: rice farming

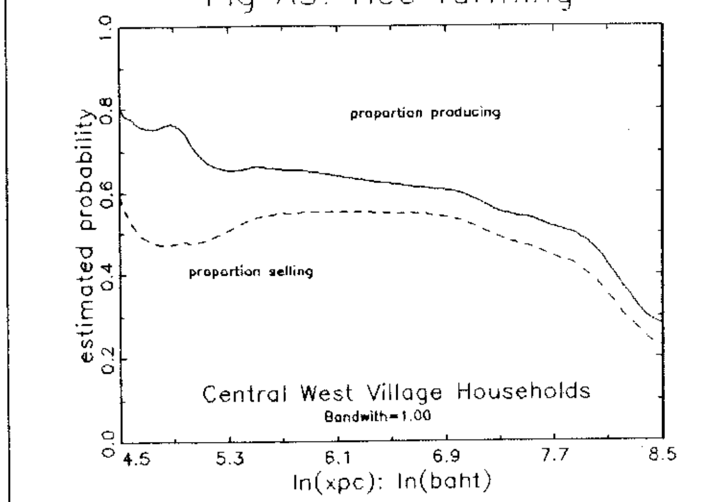
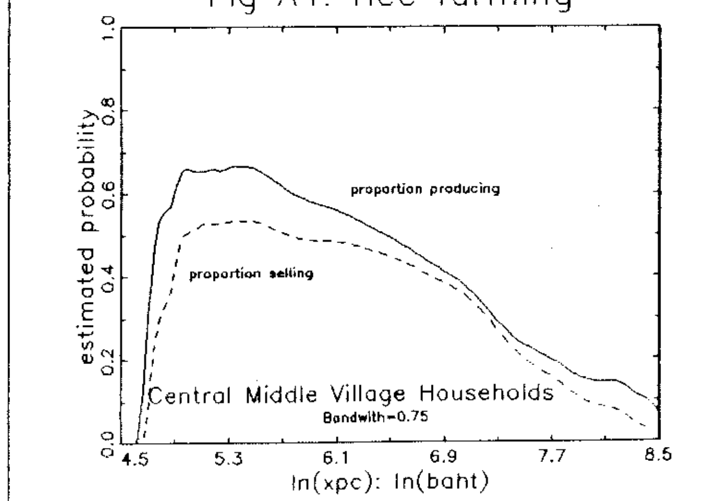


Fig A4: rice farming



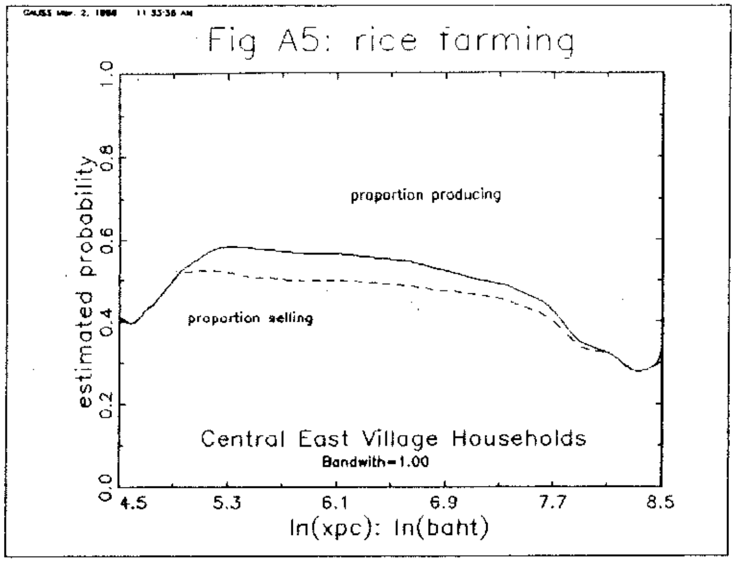


Fig A5: rice farming
estimated probability
proportion producing
proportion selling
Central East Village Households
Bandwith=1.00
ln(xpc): ln(baht)

