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Robert M. Townsend

Institutions: University of Chicago

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Robert M. Townsend

Department of Economics
Population and Economic Research Centers, NORC
The University of Chicago

and

Senior Research Fellow
Institute for Policy Reform

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Institute for Policy Reform
1400 16th Street N.W.
Washington, D.C. 20036
Phone (202) 939-3450
Fax (202) 939-3458

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by

Robert M. Townsend

Department of Economics

Population and Economic Research Centers, NORC

The University of Chicago

Senior Fellow, Institute for Policy Reform

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ABSTRACT

With the theory of optimal risk bearing and complete markets in mind, field research and an administered survey attempted to measure the key features of the environment and the outcomes of ten poor, high risk villages in northern Thailand. Various key features are uncovered. The paper presents these features and then tries to explain or interpret these features with either a full risk sharing complete markets general equilibrium model or an information constrained version of the same model. Observations from some of the villages are consistent with one or the other of these models, but in many of the villages one is left with risk-response variations across households which suggest that Pareto improvements are possible. The paper identifies these villages and households along with the nature of the apparent inefficiency.

The information provided in this paper might be used by policy makers in the evaluation of existing village level programs or in targeting potential clients and the design of new programs. Alternatively, observations which are anomalous to the benchmark models might indicate there are factors left out of the models. The field research provides some specific guesses about what some of these factors might be.

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1. Introduction

With the theory of optimal risk bearing and complete markets in mind, field research and an administered survey attempted to measure the key features of the environment and the outcomes of ten poor, high risk villages in northern Thailand. Various key features are uncovered. The paper presents these features and then tries to explain or interpret these features with either a full risk sharing, complete markets general equilibrium model or an information constrained version of the same model. Observations from some villages are consistent with one or the other of these models, suggesting little scope for improvement. But observations from other villages are not. One is left with risk-response variations across households within villages and with variations across villages in districts which suggest that if the world is like the model, Pareto improvements are possible. The paper thus provides specific guidance for research and policy efforts.

In effect the current paper displays a two-pronged strategy for research and policy efforts: 1. Use a benchmark model and the results of surveys to identify "inefficient" households and villages and to identify the nature of the inefficiency -- in order to propose a policy remedy, and/or 2. extend benchmark models and the survey to better incorporate and measure features left out of the existing models, features which might explain some of the anomalous variations. The current paper should be regarded as a prototype for expanded research and policy efforts.

The key features discovered in this research effort are briefly enumerated:

1. The villages of the survey are poor, high risk villages (Table 2). The average income across households and villages is $160 per adult. The percentage fluctuation in incomes (Table 4) between good years and bad years

is 59%. Fluctuations in incomes can be attributed to rainfall, crop disease, pests, and human illness (again see Table 5).

2. These sources of variation or shocks do not hit households uniformly. For example, in one village, Yang Pieng, 6, 2, 2, and 2 farmers claim 1988, '87, '86, and '85 as good years, while 2, 2, 6, 2, 1 claim 1988, '87, '86, '85 and '82 as bad years. In short, good years and bad years are not identical across households (again see Table 4).

3. Landholdings and household wealth generally vary enormously across households in a "typical" village. In Yang Pieng from the survey there are three lesser households with no landholdings at all and one with only 2 rai (a rai is a unit of area equal to .4 acres). There are 3 larger households with 4, 10 and 25 rai (see Table 3).

4. Responses to risk and income shocks vary considerably across household types in a given village. Landless or small households claim to respond to a bad year by working harder, often in the forest or by outmigration to district cites. A subset of these lesser households typically remain isolated, while another subset smooth in part with credit transactions, borrowing and lending from friends and relatives, from local lenders, or from the quasi-formal village institutions noted below. Larger landed households attempt to smooth with the use of livestock, rice carryover, and currency if not other assets. Again, a subset of these larger households smooth on their own and remain isolated while another subset borrow and lend locally.

5. There are apparent variations in farming practices across farmers, possibly even across farmers operating otherwise identical plots. Techniques, seed, and amount of fertilizer, pesticide, and herbicide can vary (Table 6). In most villages farmers claim they would borrow more to finance inputs even

at market rates were it not for the risk of fluctuating yields. Various farmers use no herbicide or fertilizer (see Table 7).

6. There are variations across villages in risk response patterns. In Ba Pai, virtually all households smooth on their own with assets and increased labor supply. There seems to be relatively little use of credit. That is, the within-village credit market does not exist. Two households claim loss of income and welfare due to an incident of household sickness.

7. Several of the villages display plot fragmentation. Of the 11 respondents to the plot survey in Maanajohn, 2 respondents hold 1 plot, 5 hold 2, 3 hold 3, and 1 holds 4. That is, a given household can have various spatially separated plots (see Table 3).

8. There are also variations in the adoption of new rice varieties. In Maanajohn 11 out of 12 farmers in the plot survey are using a traditional variety, with a stable but low yield. In Yang Pieng 11 out of 16 farmers mention a combination of that traditional variety with one or both of two new varieties.

9. There are variations across villages in the existence and use of quasi-formal village organizations. Mae Wak has a rice bank, investment fund, housewife fund, pig fund, fertilizer fund, and various community organizations. Virtually all households participate, e.g. via savings. Mae Wak apparently has not had problems with internal default and has become something of a regional lender. Nearby Sop Wak had default problems on its rice bank and investment fund. Villagers have had difficulty sustaining participation. Occasional households complain of lack of village leadership.

Are these facts consistent with the existence of a Pareto optimal allocation of resources in the village or with a complete markets competitive

equilibrium?

At least one salient feature is consistent with the theory. Laborers and farmers are acutely aware of the risk in their environment and make efforts to smooth idiosyncratic and aggregate shocks. Increased labor supply, rice storage, livestock transactions, and the use of currency and credit are among the risk response patterns described by households in interviews. Similarly, plot, crop and seed diversification can be interpreted as evidence of efforts, sometimes costly, to reduce risk. Quasi- formal village institutions and the terms of loan contracts in informal credit village markets often incorporate implicit or explicit provisions for insurance, with loans on occasion rolled over or forgotten in the event of idiosyncratic if not aggregate shocks.

Still, the response patterns across households in many villages seem inconsistent with a Pareto optimum or complete markets equilibrium (though data on consumptions and labor supplies is needed for more precise tests). The relatively rich should be storing for the entire village economy, determined by the state of the village economy, not smoothing on their own with the state of their own incomes. If income variations are not uniform across these relatively rich households while consumptions are not completely smoothed, then allocations are not Pareto optimal; more insurance via flexible, informal lending or reciprocal gift-giving among the relatively landed households should be observed.

Similarly, the poor claim increased labor supply in bad years, and this is not Pareto optimal even among the class of poor households if labor supplies do not comove. Labor supply should not be linked to own storage; poor households who borrow and lend mitigate this effect, but others do not.

In principle, consumptions and labor supplies should comove over all

households in the village. Given the high but nonuniform risk described above, comovement requires that virtually all be linked either to the village credit market with risk contingencies or to quasi-formal village institutions with risk contingencies. In many villages this does not seem to be the case.

The efficiency of village funds is problematic. The funds often bear high internal rates of return while others in the village save externally at low rates. Rice is held in carry over despite a rate of depreciation of 3 about percent. The rate for borrowing from the various funds in a village appears time invariant. Not all funds in all villages have explicit provision for insurance, though implicit practice is hard to document.

Variations in agricultural practices and inputs is not consistent with the theory, though it is difficult to get an experiment which controls for land types, if not human capital. Related, farmers should not complain that they fail to borrow for fear of risk if there are complete markets for contingent claims.

Various private information models can be brought in to try to explain the anomalies. A model with unobserved labor efforts and idiosyncratic plot specific shocks would deliver (i) incomplete risk sharing, with consumptions comoving in part with own incomes, (ii) variations in farming practices, and (iii) partial land fragmentation. Yet, if the world were like the model, households would not live in isolation, one from the other, given that income fluctuations are not uniform over households. Private information theory still predicts risk contingencies in debt contracts, though the extent of this depends on preferences, technologies, and shocks. Optimally designed information constrained incentive systems mitigate the effects in (i), (ii) and (iii) above. In an optimally designed system much information would be

communicated and much information would be inferred *ex post*, even if information were private *ex ante*.

Further, in an effort to induce labor efforts and mitigate incentive problems, control over storage, borrowing and lending, and other forms of intertemporal smoothing would be in complete control of the village funds. Only if assets, storage, and credit decisions are unobserved by village residents would pure borrowing and lending in informal markets emerge as a prediction of private information theory.

Direct efforts in the survey to measure what is or is not known in a "typical" village economy and who is or is not communicating with whom turn up additional salient features. First, households who are isolated in risk response patterns tend also to be isolated in information and communication, knowing little about others and claiming to talk with no one. Others involved in credit markets are talking and tend to know something about their credit partners if not their neighbors. Yet the degree of communication and shared information seems to vary village by village. In the fragmented village of Ba Pai, villagers are surprisingly isolated. The inference in general is that information is not perfect nor costless even at the level of the village.

Though the observations are consistent with information as a constraint, the observations are also consistent with credit-insurance systems and the extent of information and communication both as endogenous. That is, additional endogenous and exogenous features may be correlated with both. The current field research and village stays suggest these features may include human and organizational capital; some measure of leadership capacity on the part of the headman, successful efforts to induce trust and self-fulfilling expectations about default, and bite in local legal systems. It is hoped

these concepts can be incorporated into the theory in a realistic way and then measured more precisely in a future research effort, following the prototype described in this paper.

The methods and conclusions of this research are related to some important contributions in the literature. Udry [1990] conducts his own field research in Nigeria and discovers risk contingencies in loan contracts and knowledge of local shocks. He argues that a complete markets equilibrium might be achieved with local credit institutions. [1] Aleem [1990] sets out to measure directly what local lenders know about the borrowers in the Sind area of Pakistan. He documents that information is far from perfect and that borrower selection and monitoring can be quite costly. In micro level research anthropologist Wade [1988] uncovers enormous variation in organization and legal systems across nearby villages in southern India. He argues that institutions arise where they are most needed, in the most risky environments, but seems to suggest at times that the poor have difficulty organizing without the cooperation of the rich. Similarly, Hirsch (1990) takes issue with the idea that villages are either well organized collective entities as in Scott (1976) or individualistic and possibly inefficient as in Popkin (1979), studying in detail two villages in Thailand's western region.

Finally, economists Siamwalla (1990) and Siamwalla et al. (1990) have studied rural credit markets in Thailand generally. Though using a framework somewhat distinct from the general equilibrium prototypes pursued here,

[1]Udry is one of the few to use the general equilibrium model in field research and to make indirect inference about whether markets are complete. Direct tests using large data sets include Abel and Kotlikoff (1988), Altonji, Hayashi and Kotlikoff (1989), Altug and Miller (1990), Cochrane (1989), Deaton (1990), Mace (1988), Rashid (1990), and Townsend (1989), using consumption, labor supply, and income data.

Siamwalla's work suggests informal interest rates are high not because of absence of externally supplied credit but because information costs are high. Siamwalla concludes that "the key to successful government intervention in rural credit is institution building that is innovative and efficient in tackling the information problems involved in lending." This paper also identifies information as a potential constraint but the picture is not uniform and additional impediments may be important as well. On the other hand, the survey techniques of the paper might be viewed as one way to supply information to government policy makers for the design of improved programs.

2. Survey Methods and Field Research

This research was carried out over a period of about a year and a half, with various degrees of intensity. The first stage in the summer of 1989 consisted of site selection and the design of two questionnaires.