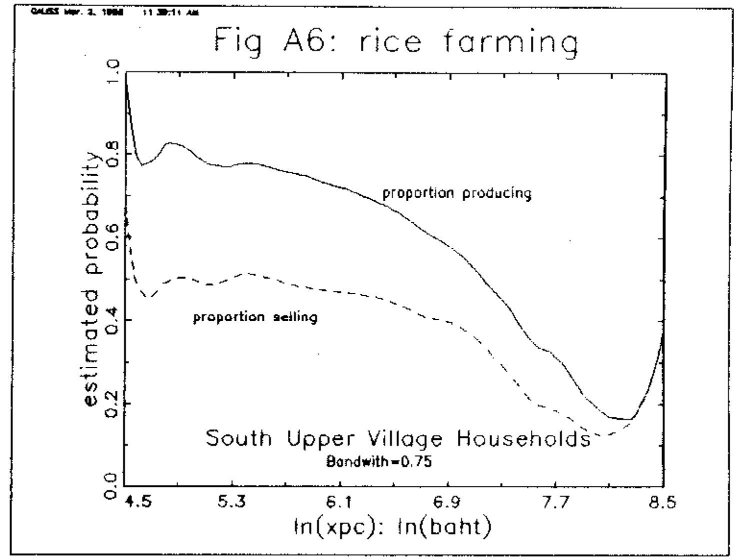


Fig A6: rice farming
estimated probability
proportion producing
proportion selling
South Upper Village Households
Bandwith=0.75
ln(xpc): ln(baht)

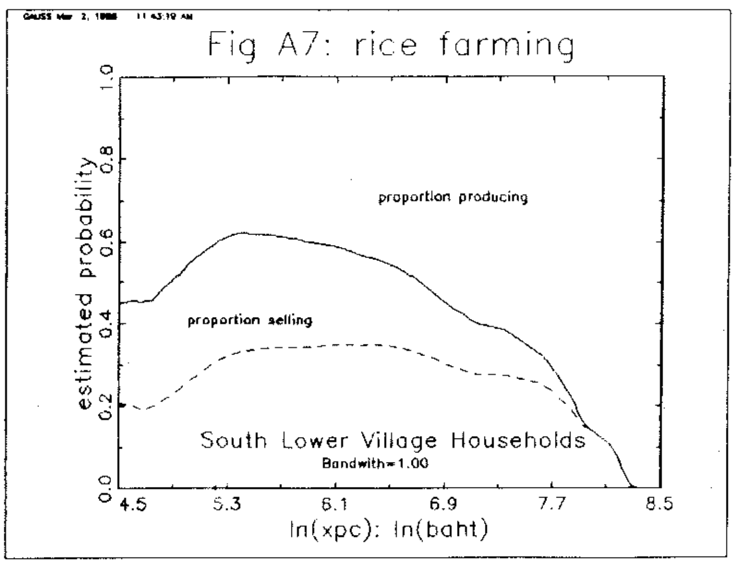


Fig A7: rice farming
estimated probability
proportion producing
proportion selling
South Lower Village Households
Bandwith=1.00
ln(xpc): ln(baht)

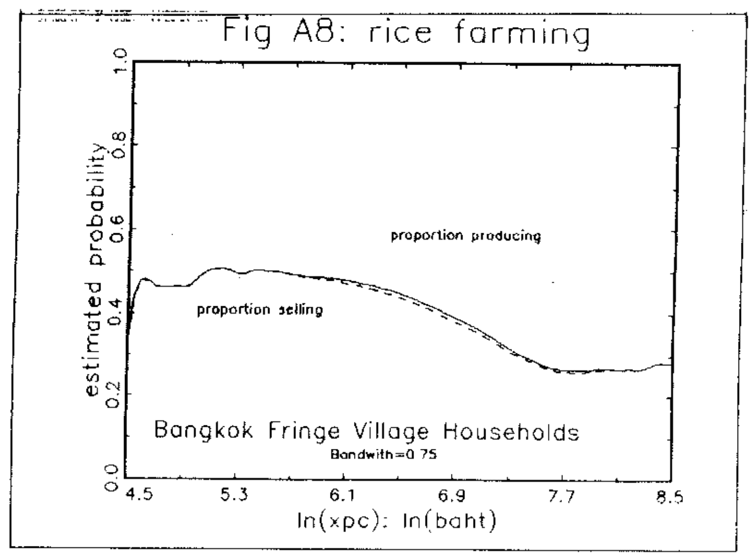


Fig A8: rice farming
estimated probability
proportion producing
proportion selling
Bangkok Fringe Village Households
Bandwith=0.75
ln(xpc): ln(baht)

Fig A9: Net Purchases

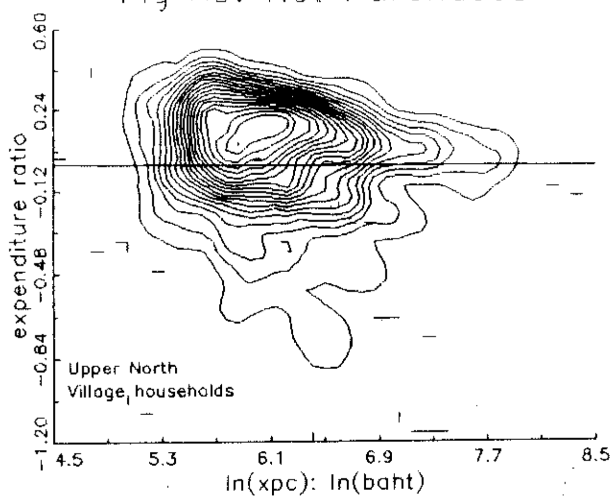
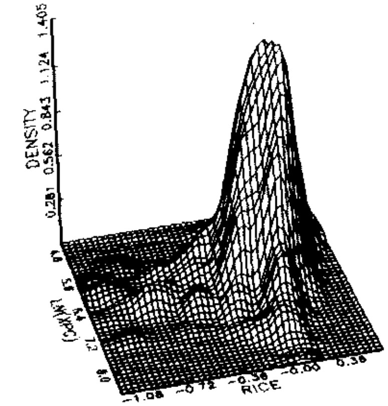


Fig A10 Net Purchases



Upper North Village Households

Fig A11: Net Purchases

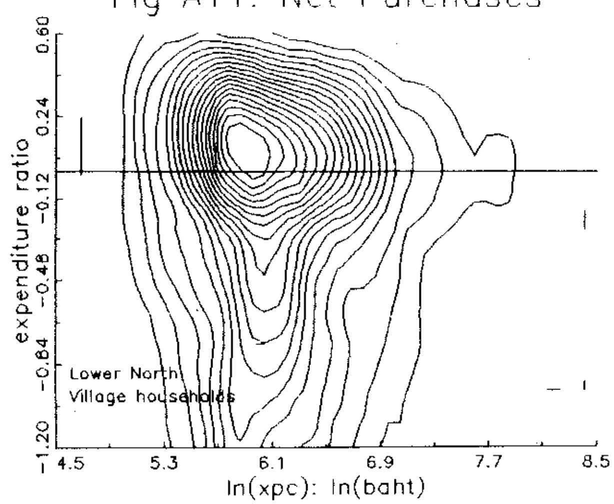
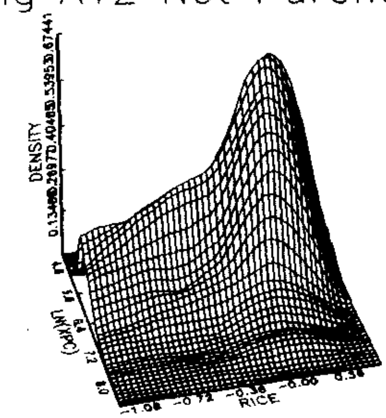


Fig A12 Net Purchases



Lower North Village Households

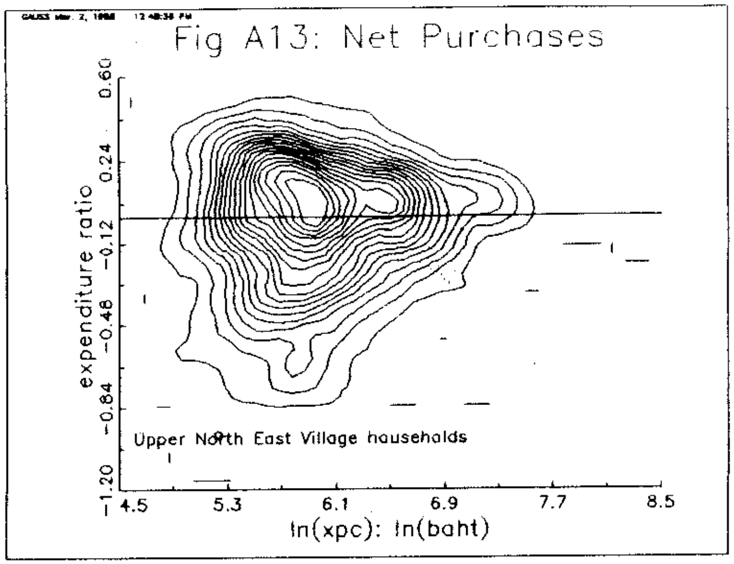


Fig A13: Net Purchases
expenditure ratio
0.60
0.24
-0.12
-0.48
-0.84
-1.20
4.5
5.3
6.1
6.9
7.7
8.5
ln(xpc): ln(baht)
Upper North East Village households