The sites selected were judged to be poor and to be risky, that is, with low levels income and erratic crop harvests due to erratic rainfall if not diseases and pests. This information was obtained from researchers at Payap University and Chiengmai University as well as from Thais involved in charitable organizations and army officers familiar with the area. The three ampeurs selected were Maajam and Omgoi in Chiengmai state and Lee in Lampun state. All three are two to three hours drive from Chiengmai. Data from the Thai Socio-Economic Survey was not available to the author at the time of site selection, though this would be used to judge levels of poverty and income were efforts continued in the future. Rainfall data was used to a limited extent.

Numerous trips were made to each of these areas. In each area an attempt was made to pick three villages, one near the district center, one in a more

outlying area, and one midway between. Information on villages was gathered from district officials, specifically agricultural extension officers. Attention was restricted to Thai villages, as opposed to hill tribe villages; that latter get far more attention from the Thai and international donor community.

On a given trip to a given village this researcher and primary research assistant would try out some preselected questions and then add to this set in informal conversations with village residents of various income levels. These original and additional questions were then modified, based on perceived accuracy of responses, the amount of information obtained, and the effort and time needed to acquire it. This led in the end, after six iterations, to two separate questionnaires.

The first, household questionnaire gathers some asset and demographic information about the family, but its main intent is to measure the size of fluctuations in crop harvests and/or income and to find out how the household responded to these fluctuations. Specifically, the household is asked to pick the best and worst years in the last five; to name the years; and to give the amount of the harvest and/or labor income for those years. The household is then asked how it responded. The various possibilities include carryover of rice from good years to bad years; buying livestock and other assets in good years and/or selling these in bad years; working harder in the labor market or elsewhere in bad years; getting help in gifts or loans from friends, relatives, or organizations; or selling crops for cash and carrying this over to bad years. Under each response category is a series of more detailed questions attempting to document and quantify the response. There is also a separate section in the questionnaire on incidents of illness with possible

adverse consequences for remaining household members. There is also a section which asks the given household if it is able to document the fluctuations of another household and how that household responded. Finally, there is a section which covers any possible use of village or district financial organizations. This structured household conversation, following the questionnaire, takes from 1 to 1 1/2 hours to administer.

The second, plot questionnaire solicits information on crop fluctuations, restricting attention to farmers, as opposed to landless laborers. The farmer is asked to recall the best and worst year in the last five, naming the years and the amount of the harvest. The farmer is also asked to rank rain, diseases, and pests as sources of any fluctuations. In addition the farmer is asked detailed questions about the number, size and characteristics of land plots; benefits and problems of have spatially separated plots, if any; and types of seed and the adoption of new varieties, if any. There follows a rather long section which chronicles exactly how a particular crop and plot was farmed over the last season, with detailed questions on planting, weeding, and harvesting; on the use of pesticide, herbicide, and fertilizer; and on problems with water, pests, and the timing of operations. There is also a section which asks the farmer to compare his plot to one of another farmer nearby, and a section which asks the farmer if he knows about the crop operations of such nearby farmers, of any friend, or of any relative. This plot questionnaire takes about one hour to administer.

Both questionnaires seem to work well in practice. Farmers enjoy talking about how they farm their plots and appreciate that the investigator is taking interest. The more difficult household questionnaire is focused on a particular question -- responses to fluctuations -- and does not attempt to

directly solicit detailed information about income. (Nevertheless estimates were attempted *ex post*). No attempt is made at measuring consumption with the exception that households were asked if their consumption dropped in a bad year.

In the second phase of the project, in the fall of 1989, these questionnaires were administered to households in ten villages, four in Maajam, and three each in Omgoi and in Lee. The target number of households was five percent of the households of each village for each questionnaire. In some villages this target was not met, in one instance because one village was in fact two separate villages. In most villages the number of household questionnaires fell short of the number of plot questionnaires. Finally, household participation was solicited by the headman at least one week in advance of the arrival of the enumerators, but participation was voluntary. Thus the sample of each village is probably too small and may be biased. Both these problems could be corrected in future efforts.

The third phase of the project began in the summer of 1990. The completed questionnaires were read one at a time, searching for possible patterns. In the end sketches with data summaries were prepared for each village.

The final stage in the winter of 1991 consisted of return trips to the villages. In six of these we stayed for three to four days, living and eating in the house of the headman, or in two instances, in the house of the assistant headman. This was an opportunity to check on the village summary; fill in missing information; interview several more households on an informal basis; and to acquire detailed information from the headman and/or the relevant committee on the functioning and use of investment funds and other

community organizations.

In summary, measurement in the questionnaires and village conversations was guided by an underlying general equilibrium framework. This framework dictates measurement across a variety of farmers in a given village and measurement over time via retrospective questionnaires for each farmer. The survey also emphasizes cross-village comparisons and finds one cannot understand one village without comparing it to the others. The survey also combines survey data with more unstructured conversations; in this way, the research is both formal and yet open-ended. In the end the effort here might be regarded as a prototype for future research.

Because village and ampeur names and characteristics are difficult to remember, Table 1 provides a summary chart as an aid to the reader. This Table lists number of households, distance from the district center, principle crops, the degree of land fragmentation, the existence of quasi formal village institutions such as rice banks and investment funds, the existence of an active informal within-village credit market, and the existence of enforcement leadership and/or human capital problems. One can see in Table 1 the potential for policy guidance offered by the research -- this and other village level information can be made available to government and nongovernment organizations interested in improvements.

3. The Village Environment

The purpose of this section is to present the relevant facts concerning the village environments. To be noted is the effort to integrate theory with observations: the environment of the general equilibrium model is described simultaneously with the presentation of data from the survey.

In the "typical" northern Thai village of the survey, landholdings (and

incomes) are unevenly distributed. One must immediately dismiss the image of a village consisting of typical households, all more or the less the same. For example, in Maanajohn among the 11 respondents to the household survey, there were 5 lesser respondents with 1/4, 2, 2, 2-1/2, and 3 rai, respectively. These coexist with 7 larger households with 4, 5, 5, 5, 9, 14, and 21 rai. In Yang Pieng, among household survey respondents, there are 3 "lesser" households with no landholdings at all and 1 with only 2 rai. There are also 3 larger household survey respondents with 4, 10, and 25 rai. In Ba Pai there are 2 "lesser" households with 1-3/4 and 2 rai and 2 with 8- 3/4 and 20 rai. Landholdings are roughly correlated with incomes (see Table 2).

Land plots also vary by number of plots held per household. In Maanajohn of the 11 plot respondents, 2 hold one plot, 5 hold 2 plots, 3 hold 3 plots, and 1 holds 4. Of the 16 plot respondents in Yang Pieng, 11 held 1 plot and 5 held 2. In Ba Pai all plot respondents held 1 plot only.

Further, land plots themselves can vary by size (from 1 to 15 rai), distance and direction from the village (from 200 meters to 8 kilometers), commuting times (from 5 minutes to 4 hours), soil type (from bad, rocky, sandy or clay to good or black), upland-lowland status, slope (flat to sloped), irrigation status (rain fed to stream-irrigated), and crop planted. As is apparent from Table 3, the environment of each village is not uniform.

As far as crop choices are concerned, villages often differ radically across regions. Farmers in Maanajohn, and in Maejam district generally, are growing glutinous rice on lowland, irrigated plots in the wet season and growing soy beans on irrigated plots in the dry season. Farmers with upland plots grow upland rice in the wet season, nothing in the dry. Glutinous rice is generally grown for home (or village) consumption, while soy beans is the

dominate cash crop. Minor crops of cabbage and green onions are sometimes seen.

In Yang Pieng, and in Omgoi district generally, the dominate crop far and away is glutinous rice grown in the rainy season. Tomatoes is an emerging cash crop, though this is not picked up in the survey.

In Ba Pai, and other villages in Lee district connected to the commercial economy, the dominate rainy season crops are all cash crops -- peppers, corn, and soy beans. Lamyai is an emerging cash crop, while minor crops of cabbage and garlic are sometimes seen.

Farming practices may appear "simple", but there are genuine choices of inputs. Again one can stress diversity; techniques can differ across farmers. Generally, rice farmers in Maanajohn are using household labor and occasionally hired and exchange labor for planting, weeding, and harvesting. Cash inputs include the use of pesticides, herbicides, and fertilizer, varying in amounts across farmers. Small power tractors are rented for initial plowing. In Yang Pieng, in contrast, while fertilizer is occasionally mentioned as an input, use of herbicides and pesticides is rare. All mention of labor is exchange labor, while tractors are rented. In Ba Pai corn is grown without cash or credit inputs, with the exception of one farmer using herbicide. For peppers both the respondents used fertilizer while one used herbicide and the other pesticide. Generally, large threshing machines are rented for corn.

Seed inputs can vary considerably across villages, especially in rice. In Maanajohn 11 out of 12 farmers in the plot survey are using a traditional rice variety, Muenong. This can be traced back to an agricultural extension program prior to the survey. Yields are said to have increased over those

from earlier varieties, but farmers complain of weak stems. One farmer in Maanajohn is experimenting with a rural development variety, RD8. In contrast, in Yang Pieng, 11 out of 16 farmers from the plot survey mention a combination of Muenong with yellow or mali rice. Five of these respondents use all 3 varieties! Yellow rice is a new variety from Sampatong, said to increase yields by 80 to 100 percent. All of those who adopt new varieties are diversified into other holdings. Several are explicit that it is risky to rely on one kind of seed.

In summary, in somewhat more formal notation, in a "typical" northern Thai village of the survey, each household j, j=1,2,...N is endowed with various units of land type ℓ in amount $N_\ell(j)$. Recall again that some households have no land at all and types ℓ can vary. Each unit of land type ℓ is associated with a household invariant agricultural (A=Ag) production function H^A_ℓ mapping household (j)'s labor input, denoted $a^A_{\ell t}(j)$ at date t; cash-credit inputs of pesticide, herbicide, fertilizer, and seed denoted $b^A_{\ell t}(j)$; and capital inputs of tractors and water buffalo, denoted $K^{Ai}_{\ell t}(j)$ into crop outputs, denote $q^A_{\ell, t+1}(j)$ at date t+1 and possibly altered capital outputs $K^{Ao}_{\ell, t+1}(j)$, to reflect depreciation. This relation is summarized by production relation

(1) $H^A_\ell \left(q^A_{\ell, t+1}(j),\ K^{Ao}_{\ell, t+1}(j),\ a^A_{\ell t}(j),\ b^A_{\ell t}(j),\ K^{Ai}_{\ell t}(j),\ \varepsilon_{\ell, t+1},\ \eta^A_{t+1}\right) \geq 0$

per unit of land type ℓ, with idiosyncratic shocks $\varepsilon_{\ell, t+1}$ and, aggregate shock η^A_{t+1} to be described momentarily. Note that all variables dated t+1 are implicitly functions of shocks at date t+1.

As noted, crops may be grown in the rainy and dry season, depending on land type ℓ. It also will prove useful to distinguish two dates in each season, with an input date at the beginning of the season and an output date

at the end. Thus with t=0 as an initial planning date, let t=1,2 denote the first two dates of the initial rainy season for inputs and outputs, respectively, and t=3,4 denote the first two dates of the initial dry season for inputs and outputs, respectively, and so on for subsequent years.

Essentially all inputs and outputs for crop production can be bought or sold in the village or in the larger district markets with households taking prices parametrically. In particular, let $P_{qt}(\eta_t^q)$ denote a vector of prices for crop outputs at output date t as a function of district or national shocks η_t^q. At the time of the survey, the price of rice was approximately 30 Baht per tang, of soy beans approximately 80 Baht per tang, of corn approximately 32 per Baht per tang, of pepper approximately 10 Baht per bag. However, the price of cash crops can vary; the price of corn reached 38 Baht a year or two before the survey. (There are roughly 25 Baht per U.S. dollar.)