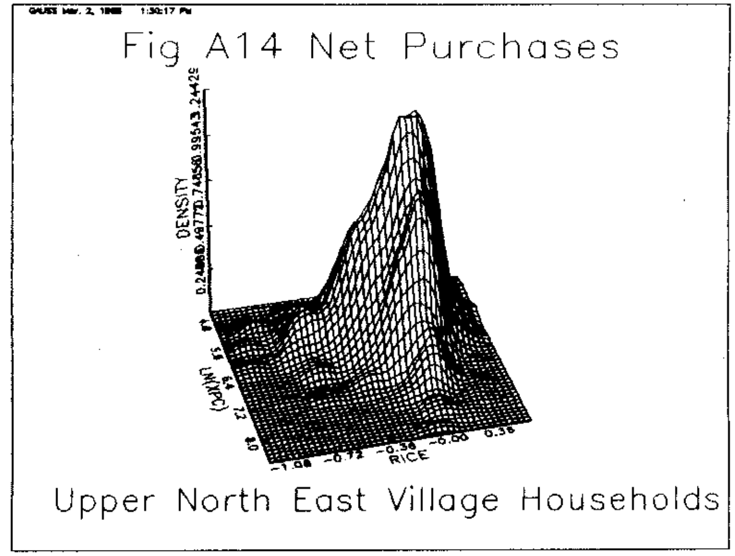


Fig A14 Net Purchases
DENSITY
LN(XPC)
RICE
Upper North East Village Households

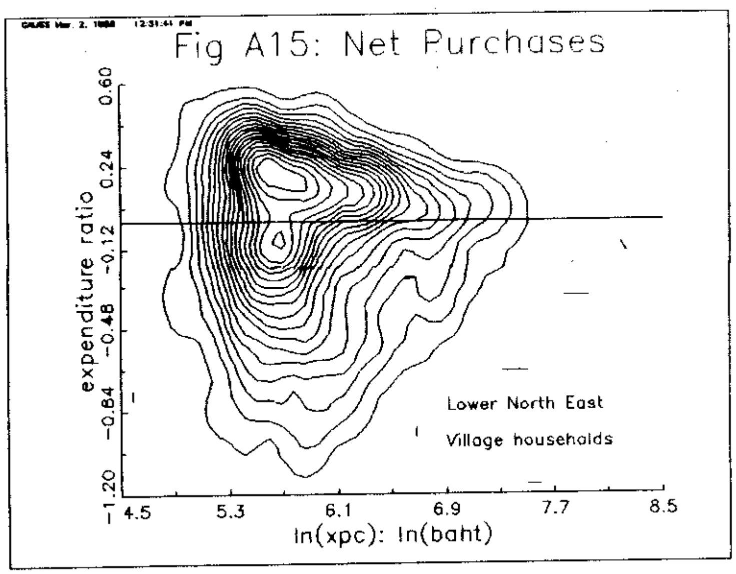


Fig A15: Net Purchases
expenditure ratio
0.60
0.24
-0.12
-0.48
-0.84
-1.20
4.5
5.3
6.1
6.9
7.7
8.5
ln(xpc): ln(baht)
Lower North East
Village households