As for inputs other than labor, typical prices $P_{bt}(\eta_t^b)$ for non-labor inputs would include one bag of fertilizer at 280 Baht, one bottle of pesticide at 25 Baht, one bottle of herbicide at 460 Baht, and so on. Apart from depreciation, the price $P_{k,t+1}(\eta_{t+1}^k)$ at all capital outputs at date t+1 less the initial price of capital inputs at date t, $P_{kt}(\eta_t^k)$ would be equivalent with the rental price of capital throughout date t, for example, the rental of one tractor at 700 Baht per day.

Gross revenue from the sale of cash crops and imputed values of rice crops are shown in Table 2, along with estimates of costs in crop production, net of the household's own resources, e.g., labor and cattle.

As for the nature of agricultural production shocks η_{t+1}^A and $\varepsilon_{\ell,t+1}$, we first note the degree and diversity of output fluctuations over farmers. For the 12 plot respondents in Maanajohn, all answering questions about rice,

Table 4 lists the amount of the harvest in the best and worst years in the last 5 years and notes the year. The percentage fluctuation is given in the last column. Similarly, tabulations are done for rice fluctuations across farmers in Yang Pieng and for corn fluctuations across farmers in Ba Pai.

Attention can be drawn to two salient facts. First, starting with Yang Pieng, one can see from Table 4 that the extent of fluctuations for each farmer is typically large. The average difference between good and bad years is about 60 percent. The second fact is that the good years and bad years are not coincident across farmers. In fact an occasional farmer will trade places in some sense, with 88, 86 a good year, bad year sequence for one farmer replaced by 86, 88 as a good year bad year sequence for another. More generally 6, 2, 2, and 2 farmers claim 88, 87, 86, 85 as their best year while 2, 2, 6, 2, 1 claim 88, 87, 86, 85 and 82 as their worst year. Though there is some tendency for recent years to be best years, this is not uniform in the sample.

Maanajohn's Table 4 is similar with the exception that fluctuations are less severe and there is a trend in yields, perhaps due to an increasing use of fertilizer. There is insufficient data to capture reliably the extent of this trend. With Thailand as a growing economy, one should watch out for trends generally. The pitfall in the interpretation of the data on fluctuations is apparent.

In Ba Pai fluctuations are quite large. On the other hand, good years and bad years for corn are more coincident, with three naming 88 as the best year and 2 naming 86 as the worst.

The implications of this risk are two-fold. First, there would seem to be an enormous need for each farmer to smooth fluctuations in some way;

otherwise, consumption would be fluctuating. Second, because fluctuations are not uniform in years across farmers, there seem to be ample possibilities for smoothing across farmers in a village in a given year, for some kind of informal or quasi-formal community insurance arrangement.

As to the cause of fluctuations in Maanajohn, from among the 12 plot respondents, 4 list water as a principle source of fluctuations while 6 and 2 list crop disease and pests as principle sources of fluctuations. More specifically Table 5 reports on reasons given for the best year in the last five, the worst year in the last five, whether there can be too much water in a good year and whether there can be too little water in a bad year. Diseases and too little water show up along with variations in the use of fertilizer as causes of fluctuations. It seems that water, crop disease, and pests are jointly responsible for fluctuations in Maanajohn.

In Yang Pieng about half of the plots rely on streams for irrigation. Yet water is still the dominate problem. Only 2 out of 15 farmers in Yang Pieng list pests as a principal source of fluctuations. More specifically, Table 5 checks off rainfall as the reason for good and bad years, and there are frequent complaints about too little water in one if not multiple years.

Similarly, farmers in Ba Pai all list water as a principle source of fluctuations, with disease and pests as secondary factors. For the 4 corn farmers, Table 5 confirms that water is a source of variation. Variation in the use of fertilizer also shows up despite the fact that few claim to use fertilizer.

From these data it seems reasonable to suppose that land type ℓ idiosyncratic shocks $\varepsilon_{\ell, t+1}$ pick up variation in water levels over crops due either to variations in local monsoon rains or to an uneven flow of water,

sensitive to elevation and slope. Crop diseases and pests may also vary with idiosyncratic shocks, though incidence or damage may be a function of fertilizer as well. Common aggregate shock η^{A}_{t+1} picks up variation in aggregate village-wide shocks.

Crop disease and pest shocks can have very severe consequences, but incidence is not uniform and would seem to be insurable, subject to moral hazard problems. Rainfall (or access to water) may also have larger idiosyncratic shocks then imagined *a priori* (or alternatively relations $H^{A}_{\ell}(\cdot)$ do not treat aggregate shock η^{A}_{t+1} uniformly across land types ℓ). Again, there is some scope for insurance.

Evidence for the existence of idiosyncratic shocks or the nonuniform impact of aggregate shocks is apparent from the distribution of land plots, given in the Table 3 for Maanajohn, and from farmers' complaints about the costs and benefits of multiple plots. With 3 exceptions, all farmers with multiple plots in Maanajohn hold these plots within a half hour's walk of the house, but all farmers with separate plots complain that having them is a bad thing. Depending on the interpretation of comments written on the margin of the questionnaire, 5 to 6 farmers complain of distance in travelling between plots, and 2 to 3 complain about inattention to crops. Nine out of 12 report differences in mean yields across plots, while 3 out of 12 are uncertain what the differences in these yields will be in a given year. Diversification of risk may be part, but perhaps only part, of the story behind multiple plot holdings. In Yang Pieng those with 2 plots can identify that mean yields are higher on one plot than the other. On the other hand, yields are said to go up and down together. Still, farmers complain about within-day commuting times and inattention to plots. Benefits, other than

risk diversification, which might counterbalance these costs remain to be explained.

In addition to farming, livestock can be a source of income for some farmers - again, see Table 2. For the household respondents in Maanajohn, 11 out of 13 have pigs ranging in number from 1 to 5 animals. These pigs are bought at prices ranging from 300 to 600 Baht and are sold at prices ranging from 900 to 1500 Baht, with higher prices for older, more mature animals. Pigs require some upkeep in terms of feed and labor, though numbers were not obtained in the survey. Two household respondents mention selling off cattle, while 2 are not involved in livestock in any way. Livestock holdings correspond roughly with these flows, with the exception that 2 to 3 farmers seem to have larger herds and that 2 farmers mention water buffalo as assets though these were not bought nor sold in the sample years.

In Yang Pieng all 4 landless and small holders buy and sell pigs in amounts ranging from 1 to 2 animals. The livestock holdings of these farmers are similarly small. Among the 3 larger landholders, though, 2 buy and sell 3 pigs each year and 1 mentions 5 head of cattle. On the asset side, these same farmers hold from 1 to 4 pigs and from 4 to 57 head of cattle, much larger numbers than is indicated in the flows.

In Ba Pai farmers are not involved with livestock in any way.

In summary, and to develop more formal notation, in a "typical" northern Thai village of the survey livestock (L=livestock) can be distinguished by type b, for example, pigs, cattle, buffalo, and by age. Thus let $K^L_{bt}(j)$ denote a vector of livestocks of type b ordered by age at date t held by household j. Each livestock type is associated with a production function H^L_b mapping for each household (j) at any date t, a vector of capital livestock

inputs $K^{Li}_{bt}(j)$ along with labor inputs $a^{L}_{bt}(j)$ and non-labor inputs $b^{L}_{bt}(j)$ such as feed into a vector of livestock type b at date t+1, that is, capital output $K^{Lo}_{b,t+1}(j)$ and perhaps a vector of animal products $q^{L}_{b,t+1}(j)$. The relation is summarized by production relation

(2) $H^{L}_{b}\left(a^{L}_{bt}(j),\ b^{L}_{bt}(j),\ K^{Li}_{bt}(j),\ K^{Lo}_{b,t+1}(j),\ q^{L}_{b,t+1}(j),\ \varepsilon^{L}_{b,t+1},\ \eta^{L}_{t+1}\right)\geq 0$

This relation displays constant or diminishing returns to scale up to the aggregate shocks η^{L}_{t+1} and idiosyncratic shocks $\varepsilon^{L}_{b,t+1}$. These shocks allow for accidents, animal disease, and random breeding outcomes.

Prices $P_{Kt}(\eta^{K}_{t})$ of livestock assets at date t are taken as given by households but can vary not only for age and type of animals but with aggregate shocks η^{K}_{t}.

Price shocks η^{K}_{t} and production shocks η^{L}_{t+1}, and $\varepsilon^{L}_{b,t+1}$ can contribute to fluctuations in livestock earnings. However, households are not required to buy all livestock at the beginning of some date t and sell all of it at subsequent date t+1. Rather, at any date t, a household can continue to hold livestock K^{Lo}_{bt}, in effect selling it as an output at date t but immediately buying it back as an input at date t for production at date t+1. This simultaneous buying and selling would take place at the same price $P_{Kt}(\eta^{K}_{t})$ and would therefore not contribute to earnings. This, of course, allows household to sell and receive revenue from livestock when other sources of income are low. Whether or not this is done is something the survey attempts to measure.

The members of a "typical" village household can be thought of as endowed with time which can be used for leisure or various production activities. Among the latter, one would include some work in the local village economy or the local district economy. This kind of labor supply seems to vary over households depending on the household's holding of land. For example,

landless laborers seek full time employment out of the household all year either in the village or district economy. For others, labor employment can be an especially important source of income in the dry season, especially for households with nonirrigated plots. However, employment patterns across households in the dry season seem to vary across villages and districts: In Maanajohn, and Maajam district generally, employment tends to be local with jobs in the district forestry division, for example. In Yang Pieng, and Omgoi district generally, many households are not present in villages in the dry season, having migrated to Chieng Mai for construction. Households members in Ba Pai, and other commercial villages in Lee district, also seek alternative sources of employment in the dry season and can migrate as far as Bangkok.

Wages for these jobs can be regarded as taken parametrically by the households with $P_{at}(\eta_t^a)$ as the local, regional, or national market wage at date t, varying over dates and perhaps varying with some aggregate shock η_t^a. In Maanajohn the going wage at the time of the survey was 25 to 30 Baht per day. In Yang Pieng it was 30 to 35 Baht per day in the village, and reaching 50 Baht per day in Chieng Mai. In Ba Pai local wages reach 50 Baht per day and are higher in Bangkok, e.g. up to 75 Baht.

Out-of-household employment is not necessarily regular nor predictable. Employment possibilities seem to vary for reasons which are difficult to quickly model. One shock to labor supply is sickness. This can reduce an individual's time allotment or can otherwise draw working members of the household into health care activities. Two out of 4 households in Ba Pai and 2 of the 10 in Yang Pieng claim an incident of household sickness which substantially lowered their incomes.

More formally one can let $T[\varepsilon_t^H(j)]$ denote the time endowment of a

household (j), summed over all its members, as a function of idiosyncratic sickness shocks $\varepsilon_t^H(j)$ occurring at date t, with $\ell_t(j)$ as household j's leisure consumed. Then $\left(T(\varepsilon_t^H(j))- \ell_t(j)\right)$ represents labor available for labor supply.

In principle demographic shocks such as birth, deaths, marriages, and migration can also induce changes in household's consumption requirements and labor supply possibilities. Due perhaps to ambiguously worded questions, the survey was not successful in documenting systematic effects from such demographic events.