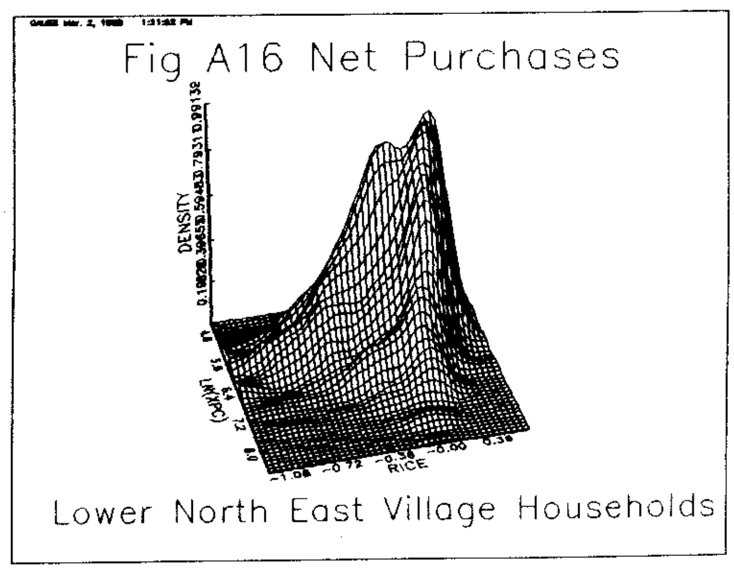


Fig A16 Net Purchases
DENSITY
LN(XPC)
RICE
Lower North East Village Households

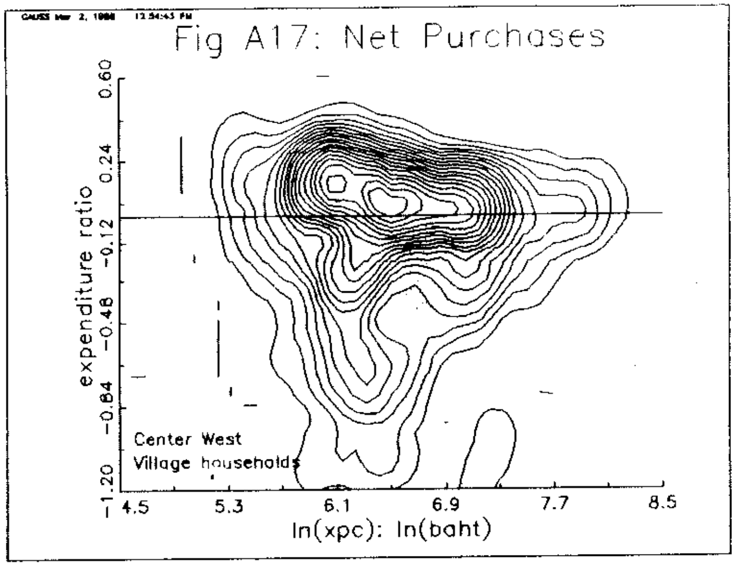


Fig A17: Net Purchases
expenditure ratio
0.60
0.24
-0.12
-0.48
-0.84
-1.20
4.5
5.3
6.1
6.9
7.7
8.5
ln(xpc): ln(baht)
Center West
Village households

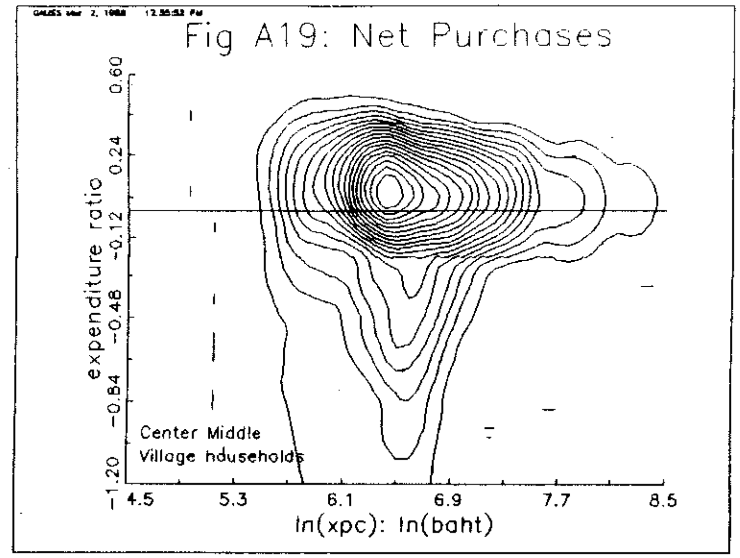


Fig A19: Net Purchases
expenditure ratio
0.60
0.24
-0.12
-0.48
-0.84
-1.20
4.5
5.3
6.1
6.9
7.7
8.5
ln(xpc): ln(baht)
Center Middle
Village hdusehold

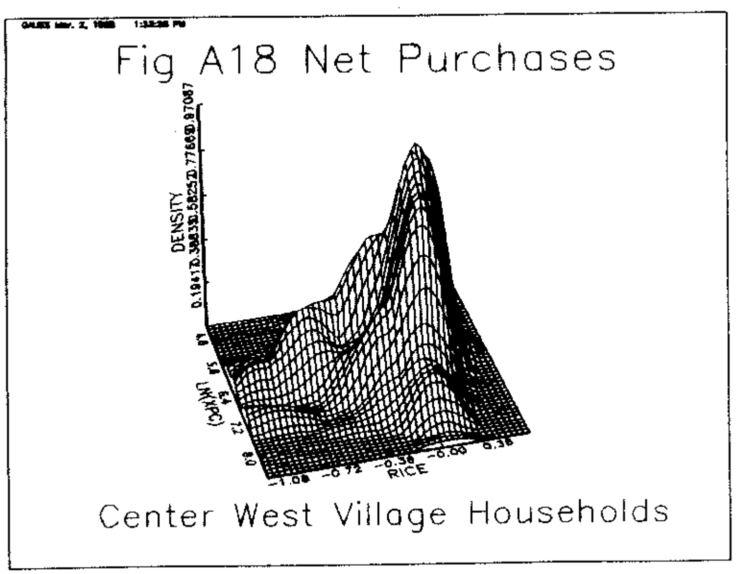


Fig A18 Net Purchases
DENSITY
LN(XPC)
RICE
Center West Village Households

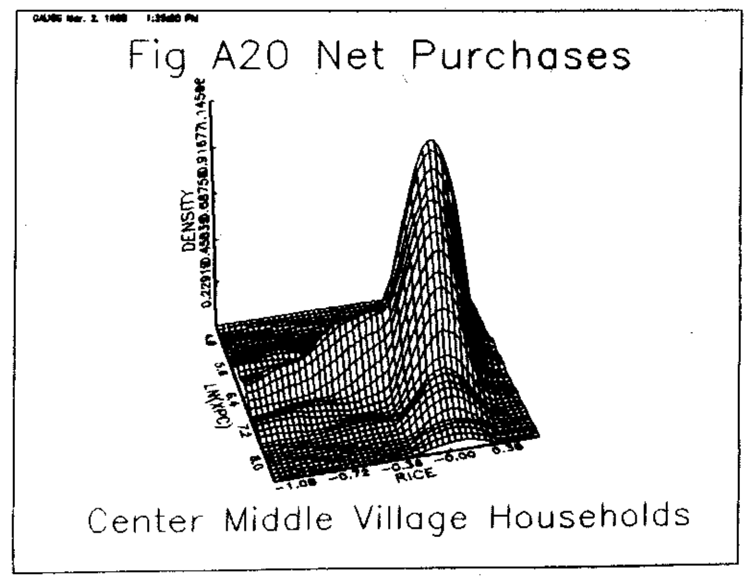


Fig A20 Net Purchases
DENSITY
LN(XPC)
RICE
Center Middle Village Households

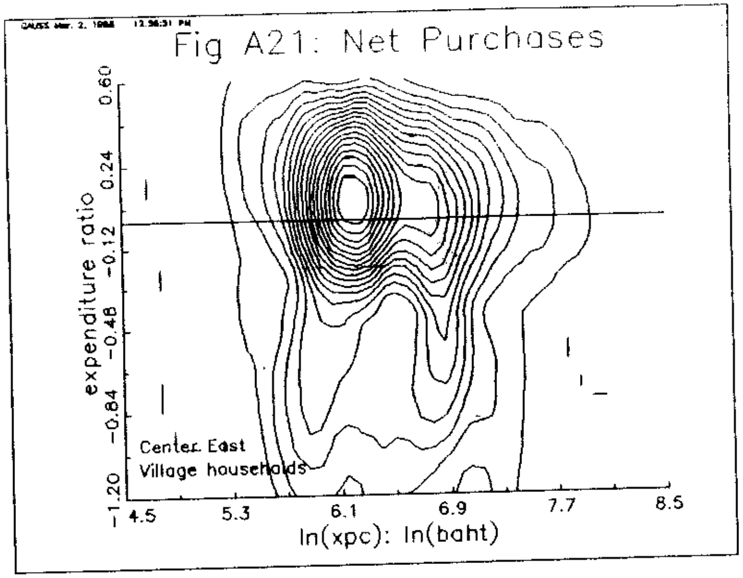


Fig A21: Net Purchases

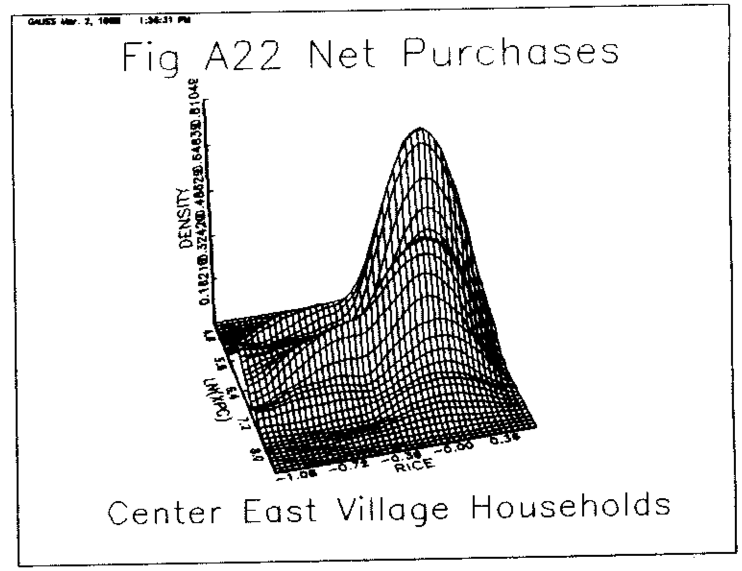


Fig A22 Net Purchases