In addition to "regular" labor market activity one should stress also employment and income generating activities associated with the northern Thai forests. Illegal logging is an important source of income in Maanajohn, though this is increasingly difficult in the face of increased enforcement by forestry officials. In Yang Pieng some households note additional income generated from gathering bamboo and mushrooms. In Ba Pai logging, and the manufacture of furniture, is an important source of additional income. Forestry, and labor market activity generally, would seem to be a potentially important device to smooth fluctuations, especially in the dry season, when other sources of income drop.

For simplicity of notation let H^F denote a production relation for forestry products (F=forestry) mapping a given household (j)'s date t labor inputs $a_t^F(j)$, nonlabor inputs $b_t^F(j)$, and capital inputs $K_t^{Fi}(j)$ such as saws into date t+1 outputs $q_{t+1}^F(j)$ and transformed capital stocks $K_{t+1}^{Fo}(j)$, subject to idiosyncratic shocks $\varepsilon_{t+1}^F(j)$ and aggregate shock η_t^F. Idiosyncratic shocks reflect random fines and imprisonment, and aggregate shocks reflect the weather or fires. The relation H^F is stated as

$$(3)\quad H^F\left(a_t^F(j),\ b_t^F(j),\ K_t^{Fi}(j),\ q_{t+1}^F(j),\ K_{t+1}^{Fo}(j),\ \varepsilon_{t+1}^F(j),\ \eta_t^F\right) \geq 0$$

The contribution of employment and forestry to income were noted in Table 2.

In addition to variable livestock, labor supply, and forestry activities, there are a variety of alternative mechanisms for smoothing income. One of these is storage of rice, often the dominate crop. Let $S_t(j)$ denote the number of units of rice put into storage by household j at date t-1, delivering units of rice available out of storage at date t in amount $(1-\delta)S_t\varepsilon_t^S(j)$. Here δ may be viewed as a common or average depreciation factor and $\varepsilon_t^S(j)$ as an idiosyncratic shock to household (j)'s storage at date t. Both δ and the $\varepsilon_t^S(j)$ capture the effect of rodents, mildew, etc. The net depreciation factor inclusive of shocks from the household survey is .027 in Maanajohn and .032 in Yang Pieng, with the positive and negative shocks $\varepsilon_t^S(j)$ around this number. Storage is never productive, and the gross depreciation rate is bounded away from zero.

As will be noted below, households differ considerably in their use of storage. There are households who begin to store rice at the harvest date of the rainy season, dates t=2, 6, 10 and so on. Not a small number of households run out of rice anywhere from 2 to 12 months after harvest, in date 3, 4, 5, or 7, 8, 9, and so on. A rare household in a good year may make it to next year's harvest, and a few households may sell rice at the harvest date or sell out of stocks.

A "typical" household can also transfer resources to the future by saving. Rates for saving outside the village in either savings banks, local agricultural cooperatives, or with the Bank for Agriculture and Agricultural Cooperatives (BAAC) are fixed more or less over time at something like 12 percent per year, denominated in currency. That is, with $L_{t+1}(j)$ as loans or savings made at date t, coming in at date t+1, $(1+r^{\ell})\ L_{t+1}(j)$ would be the

receipts in interest and principle at date t+1.

One way to bring resources forward from the future to the present, that is, from t+1 to t, is to borrow. Yet, with rare exceptions, the sources of loans outside the village are for borrowing for inputs, either from agricultural cooperatives, the local agricultural extension officer, or the BAAC. On occasion an Ngo or government group will allocate cash or rice into a local fund for eventual repayment within the year, as with housewife funds, or allocate rice as a lump sum grant with no obligation of repayment, as with rice banks. In general, then, ignoring these special cases, let $B_{t+1}(j)$ denote the amount borrowed by household j at date t denominated in currency, for repayment at date t+1 in amount $(1+r^{b})B_{t+1}(j)$ inclusive of principle and interest. Rates for such input loans range up to 16 percent, varying across farmers in the survey. In general there is a spread between the borrowing rate and the lending rate mentioned earlier. Further, in borrowing for inputs the household (j) in effect faces a constraint of the form

$$(4)\quad P_{bt}(\eta_t^b)\bar{b}_t(j) \geq B_{t+1}(j)$$

That is, the household must be able to claim that borrowings $B_{t+1}(j)$ were for inputs use $\bar{b}_t(j)$; borrowings can not exceed the value of input use.

Finally, not all households can borrow in the manner described above. In particular, land title may be required by the local BAAC officer, and farmers in many of these mountain villages have at best land use certificates. Other requirements from the BAAC may include asset holdings, and involvement in cash-crop farming. In practice access to loans also varies across villages. In Maanajohn the local agricultural cooperative supplies pesticides, fertilizer and herbicides. In Ba Pai the BAAC provides loans, but only to

subsets of farmers; most of the farmers in Ba Pai finance inputs with cash. In Yang Pieng there seem to be few sources of outside finance of any kind.

A third way of saving to smooth fluctuations is to sell crops for cash and accumulate the cash balances for future use. That is, converting all previous and future Baht prices in the text to rice prices by letting the price of rice be the numeraire, let $P_{Mt}(\eta_t^M)$ denote the rice price of money at date t. Money $M_{t+1}(j)$ stored by household j at date t for use at date t+1 yields $P_{M,t+1}(\eta_{t+1}^M)M_{t+1}(j)$ units of potential revenue at date t+1. More specifically, at date t, $\left[M_t(j) - M_{t+1}(j)\right] P_{Mt}(\eta_t^M)$ denotes purchasing power available at date t for household j from money decumulation. The negative rate of return on currency depends on the inflation rate, estimated in Thailand at 9% per year during the years of the sample.

With rare exception, there is little provision for insurance outside the village. Loans are due without contingencies and at best can be rolled over with additional interest as if taking a new loan. An exception concerns the relatively recent establishment of health care insurance plans in many of the villages. Under these plans, households contribute premiums payable in advance, and these entitle households to a specified number of prepaid treatments for sickness during the year.

To facilitate notation for the budget constraint, to be written down momentarily, labor inputs on land type ℓ, $a_{\ell t}^A(j)$, on animal livestock type b, $a_{bt}^L(j)$, and in forestry $a_t^F(j)$, are all assumed to lie in the same space. That is, labor units are identical and can be added, as will leisure units below. Similarly, one can deliver an ordered vector of nonlabor inputs $b_{\ell t}^A(j)$, $b_{bt}^L(j)$, $b_t^F(j)$ in agriculture, livestock and forestry, all now assumed to lie in the same vector space. Thus there is a component for pesticide in each of

the three vectors, though this must be zero in livestock, for example. Similarly, capital input vectors $K^{Ai}_{\ell,t}(j)$, $K^{Li}_{b,t}(j)$ and $K^{Fi}_{t}(j)$ in all 3 sectors and capital outputs $K^{Ao}_{\ell t}(j)$, $K^{Lo}_{bt}(j)$, $K^{Fo}_{t}(j)$ in all 3 sectors are all assumed to lie in the same vector space. Similarly, expanded output vectors $q^{A}_{\ell,t+1}(j)$, $q^{L}_{b,t+1}(j)$, $q^{F}_{t+1}(j)$ in all 3 sectors are assumed to lie in the same vector space, as will be consumptions below.

The notation for prices given earlier is presumed now to apply here with the difference, for example, that $P_{qt}(\eta^{q}_{t})$ is a vector with as many components as the $q_t(j)$ is above and that, as noted, the rice price at date t is taken as the numeraire.

Each household j is presumed to care at each date t about consumption $c_t(j)$ and leisure $\ell_t(j)$. For simplicity, consumptions $c_t(j)$ are presumed to lie in the same space as the $q_t(j)$ and household leisures $\ell_t(j)$ have the same scalar units as labor time. Then utility is of the discounted time separable form, $E\sum_{t=1}^{T}\beta^{t}U^{j}\left[c_t(j),\ \ell_t(j)\right]$ where β is a common discount rate and E is an expectation operator over all shocks as specified above, to be made explicit again momentarily.

To proceed then to the date t, budget constraint for household j, add up all potential labor, nonlabor, and capital-livestock inputs at date t

$$(5)\quad \bar{a}_t(j) = \sum_{\ell} a^{A}_{\ell t}(j)N_{\ell}(j) + \sum_{b} a^{L}_{bt}(j) + a^{F}_{t}(j)$$

$$(6)\quad \bar{b}_t(j) = \sum_{\ell} b^{A}_{\ell t}(j)N_{\ell}(j) + \sum_{b} b^{L}_{bt}(j) + b^{F}_{t}(j)$$

$$(7)\quad \bar{K}^{i}_{t}(j) = \sum_{\ell} K^{Ai}_{\ell t}(j)\ N_{\ell}(j) + \sum_{b} K^{Li}_{bt}(j) + K^{Fi}_{t}(j)$$

and add up outputs of product and capital at date t+1,

$$(8)\quad \bar{q}_{t+1}(j) = \sum_{\ell} q^{A}_{\ell,t+1}(j)N_{\ell}(j) + \sum_{b} q^{L}_{b,t+1}(j) + q^{F}_{t+1}(j)$$

$$(9)\quad \bar{K}^{o}_{t+1}(j) = \sum_{\ell} K^{Ao}_{\ell,t+1}(j)\, N_{\ell}(j) + \sum_{b} K^{Lo}_{b,t+1}(j) + K^{Fo}_{t+1}(j)$$

Now suppose, momentarily, that household (j) lives in autarky, even within the village, and can at most smooth by using labor supply, livestock, storage, borrowing and lending, and currency accumulation. That is, in the absence of internal village insurance-credit schemes, the relevant budget constraint for household (j) for each date t is of the form, expenditures on consumption and inputs equals revenue from output and from capital sales plus revenue from storage plus revenue from market labor supply

$$(10)\quad P_{qt}(\eta^{q}_{t})c_{t}(j) + P_{Kt}(\eta^{K}_{t})\bar{K}^{i}_{t}(j) + P_{bt}(\eta^{b}_{t})\bar{b}_{t}(j) + P_{at}(\eta^{a}_{t})\bar{a}_{t}(j) = P_{Kt}(\eta^{K}_{t})\bar{K}^{o}_{t}(j)$$
$$+ P_{qt}(\eta^{q}_{t})\bar{q}_{t}(j) + (1-\delta)S_{t}(j)\varepsilon^{S}_{t}(j) - S_{t+1}(j) + P_{at}(\eta^{a}_{t})\left[T(\varepsilon^{H}_{t}(j) - \ell_{t}(j)\right]$$

plus an increment from new borrowing, less losses due to loans out, plus revenue from money decumulation

$$+ \left[B_{t+1}(j) - (1+r^{b})B_{t}(j)\right] P_{Mt}(\eta^{M}_{t}) - \left[L_{t+1}(j) - (1+r^{\ell})\, L_{t}(j)\right] P_{Mt}(\eta^{M}_{t})$$

$$+ \left[M_{t}(j) - M_{t+1}(j)\right] P_{Mt}(\eta^{M}_{t})$$

Note as special cases that at input dates 1, 3, etc. there is no output from agriculture, and at output dates t=2, 4, etc. there are no inputs into agriculture.[22]

[2]Thus far we have emphasized only three villages, one for each district. Despite important similarities, there are also important differences across villages within the same district. For example, Ban Pong in Omgoi is striking in contrast with the benchmark village of Yang Pieng. There is little labor migration during the dry season, with many adult males present in the village in the month of January and February, willing to be interviewed. Similarly, residents in Ban Pong hold plots quite distant from the village, presumably because it was founded as a village separately from Ban Luang only 50 years ago or so. Meanwhile, Ban Luang has some land fragmentation as well. Not unrelated, perhaps, households in Ban Pong seem able to borrow outside the village, from residents or institutions in Ban Luang.