Center East Village Households

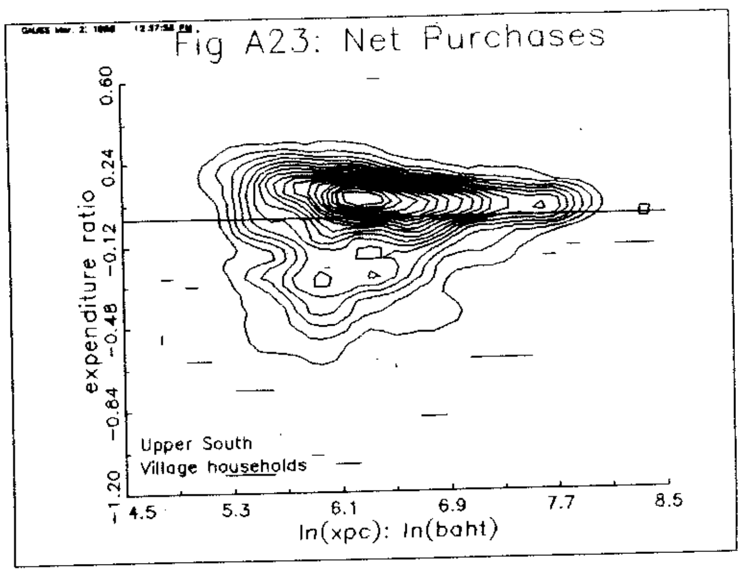


Fig A23: Net Purchases

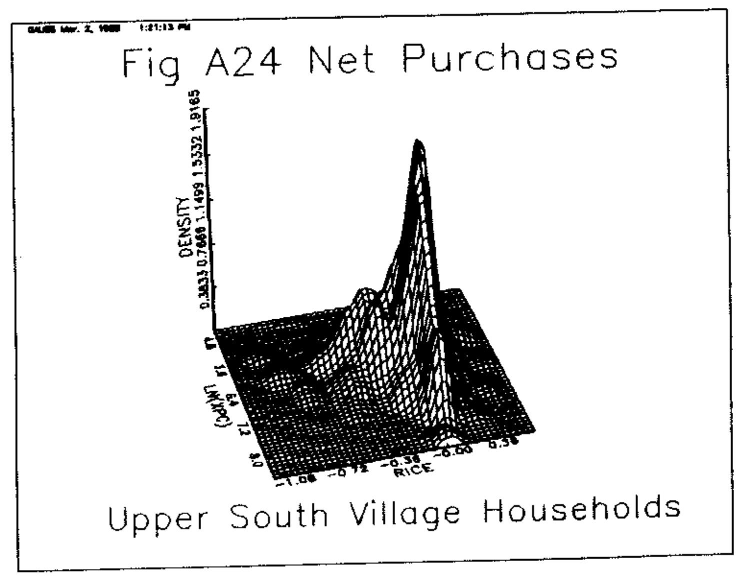


Fig A24 Net Purchases

Upper South Village Households

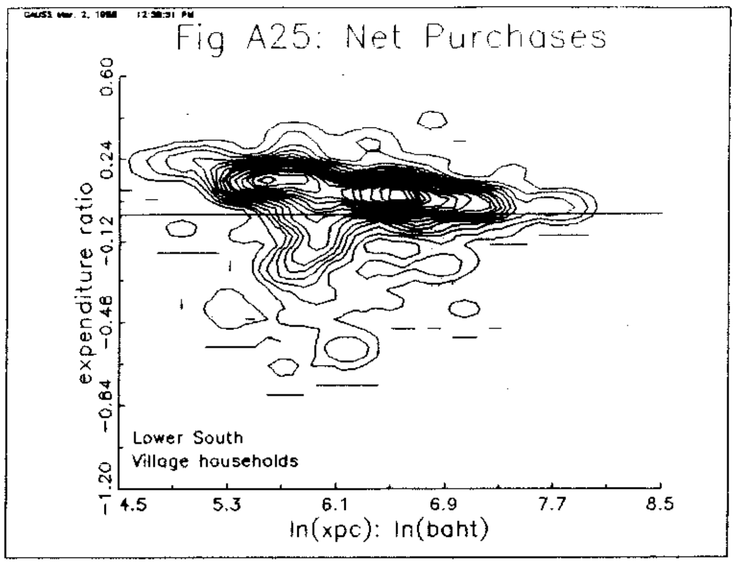


Fig A25: Net Purchases
expenditure ratio
0.60
0.24
-0.12
-0.48
-0.84
-1.20
4.5
5.3
6.1
6.9
7.7
8.5
ln(xpc): ln(baht)
Lower South
Village households

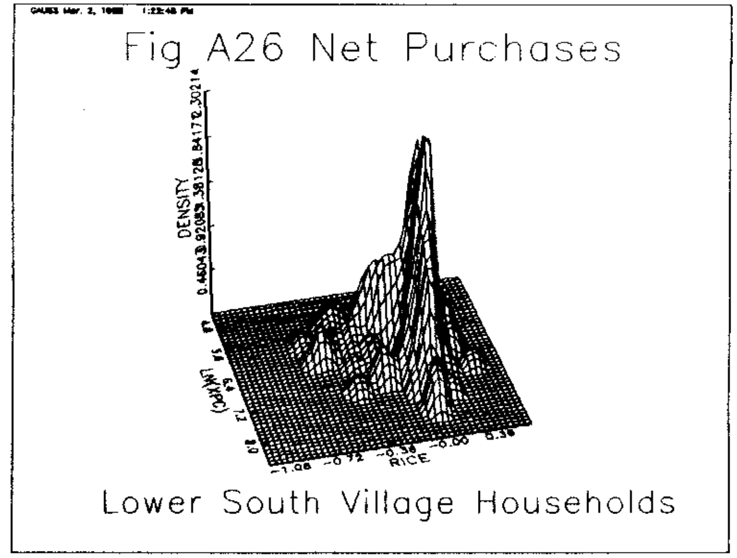


Fig A26 Net Purchases
DENSITY
LN(XPC)
RICE
Lower South Village Households

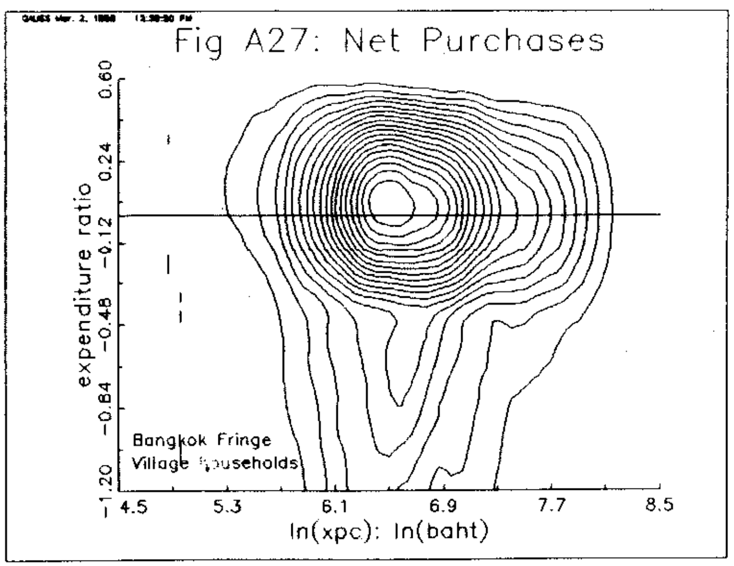


Fig A27: Net Purchases
expenditure ratio
0.60
0.24
-0.12
-0.48
-0.84
-1.20
4.5
5.3
6.1
6.9
7.7
8.5
ln(xpc): ln(baht)
Bangkok Fringe
Village households

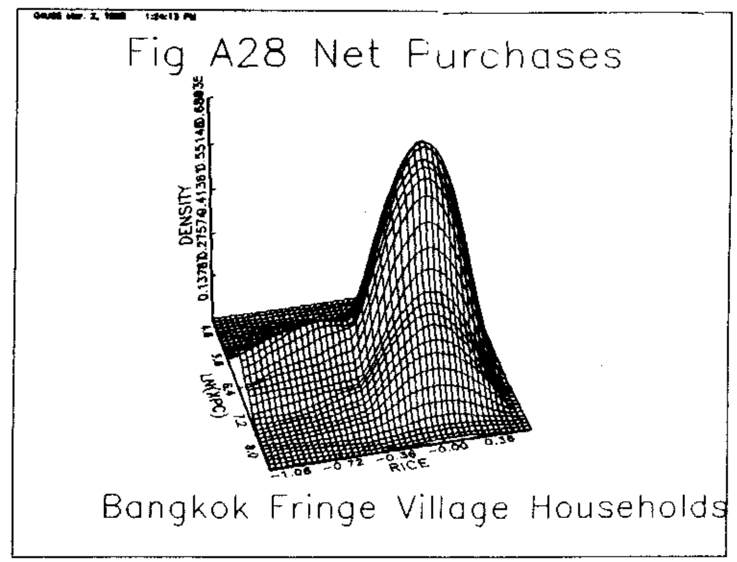


Fig A28 Net Purchases
DENSITY
LN(XPC)
RICE
Bangkok Fringe Village Households