More extreme contrasts abound in Maajaam with the village of Mae Wak running a rice surplus. It has become something of a local financial center, financing villagers (even some in the survey) from nearby Maanajohn and Sop Wak. In general financial institutions vary a lot across villages. More on

4. Pareto Optima for the Village Economies

Households need not live in isolation, each with its own budget constraint. In theory, and perhaps in practice, credit and risks can be pooled, either informally as in relations among friends and family, or formally as in credit markets or quasi-formal village institutions.

To solve for the consumption, leisure, production, storage, asset and credit allocations which are Pareto optimal in the village economies one needs to enumerate the set of all possible states of the world, i.e., realizations of all random variables. One can then talk about transfers of resources conditioned on these states.

A state is characterized in part by the realizations of aggregate shocks pushing district level prices, specifically η_t^M, η_t^K, η_t^b, η_t^q, η_t^a for the price level, capital, nonlabor inputs, outputs, and labor. There are also aggregate village shocks η_t^A, η_t^L, η_t^F for agriculture, livestock and forestry activities. In addition there are shocks peculiar to land plots and livestock types $\varepsilon_{\ell t}^A$, ε_{bt}^L, over all land types ℓ and livestock types b. Finally, a state for a particular village economy must also include realizations of the idiosyncratic household specific shocks $\varepsilon_t^H(j)$, $\varepsilon_t^S(j)$, $\varepsilon_t^F(j)$, $j=1,2,\ldots,N$ for health, storage and forestry activities. One can then let ε_t denote the <u>entire</u> vector of <u>all</u> these shocks, aggregate and idiosyncratic inclusive. State ε_t completely describes the realizations of all random variables relevant to a given village economy.

With this notation consumption and leisure of household (j) should be

this below.

In district Lee, Ba Pai is more in the commercial economy than are the two off-the- road villages of Gong Wah and Mae Wah. The latter two villages grow soy beans, primarily, and seem to rely heavily on the forests. Dry season out migration in these two villages seems limited relative to Ba Pai.

indexed by the entire contemporary state ε_t and the entire prior history $(\varepsilon_1,\ldots,\varepsilon_{t-1})$. That is, write $c_t(j)(\varepsilon_1,\ldots,\varepsilon_t)$ and $\ell_t(j)(\varepsilon_1,\ldots,\varepsilon_t)$. Let $\text{prob}(\varepsilon_1,..,\varepsilon_t)$ denote the probability of this entire vector, as of some planning date t=0, allowing for arbitrary serial correlation or other stochastic processes. The discounted expected utility for household (j) is then just

$$(11)\quad \sum_{t=0}^{T}\beta^t \sum_{(\varepsilon_1,\ldots,\varepsilon_t)} \text{prob}(\varepsilon_1,\ldots,\varepsilon_t)\, U^j\left[c_t(j)(\varepsilon_1,\ldots,\varepsilon_t),\ell_t(j)(\varepsilon_1,\ldots,\varepsilon_t)\right].$$

The search for Pareto optimal allocation can then be conducted by maximizing ω^j- weighted sum of the utilities

$$(12)\quad \sum_{j=1}^{N}\omega^j\left[\sum_{t=1}^{T}\beta^t \sum_{(\varepsilon_1,\ldots,\varepsilon_t)}\text{prob}(\varepsilon_1,\ldots,\varepsilon_t)U^j\left[c_t(j)(\varepsilon_1,\ldots,\varepsilon_t),\ell_t(j)(\varepsilon_1,\ldots\varepsilon_t)\right]\right.$$

subject to the relevant budget and technology constraints. At the moment the ω^j- weighted sum captures household (j)'s relative weight in the village economy, say its status or rank. Subsequently, the weight ω^j will be linked to household (j)'s wealth at market prices.

The ε_t state-space notation can, at times, be misleading. In practice the income of any particular household is determined by a <u>subset</u> of shocks only. For example, total output for household (j) at date t+1, $\bar{q}_{t+1}(j)$, is a function of aggregate shocks, η^A_{t+1}, η^L_{t+1}, η^F_{t+1} as well as some, but only some, land type ℓ and livestock type b shocks, namely the $\varepsilon^A_{\ell,t+1}$ and $\varepsilon^L_{b,t+1}$ over land types ℓ and livestock types b actually held at date t by household (j). Similarly, some price shocks do not matter to household j if it is not hiring the relevant inputs or producing the relevant outputs. Of course idiosyncratic shocks for sickness, storage and forestry are household specific, only.

But this is precisely the power of the state space notation. Resource transfers and hence consumptions can be made contingent on the entire state $\varepsilon_1,\ldots,\varepsilon_t$, in effect providing (partial) insurance against shocks which might move one household's income around but not another's. A Pareto optimum would then describe the state-contingent allocations in which no further transfers to one agent from other agents are welfare improving.

Because in an optimum resources can be moved around among households, the relevant budget constraint for the entire village economy is the sum over (j) of the household (j) specific autarky budgets constraints (10) described above. The village as a whole must finance its deficit or save its surplus in some way. This is captured by this aggregate budget. Notationally, adding up these budgets and suppressing the household (j) notation where possible delivers the aggregate budget constraint at date t:

$$(13)\quad P_{qt}(\eta_t^q)\,\bar{c}_t + P_{Kt}(\eta_t^K)\,\bar{K}_t^i + P_{bt}(\eta_t^b)\,\bar{b}_t + P_{at}(\eta_t^a)\,\bar{a}_t = P_{Kt}(\eta_t^K)\,\bar{K}_t^o + P_{qt}(\eta_t^q)\bar{q}_t + (1-\delta)\sum_{j=1}^{N} S_t(j)\varepsilon_t^S(j) - \sum_{j=1}^{N} S_{t+1}(j) + P_{at}(\eta_t^a)\Big[\sum_{j=1}^{N}\Big[T(\varepsilon_t^H(j)) - \ell_t(j)\Big] + \Big[B_{t+1} - (1+r^b)B_t\Big]\,P_{Mt}(\eta_t^M) - \Big[L_{t+1} - (1+r^\ell)\,L_t\Big]\,P_{Mt}(\eta_t^M) + \Big[M_t - M_{t+1}\Big]\,P_{Mt}(\eta_t^M)$$

and aggregate credit or financing constraint

$$(14)\quad P_{bt}(\eta_t^b)\,\bar{b}_t \geq B_{t+1}\,P_{Mt}(\eta_t^M).$$

These aggregates are easily defined by

$$(15)\quad \bar{c}_t = \sum_{j=1}^{N} c_t(j), \quad \bar{K}_j^i = \sum_{j=1}^{N} \bar{K}_t^i(j), \quad \bar{K}_t^o = \sum_{j=1}^{N} \bar{K}_t^o(j)$$
$$\bar{b}_t = \sum_{j=1}^{N} \bar{b}_t(j), \quad \bar{a}_t = \sum_{j=1}^{N} \bar{a}_t(j), \quad \bar{q}_t = \sum_{j=1}^{N} \bar{q}_t(j)$$

All household equations (5)-(9) above remain intact and will not be repeated

here. In addition, of course, all household production relations (1)-(3) above remain intact and need not be repeated.

The entire class of Pareto optimal allocations can then be delivered by maximizing equation (12) subject to aggregate budget constraints (13), aggregate credit constraint (14), production relations (1)-(3) for every (j), aggregate definitions (5)- (9) for every (j) and aggregate relations (15). In so doing it should be understood that all choice variables are indexed at date t by state $(\varepsilon_1,\ldots,\varepsilon_t)$, so in effect we are planning <u>date and state contingent choices</u>. By the same logic there are constraints at date t for all states $(\varepsilon_1,\ldots,\varepsilon_t)$.

The optimum can be interpreted as something which might be sustained among family and friends or large informal networks of village residents. It is something that can be sustained with state-contingent transfers for the group as a whole, respecting the village-wide resource constraint.

Rather dramatic implications turn up immediately from the first-order conditions to this problem. First, among these are relations pinning down consumptions and leisures, assuming no binding corner constraints for consumptions $c_t(j) \geq 0$ and leisures $0 \leq \ell_t(j) \leq T(\varepsilon_t^H(j))$.
Specifically,

$$(16)\quad \omega^j\beta^t \text{ prob}(\varepsilon_1,\ldots,\varepsilon_t)U_c^j\left[c_t(j)(\varepsilon_1,\ldots,\varepsilon_t),\ell_t(j)(\varepsilon_1,\ldots,\varepsilon_t)\right] = \lambda_t(\varepsilon_1,\ldots,\varepsilon_t)\, P_{qt}(\eta_t^q)$$

$$(17)\quad \omega^j\beta^t \text{ prob}(\varepsilon_1,\ldots,\varepsilon_t)U_\ell^j\left[c_t(j)(\varepsilon_1,\ldots,\varepsilon_t),\ell_t(j)(\varepsilon_1,\ldots,\varepsilon_t)\right] = \lambda_t(\varepsilon_1,\ldots,\varepsilon_t)P_{at}(\eta_t^a)$$

where $\lambda_t(\varepsilon_1,\ldots,\varepsilon_t)$ is the date t, history $(\varepsilon_1,\ldots,\varepsilon_t)$ contingent Lagrange multiplier for the village budget constraint at date t and state $(\varepsilon_1,\ldots,\varepsilon_t)$.

From (16) and (17) it is apparent that at any date t and state $(\varepsilon_1,\ldots,\varepsilon_t)$ the weighted marginal utilities across households for consumptions and leisures are equated across households to a common margin utility of income. Thus, there is a surprising degree of coinsurance across households. Shocks of various kinds which impact on one household's income but not another's nevertheless should determine virtually all households' consumptions and leisures. Certainly households with identical ω^j-weights and utility functions should bear identical consumption and leisure profiles over time and over shocks despite the existence of shocks which are not necessarily identical among them and despite potential differences in landholdings, contemporary stocks, production choices, prior savings, etc. Even if ω^j-weights of 2 households differ one from the other, these weights determine differences in levels of consumption and leisure of entire time profiles. Essentially, aggregate consumption and aggregate leisure determine household (j) specific consumption and leisure, allowing for variation in level effects. Household (j)'s income at date t determines its consumption and labor supply at date t only through these aggregates. For example, if utility functions are separable in consumption and leisure and of the exponential or power form then either household (j)'s consumption or the log of household (j)'s consumption is a fixed fraction of aggregate consumption or the log of aggregate consumption, respectively. When aggregate consumption moves up, so should a scale downed version of household (j)'s specific consumption, and similarly for leisure. Household (j)'s consumption should not respond to household j's income beyond the effect of these aggregates. Thus household (j)'s specific income shock should not move household (j)'s consumption if household (j) is small and its shocks are uncorrelated with village shocks.

Alternatively, all shocks should be shared in consumption even if not all shocks are shared in production or in the determination of income.

A point closely related is that the marginal rates of substitution are driven into equality across all households in an optimum. For example, with one good, rice, one gets from (16)

$$(18)\quad \frac{\beta^t \text{prob}(\varepsilon_1,\ldots,\varepsilon_t)U_c^j\left[c_t(\varepsilon_1,\ldots,\varepsilon_t),\ \ell_t(j)(\varepsilon_1,\ldots,\varepsilon_t)\right]}{\beta^{t+1}\text{prob}(\varepsilon_1,\ldots,\varepsilon_{t+1})U_c^j\left[c_j(\varepsilon_1,\ldots,\varepsilon_{t+1}),\ \ell_{t+1}(j)(\varepsilon_1,\ldots,\varepsilon_t)\right]} = \frac{\lambda_t(\varepsilon_1,\ldots,\varepsilon_t)}{\lambda_t(\varepsilon_1,\ldots,\varepsilon_{t+1})} \qquad j=1,2,\ldots,N.$$

for all dates t, t+1 and histories $(\varepsilon_1,\ldots,\varepsilon_t)$, $(\varepsilon_1,\ldots,\varepsilon_{t+1})$.

As is apparent from (16) and (17), the variable which determines household specific consumptions and leisures is the variable $\lambda_t(\varepsilon_1,\ldots,\varepsilon_t)$, the marginal utility of income. Marginal utility of income in the village is determined endogenously in the village by choices over village-wide storage, debt, lending, and currency options and by choices in production. One would not expect the marginal utility of income in a village to be constant over dates and states; clearly there are aggregate village level shocks to technology and prices and there is a limited degree of outside insurance. Village smoothing takes place at some cost. Nevertheless, some *ex post* smoothing can be anticipated.

Specifically, from the storage of rice one obtains first-order conditions at date t and history $(\varepsilon_1,\ldots,\varepsilon_t)$,

$$(19)\quad \lambda_t(\varepsilon_1,\ldots,\varepsilon_t) \geq \sum_{\varepsilon_{t+1}} \lambda_{t+1}(\varepsilon_1,..,\varepsilon_{t+1})(1-\delta)\varepsilon^s_{t+1}(j) \qquad j=1,2,\ldots N$$

from lending

$$(20)\quad \lambda_t(\varepsilon_1,\ldots,\varepsilon_t)\ P_{Mt}(\eta^M_t) \geq \sum_{\varepsilon_{t+1}} \lambda_{t+1}(\varepsilon_1,\ldots,\varepsilon_{t+1})(1+r^{\ell})P_{M,t+1}(\eta^M_{t+1})$$

from currency

$$(21)\quad \lambda_t(\varepsilon_1,\ldots,\varepsilon_t)P_{Mt}(\eta_t^M) \geq \sum_{\varepsilon_{t+1}} \lambda_{t+1}(\varepsilon_1,\ldots,\varepsilon_{t+1})P_{M,t+1}(\eta_{t+1}^M)$$

and from borrowing

$$(22)\quad \left[\lambda_t(\varepsilon_1,\ldots,\varepsilon_t)-\theta_t(\varepsilon_1,\ldots,\varepsilon_t)\right]P_{Mt}(\eta_t^M) \leq \sum_{\varepsilon_{t+1}} \lambda_{t+1}(\varepsilon_1,\ldots,\varepsilon_{t+1})(1+r^b)P_{M,t+1}(\eta_{t+1}^M)$$

Here $\theta_t(\varepsilon_1,\ldots,\varepsilon_t)$ is the Lagrange multiplier on the finance constraint (14).

The first three first-order conditions, (19), (20) and (21) are relevant when the village as a whole wishes to carry resources forward to the future in some form of saving. The inequality on each side reflects the fact that saving can not go negative. The marginal utility of present consumption can be greater than expected marginal utility of future consumption but it can not be less for otherwise there would be saving. However, even if there is saving in some form, all three equations are not likely to hold at equality. In fact, with lending rate $r^\ell > 0$, depreciation rate $\delta > 0$, and more or less stable prices it would seem that (20) would hold at equality with (21) and (19) at inequality, that is, with storage of rice and money holdings, at zero. Intuitively, one picks the most productive form of savings.

When the village as a whole wants to borrow, equations (19) through (21) would all hold at inequality and equation (22) may apply at equality. Indeed ignoring the finance constraint (14), for a moment, by setting $\theta_t(\varepsilon_1,\ldots,\varepsilon_t) = 0$, (22) states that borrowing B_{t+1} should equate current marginal utility to future expected marginal utility. In this sense borrowing for inputs may still allow consumption smoothing over some dates and states. However, at some dates and states, the solution with $\theta_t=0$ ignoring equation (14) may violate equation (14), i.e. the amount of borrowings that would be used to

smooth consumption is greater than that consistent with the value of financial inputs. When this happens equation (22) will hold at equality but θ_t will be positive. The marginal utility of present consumption λ_t can exceed the future expected marginal utility but is impossible to finance this consumption with borrowing. In this sense the finance constraint limits consumption smoothing. The finance constraint will also have implications for financing production as indicated below.

Only the aggregate finance constraint (14) is imposed in the optimum problem, not individual constraints

(4) $P_{bt}(\eta_t^b)\bar{b}_t(j) \geq B_{t+1}(j)P_{Mt}(\eta_t^M)$.

For suppose constraints (4) were imposed over all households (j) and at the supposed optimum one household is slack, so that the value of its input use exceeds its borrowings, while for a second household the constraint is at equality and it would like to borrow more for consumption smoothing then the value of its inputs allows. Technically, the second household can not do this borrowing from outside sources. But the first household could borrow more since its input use allows it, and this first household could then transfer these resources to the second household for consumption. This does not violate the terms of any outside lender because both households apparently are borrowing to finance inputs.

Related, household specific strategies for smoothing household specific incomes fluctuations no where enter the analysis explicitly. The village level savings and borrowing decisions are determined at the village level taking into account shocks over all households simultaneously. It matters little in fact at the village level how these saving and debt decisions are

accomplished over households as long as they sum up correctly to the desired village level aggregates. Internal redistribution can be achieved with transfers.

Conditions for efficiency in production are also easily determined. As an example, one could consider the marginal product of labor in land type ℓ held by some household (j). Conditioned on date t and state $(\varepsilon_1,\ldots,\varepsilon_t)$, first-order conditions appears as

$$(23)\quad \lambda_t(\varepsilon_1,\ldots,\varepsilon_t)P_{at}(\eta^a_{t+1}) = \sum_{\varepsilon_{t+1}} \lambda_{t+1}(\varepsilon_1,\ldots,\varepsilon_{t+1})P_{q,t+1}(\eta^q_{t+1}).$$
$$\cdot \frac{H^A_{\ell a}\left[\ldots a^A_{\ell t}(j)(\varepsilon_1,\ldots,\varepsilon_t),\ldots,\varepsilon_{\ell,t+1},\ \eta^A_{t+1}\right]}{H^A_{\ell q}\left[q^A_{\ell,t+1}(j)(\varepsilon_1,\ldots,\varepsilon_{t+1})\ \ldots,\varepsilon_{\ell,t+1},\eta^A_{t+1}\right]}.$$

Roughly speaking, the marginal cost of labor is equated to the expected marginal product of labor in output, with cost and benefits expressed in terms of the marginal utility of incomes. The point is that this equation holds over all households (j) who are farming land type ℓ, at date t and state $(\varepsilon_1,\ldots,\varepsilon_t)$, so that production efficiency is obtained over type ℓ technologies independent of a household's wealth or ω^j-weight.

Similar equations hold, of course, over inputs and livestock production. Indeed, livestock choices can be viewed both as input, output choices and as a way to transfer income over time, as with savings and borrowing described above. That is, at date t and state $(\varepsilon_1,\ldots,\varepsilon_t)$,

$$(24)\quad \lambda_t(\varepsilon_1,\ldots,\varepsilon_t)P_{K_b}(\eta^K_t)=\sum_{\varepsilon_{t+1}} \lambda_{t+1}(\varepsilon_1,\ldots,\varepsilon_{t+1})P_{K_{bt+1}}(\eta^K_{t+1})$$
$$\cdot \frac{H^L_{b,K^i_{bt}}\left[\ldots,K^{Li}_{bt}(j)(\varepsilon_1,\ldots,\varepsilon_t),\ldots,\varepsilon^L_{b,t+1},\eta^L_{t+1}\right]}{H^L_{b,K^o_{b,t+1}}\left[\ldots,K^{Lo}_{b,t+1}(j)(\varepsilon_1,\ldots,\varepsilon_{t+1}),\ldots,\varepsilon^L_{b,t+1},\eta^L_{t+1}\right]}.$$

Equations (24) add to or is at least are consistent with the determination of

Lagrange multipliers λ_t. Household specific livestock strategy should not be determined by household specific incomes.

A potential exception to production efficiency across households concerns nonlabor inputs b_t, as these may be constrained by credit. The relevant first-order condition for input use $b^A_{\ell t}(j)$ in land type ℓ for household (j) at date t and state $(\varepsilon_1,\ldots,\varepsilon_t)$ is

$$(25)\quad \left[\lambda_t(\varepsilon_1,\ldots,\varepsilon_t))-\theta_t(\varepsilon_1,\ldots,\varepsilon_t)\right]P_{bt}(\eta^b_t) = \sum_{\varepsilon_{t+1}} \lambda_{t+1}(\varepsilon_1,\ldots,\varepsilon_{t+1})P_{q,t+1}(\eta^q_{t+1})\frac{H^A_{\ell b}\left[\ldots b_{\ell t}(j)(\varepsilon_1,\ldots,\varepsilon_t),\ldots,\varepsilon_{\ell,t+1},\eta^A_{t+1}\right]}{H^A_{\ell q}\left[q^A_{\ell,t+1}(j)(\varepsilon_1,\ldots,\varepsilon_{t+1}),\ldots,\varepsilon_{\ell,t+1},\eta^A_{t+1}\right]}.$$

Suppose the finance constraint (14) is binding, i.e., $\theta_t(\varepsilon_1,\ldots,\varepsilon_t) > 0$. Then the marginal cost of input (narrowly defined) is greater than the expected future benefit, as if too much were used. In this sense the credit constraints hurts consumption smoothing and distorts inputs choices. Nevertheless, equation (25) still holds over all households (j) uniformly. Credit constraints do not impact on some households more than any other households regardless of any household's asset position, wealth, ω^j-weight, and so on.

A final implication of the optimum problem: if plot fragmentation is costly, then it should not be observed in the village economy. Households can achieve any optimal allocation of risk bearing by appropriate choices state contingent transfers, the difference between idiosyncratic incomes and state contingent consumptions. There is no sense in costly diversification of plot holdings for any given household; this consumes aggregate resources without an improvement in the risk bearing capabilities of the village as a whole. Similarly, if multiple rice varieties are costly, say a loss of gains

from specialization, then no one household should diversify. Only the village- wide composition of seed matters.

5. Achieving a Pareto Optimum with Market for State-Contingent Debt

The programming problem described in the previous sections makes vague references to transfers among family and friends and the use of village networks generally as mechanisms to achieve any particular optimum. In practice one would like to be more explicit about the mechanisms that are used and ask whether the markets or institutions actually observed in a village economy might be enough to achieve some optimum.

This is done as follows. Suppose we modify the autarky like individual household (j) budget constraints (10) by allowing household (j) to buy and sell two types of financial instruments at each date t and state $(\varepsilon_1,\ldots,\varepsilon_t)$. In particular let $d_{t+1}(j)$ denote debt acquired internally, within the village, by household (j) at date t with the state $(\varepsilon_1,\ldots,\varepsilon_t)$ implicit and let (1+r) $d_{t+1}(j)$ denote the obligation to repay principle and interest at date t+1. Rate of interest r will be chosen momentarily. Some households may borrow in this way whether for consumption or inputs while other households may lend. Also let $\tau(j)(\varepsilon_{t+1})$ denote an insurance indemnity, a payoff to be received at date t+1 under state ε_{t+1}. This claim is purchased at date t at internal village price $p_t(\varepsilon_{t+1})$. Price $p_t(\varepsilon_{t+1})$ at date t for payoffs under state ε_{t+1} at date t+1 will be chosen momentarily. Some households may purchase such claims; others may issue them.

One now need only append onto the right-hand side of the earlier autarky budget constraint (10) an additional term

$$(26)\quad \tau_t(\varepsilon_t)(j) - \sum_{\varepsilon_{t+1}} p_t(\varepsilon_{t+1})\tau(\varepsilon_{t+1})(j) + d_{t+1}(j) - (1+r)d_t(j)$$

As a matter of interpretation the term $\left[(1+r)d_t(j) - \tau_t(\varepsilon_t)(j)\right]$ in equation (26) as is interest payable on debt previously contracted at date t-1 but reduced by possible insurance indemnities coming in at date t and state ε_t. Alternatively, some household (j) might have saved (lent money) at date t-1 so that d_t is negative, and the term $\tau_t(\varepsilon_t)(j)$ might represent insurance indemnities paid out to others at date t and state ε_t, reducing receipts. Similarly, term $d_{t+1}(j) - \sum_{\varepsilon_{t+1}} p_t(\varepsilon_{t+1})\tau(\varepsilon_{t+1})(j)$ represents incoming resources contracted by a borrower at date t and state ε_t, with the debt reduced by the implicit purchase of insurance premiums also payable at date t. For savers $d_{t+1}(j)$ is negative as a resource outflow, though this outflow may be reduced in amount by the receipt of implicit premiums.

Maximization by household (j) with respect indemnities $\tau(\varepsilon_{t+1})(j)$ at date t yield first-order condition

(27) $p_t(\varepsilon_{t+1})\lambda_t^j = \lambda_{t+1}^j(\varepsilon_{t+1})$

where the λ_t^j are Lagrange multipliers for household (j)'s budget constraints at date t, implicitly a function of $(\varepsilon_1,\ldots,\varepsilon_t)$. Moreover, equations (27) hold over all households (j), and prices p_t are held in common. Thus ratios of household marginal utilities must be driven into equality under this credit insurance scheme as in (18). This is a big step toward achieving any one of the optima noted earlier. In particular, one can let the indemnity price $p_t(\varepsilon_{t+1})$ denote this common ratio of marginal utilities.

Maximization by household (j) with respect to internal village debt $d_{t+1}(j)$ yields a familiar interest rate equation

(28) $\lambda_t^j = \sum_{\varepsilon_{t+1}} \lambda_{t+1}^j(\varepsilon_{t+1})(1+r).$

Again this equation can be made to hold over all (j) by setting ratio of

marginal utilities equal to the common ratio of an earlier optimum. This pins down the internal village rate r.

In a competitive equilibrium with these security markets each household j would maximize discounted expected utility subject to its sequence of budget constraints (10) with (20) added on to the right-hand side and subject to technology constraints in production (1)-(3). As above, this would yield equations of the form

$$(29)\quad \lambda^j_t(\varepsilon_1,\ldots,\varepsilon_t)P_{at}(\eta^a_t)=\sum_{\varepsilon_{t+1}} \lambda^j_{t+1}(\varepsilon_1,\ldots,\varepsilon_{t+1})P_{q,t+1}(\eta^q_{t+1}) \cdot \frac{H^A_{\ell a}\left[a^A_{\ell t}(j)(\varepsilon_1,\ldots,\varepsilon_t),\ldots,\varepsilon_{\ell,t+1},\ \eta^A_{t+1}\right]}{H^A_{\ell q}\left[q^A_{\ell,t+1}(j)(\varepsilon_1,\ldots,\varepsilon_{t+1})\ ,\ldots,\varepsilon_{\ell,t+1},\eta^A_{t+1}\right]}$$

However, substituting $\lambda^j_{t+1}(\varepsilon_{t+1})$ from (27) into the right-hand side of (29) yields equation

$$(30)P_{at}(\eta^a_\tau)=\sum_{\varepsilon_{t+1}} p_t(\varepsilon_{t+1})P_{q,t+1}(\eta^q_{t+1})\cdot\frac{H^A_{\ell a}\left[\ldots a^A_{\ell t}(j)(\varepsilon_1,\ldots,\varepsilon_t),\ldots,\varepsilon_{\ell,t+1},\eta^A_{t+}\right.}{H^A_{\ell q}\left[q^A_{\ell,t+1}(j)(\varepsilon_1,\ldots,\varepsilon_{t+1})\ ,\ldots,\varepsilon_{\ell,t+1},\eta\right.}$$

This appears as a first-order condition for profit maximization when there are complete contingent claims market, so that the output q is sold forward at date t under each and every state ε_{t+1} at the date t price $P_t(\varepsilon_{t+1})$. In effect uncertainty is removed from profits by the existence of these forward contingent insurance markets.

This then gives us a way to attach revenues and costs to all future time and state contingent outputs and inputs over storage, agriculture, livestock, and forestry activities. The initial wealth of household j consists of the date t=0 value of these profits over all the technologies that it operates plus the discounted present value of its time endowment plus the value of its initial stocks of rice, money, and loans less initial indebtedness. As in a

virtually static household decision problem, this initial wealth determines household (j)'s marginal utility of income. Recall also that in a Pareto optimum levels of marginal utility of income were equated up to a scalar associated with household j's ω^j-weight. It is thus clear that in a competitive equilibrium wealths will pin down the ω^j-weights and vice versa, that is, any particular optimum requires a certain distribution of wealth.

Less obvious forms of insurance may be available in a typical village economy. Instead of trading at date t pure income transfer claims, payable at date t+1 under state ε_{t+1}, let any household (j) at date t trade claims on various mutual funds, that is, with the return on savings determined by the performance over a loan portfolio. These mutual funds thus may have state contingent returns depending the performance of loans. If the number of mutual funds with return vectors which are independent from one another equals or exceeds the number of states of the world, then a Pareto optimum can be achieved with these restricted funds. Note that savings funds in a village economy, funds which continue in existence from one date to the next, or may even accumulate in amount from date to date, can be interpreted in this way. A decision to retain savings in the fund is in effect a decision to reinvest the proceeds of fund returns at each relevant date. Borrowing from the fund may represent negative savings; it is the net position of the household which matters, that is, net holdings of the mutual fund. Alternatively, funds may be regarded as collections of securities, with savers paid out on average returns, while borrowers have loans (partially) forgiven contingent on their idiosyncratic income shocks. In this latter case there is a reason to distinguish the borrowing position of a given household from its savings position since it is holding different securities.

Again, one only needs securities for each household which are sufficient to span the space of all possible returns.

6. Taking the Full Insurance, Full Information Prototype to Data from the Village Economies

As noted then in Section 3 on the environment, each village is beset with idiosyncratic and aggregate shocks which are the cause of fluctuations in household income. The two theory Sections, 4 and 5, make predictions about the nature of responses to fluctuations on the presumption that allocations are to be Pareto optimal. In turn, the household questionnaires attempts to measure actual household responses. This section reports on these responses and then goes on to see if measured responses are consistent with the predictions of theory.

6.1 Response Patterns in a Benchmark Village - Yang Pieng

Though observed risk response patterns differ somewhat across villages, the basic pattern is illustrated by a review of the household questionnaires from Yang Pieng. Exceptions in other villages and regions can then be noted.

As noted earlier, four of the seven household respondents in Yang Pieng get their basic income in rice from either small landholdings, e.g. two rai, or from labor income. The four list their current income at 104, 100,70, and 50 tang. The difference between their best year and worst year is 24, 20, 0 and 20 tang. Thus all but one of these small lesser households experienced fluctuations in the order of 20 to 40 percent. The claimed principal response to these fluctuation by all but one household is to work harder in the labor market. Yet none of them are actually able to document differences in days worked in good and bad years. Indeed, when asked in detail, they say they always work hard every year, though this question may have been

inappropriately posed. Three of the four list hunting for plants in the woods as a secondary response. Two list getting help in gifts and loans as a secondary response. Actually, all four borrow in their worst year, either from relatives or from a village organization such as the rice bank or housewife fund. These loans range in rice from 20 to 45 tang, or in cash from 300 to 500 Baht. Thus at least half the fluctuation gap is filled, sometimes more than filled. Two of the households acknowledge lending to relatives in their best year, from 100 to 500 Baht, at zero and 2 percent interest per month, respectively. Conversations in the village confirmed that some households go for help first to relatives, yet others go only to one of the village institutions.

All four of these smaller households hold livestock, though three of the four have pigs which they claim to buy and sell in equal numbers every year. Only one of the four claims buying and selling livestock is a response to fluctuations. None of the four has rice in carryover after a good year, and all four run out of rice in the bad year, at 4, 8-9, 9, 5-6 months after harvest, respectively. Thus some have rice to get through the subsequent dry season, while others may get part way through the subsequent rainy season. None reach the next harvest.

In contrast, the other three household respondents in Yang Pieng have a basic rice income of 340, 600 and 200 tang, from 25, 10 and 4 rai, respectively. The difference between good years and bad years is 190, 450 and 40 tang, confirming large if not extraordinary fluctuations. The claimed principle response of two of the three is to sell livestock, and in fact all three have herds of buffalo ranging from 4 to 30 animals, as well as pigs. One of the households lists storage as a secondary response, and in fact all

three have carryover after a good year. Two of the three run out of rice in a bad year, after 10 and 11 months, respectively, relatively late, and one household never buys rice at all. Indeed, two of the three sold some rice in the current year. Only one of the three lists working harder as a response.

None of the three larger farmers got help in gifts in loans in bad years, neither from friends or relatives nor from a village institution. One did lend 20 tang to his mother in its best year, however. In the end only one of the three has managed to document a response which accounts for half of the income fluctuation gap.

According to theory, if there were complete markets or some other mechanism used to achieve a given Pareto optimum, then livestock and rice storage used by the relatively rich as smoothing devices should be determined by the entire state of the village economy, not necessarily by household specific income fluctuations. Of course, if household specific income fluctuations mirror aggregate fluctuations, the observations on livestock and rice storage are not inconsistent with the existence of an optimum. But, in fact, as was emphasized in the earlier section on the environment, good years and bad years are not coincident across households. That is, in a given year, a household with a relatively high income is accumulating rice and buying livestock while at the same time a household with a relatively bad year is decumulating rice and selling livestock. Actually, even this would be consistent with the implications theory if the net rice storage and livestock transactions were consistent with the predictions at the aggregate level. But these relatively rich households would still need to be linked up one with the other via loans or gifts in order for their consumptions to be consistent with the theory, that is, to comove with aggregate fluctuations. Imagine, for

example, that each of these larger households have identical ω^j-weights and utility functions. Then consumptions should be identical one with the other and comove together. In fact, it appears from the data that household consumptions comove with household incomes, in as much as reported transactions fail to cover half the income gap. Further, these relatively rich households report they are not much linked to other households via borrowing and lending and gifts, so there is indeed no mechanism in place, apparently, to allow the requisite transfers for consumption smoothing.

As noted, the relatively poor households in Yang Pieng do not smooth their income fluctuations with asset transactions. That, however, is not inconsistent with the theory which makes no predictions about who is doing those transactions, that is, who is doing the storing. In fact, the relatively poor respondents are all linked to the local loan market via savings and borrowing, so in principal they have access to storage being provided by some of the others. That is, in a bad year they may borrow from this storage and in a good year save and in effect invest in storage. The lenders themselves with storage facilities might view storing and lending as alternative modes of smoothing. The fact that the relatively poor households claim transactions to smooth up to half of their income gap would seem to suggest that consumption in the end is not fluctuating much. Though this is good for them individually, the situation would not be Pareto optimal for the village as a whole if the relatively rich in Yang Pieng are left with fluctuating consumptions.

More challenging to the predictions of the theory are the observations on labor supply. Subject to measurement problems the claimed principle response to bad years by the relatively poor is to work harder. If bad years are not

coincident, then labor supplies and hence leisures are not comoving as the theory predicts; again, imagine that all four households have the same ω^j-weight and utility functions. Further, the relatively rich never claim increased labor supply as a response to fluctuations, and so, again, this is hard to justify from theory. Being better off the relatively rich may indeed work less hard on average, that is, levels of leisure should be higher. Still, the relatively rich should suffer fluctuations in some proportion, that is, share fluctuations in aggregate labor supply to some degree holding, aggregate consumption fixed. Apparently, one needs to modify the theory to include some fixed cost to labor supply, perhaps to out-migration, to keep the relatively rich above some threshold, below which they would have worked harder by out-migration.

If being relative rich is measured by a household's assets at a point in time, as it is in the survey, and these assets have been accumulated from the past, then even the modified theory with a fixed cost to out-migration faces a contradiction. It should be a household's initial wealth or ω^j-weight that matters for levels of consumption and leisure, not assets accumulated over time.

Related, it appears that for the relatively poor the greater is storage the less is increased labor supply in the dry season, at least according to conversations in the village. Basically, households claim to work hard when they forecast that rice in storage is insufficient to get to next year's harvest. This links decreased labor supply to increased individual storage in a way that is inconsistent with the predictions of the theory. The theory supposes the existence of a loan market or gift-giving mechanism which intermediates storage over households in such a way as to make labor supplies

comove.

Part of the negative case against the theory is the apparent absence of an internal village mechanism to intermediate funds from relatively rich to relatively poor. One farmer in the village informed us that 11 or 12 larger landholders in Yang Pieng were still involved in personal lending, the headman and his brother among them. The sampling scheme here, unfortunately, was not designed explicitly to include or scrutinize lenders, and in practice their existence and identity can be difficult to determine. Still, suppose that the number of lenders in Yang Pieng is, in fact, as high as 12. From tax records held by the headman, we determined the number of households with landholdings over 5 rai. Among them there are 35 households with at least 10 rai and 86 with 6 to 10. It thus seems unlikely that all three of the interviewed relatively rich households of the survey, out of 86 to 121 possibilities, represented one of the 12 lenders who were concealing their lending activity. The reverse may be true, in fact, and if so the lack of intermediation from rich to the poor remains as an apparent fact.

From the point of view of village aggregates, village-wide storage and saving levels appear anomalous. Apparently, some of the relatively rich are savings funds in a nearby district town at 1 percent per month. At the same time, there is not a small amount of rice in storage in the village held by individual households and by the local rice bank. From the survey it seems rice depreciates in storage, 3.2 percent per year, so there appears to be a clear cut case of rate of return dominance even accounting for an average inflation rate of 9 percent, often less. Indeed, the theory as it stands predicts only one form of saving, presumably outside lending. Transactions costs and trips to the savings bank may help explain some within-year storage,

though consumption needs are fairly predictable. But apparently some rice is carried over from year to year.

Internally, within the village, interest rates are charged on rice bank loans. The interest rate for a one year loan is 50 percent for first time borrowers, 20 percent subsequently. Under the theory this relatively high rate would need to be justified by reference to equation (28) with high marginal utility of current consumption relative to the future. But, in fact, the rate is rarely altered despite apparently varying levels of consumption over time, as the village as a whole experiences income fluctuations. Many Yang Pieng farmers noted in the questionnaire that their consumptions did drop in a bad year.

Related, perhaps, the interest rate payment on rice bank loans is fixed, independent of the month when a household borrows, for example, 2 out of every 10 tang borrowed are due at harvest time as interest. Nor will early repayment before the next harvest lower the amount due. This seems peculiar if relatively low income households are running out of rice and are forced onto the labor market. There should, it would seem, be incentives for early repayment to facilitate labor smoothing for others. This effect would only be accentuated were the rice bank able to convert its depreciating rice to interest bearing cash savings.

The issue arises as to whether the rice bank or other village financial funds have implicit or explicit provision for insurance, as suggested by equation (26) above. Rice bank loans can be rolled over with the principal deferred for two years. An additional loan can be taken if interest is paid on the first. Beyond two years, loan privileges await eventual repayment. By and large, then, variable loan sizes are allowed, but there is little

provision for insurance. Still, an important exception emerged in conversations with the headman. If there is an insect problem, flooding, a bad crop year, or if a private residence burns down, then the terms of a loan can be modified at the discretion of the rice bank committee - 4 people - including the provision to charge interest. This more clearly resembles the insurance indemnities predicted by theory and is of potentially great importance.

Prepaid insurance premiums for externally provided health care also accumulate in a village health care fund during the year. The fund in Yang Pieng is more refined than in other villages, with some portion of the fund earmarked for lending for herbicide, a second portion for emergencies, and a third for health and sanitation. Loans are granted for the first two purposes at 2 percent per month. Notably absent, given the explicit insurance for health care, is insurance for other risks, say with yet higher premiums and pure, zero interest indemnities in emergencies. It remains to be determined if various emergency events are indeed underinsured in this village.

A housewife fund also grants loans at 2 to 3 percent per month, another source of externally provided funds relent in the village. Curiously, the housewife fund also encourages household savings, with the funds put out externally at the 1 percent figure noted earlier. The housewife fund, the rice bank, and the health care fund all appear to have internal rates of return higher than the external savings rate. Equations (19)-(21) from the theory thus dictate that there should be no external savings. One way to explain the anomaly is to suppose internal rates of return are not certain, due to default or the provision of insurance. With the exception of the rice bank, though, the extent of default and insurance is problematic. If rates of

return are reasonably certain, the anomalies persist. In fact, if the inequality in (20) is binding, this would suggest outside savings should be negative, that in effect funds should be borrowed at 1 percent and relent in the village. Though this is not possible it begs the issue of way there is not more intra village intermediation.

The theory also suggests that profit maximizing production decision can be separated from consumption decisions, specifically that all land plots of a given type should be farmed the same way independent of landholdings, wealth, assets, labor supply, or the risk responses of households, and whether or not households have access to external credit. The plot questionnaire for Yang Pieng picks up some differences in farming rice plots, specifically, as in Table 6 the use of buffaloes rather than motorized plows. There is great variation in the depth of plowing and seed planted per rai (as well as variation in the type of seed). Most farmers weeded twice but labor used per rai is not uniform; most but not all complain of some damage due to weeds. On the other hand, variations in water levels over plots might suggest there is insufficient control in the questionnaire for various land types; responses to water problems after seeding are quite mixed. Yet virtually all complain of rain which delayed or damaged the rice harvest. The use of pesticides, herbicides, and fertilizer is not at all uniform over rice plots as is apparent in Table 7. Striking in particular is the use of no pesticide (1 out of 5), little use of herbicide (3 out of 6), and mixed use of fertilizer (11 out of 16). When used, the amount of fertilizer and herbicide per rai also seems to vary.

The plot questionnaire also asks whether a given household would be willing to borrow more (presumably at prevailing interest rates) to finance

labor, fertilizer, or herbicide, that is, would profits be increased? Here 8 out of 12 farmers in Yang Pieng say yes that they are "credit constrained", three saying they fear debt, two saying they are not brave enough for the risk, two citing no place to borrow or lack of money, and one citing lack of experience in inputs. The theory which allows implicit or explicit insurance indemnities in effect prices out all risks in the village so that profits are a sure thing. The response to this problematic question thus seems inconsistent with theory if the market rate the respondents had in mind was the village rate. On the one hand, the village as a whole cannot make state-contingent loans from the outside, and this may be constraining. It might be noted that the funds from the relatively new health care fund are easily absorbed by willing borrowers for herbicide, a little used input.

6.2 A Well-Organized Village With Quasi-Formal Village Institutions - Mae Wak

No two villages in this study are alike. In particular, Yang Pieng can be contrasted with various other possibilities present in the village sample.

On one extreme lies Mae Wak, perhaps the most well-organized village in terms of quasi-formal village organizations. Differences in household responses to risk again show up in the questionnaires; some have livestock and carry over while some do not. Yet, unlike Yang Pieng, every single household in Mae Wak was contributing at least a small amount, often more, to the village savings fund. Thus in principle all households in the village are linked to one another through the fund. This may represent a key institutional mechanism to allow cross household intermediation.

Two features of the savings fund may present barriers. The first is that the fund is not to be used for consumption smoothing. Still, as is apparent from the theory, funds for consumption smoothing and for productive

investments are fungible within the household budget. In particular, consumption smoothing is allowed even with this restriction. Also, funds may be used for consumption after all, at least according to one villager.

The second constraining feature of the funds is that nominal borrowings are limited to 50 percent of a given household's savings, though all funds can be withdrawn on demand. Apparently, though, more can be borrowed from the fund if there are cosigners. So, in effect, for a given year, a given household may be a net debtor, as the theory requires. As noted, this may be essential to achieve a full allocation of risk bearing given diversity across households in income fluctuations.

Measured fluctuations in Mae Wak do not seem severe. Granting that, one can still set out in search of explicit or implicit insurance provisions in the various financial funds. Here a key feature emerges: there are multiple funds and two of them have state contingent returns. In particular, the savings fund pays off members' savings by computing returns per unit share. In the year prior to the survey the return was 15 percent. A housewife fund also pays off in earnings per share with a prior year return of 19 percent. The inference is that both returns are variable and contingent on project outcomes in the loan portfolio. There is also a fund to finance the purchase of pigs and a fund to finance the purchase of fertilizer, with apparently fixed rates of interest but some provision for roll over. As noted in the theory, if there are as many funds with state independent returns as there are states of the world, then market structure is complete. This leaves us with the possibility of counting states, which certainly must exceed three by a large margin or alternatively of asking again what, if any, implicit provisions for insurance for borrowers there are in the fixed loan funds.

As to the predictions of the theory that all farmers in Mae Wak should farm plots of a given type in the same way the sample is too sparse to say much at all. However, respondents seemed to indicate that they would not borrow more at prevailing rates. The headman assured us he was not interested in additional outside funds at 2 percent per month. The reason: not all internally generated funds are placed out in loans. Indeed, Ma Wak allows out of village residents to borrow from its rice bank savings fund and housewife fund if a village resident cosigns the loans. The total amount of such borrowings was estimated at 20,000 Baht, out of 160,000 in loans total. The survey itself seems to pick up one household in Maanajohn engaged in such borrowing from Mae Wak, and farmers in Sop Wak and a hill tribe village up the mountain confirmed in conversations that they visit Mae Wak for loans. Mae Wak thus represents a rare exception to the apparent lack of intra village intermediation.

6.3 Maanajohn and Ba Pai - An Evaluation of Informal Credit Markets in a Village Lacking Quasi-Formal Funds

On the other extreme, in contrast to Yang Pieng and Mae Wak, are villages like Ba Pai and Maanajohn. With the exception of a day care center in Ba Pai and a death benefit and health care fund in Maanajohn these villages have no quasi-formal village organizations whatever. A natural question to ask is whether quasi-formal organizations are needed, whether in fact traditional systems are good if not better.

Maanajohn, for example, was said by the headman to have 2 or 3 lenders, merchants willing to lend at 5 percent per month and little other borrowing. Yet the sample picks up what appears to be a nontrivial and more diverse internal credit market. Six out of 13 respondents to the household

questionnaire borrow in bad years, and two of these along with a third lend in good years. Six of these nine transactions have open-ended repayment, that is, with no time limit for repayment or have roll-over provisions. In the context of Maanajohn's risky environment these loans may have the necessary insurance contingencies. Loans are nontrivial in amount, up to 3000 Baht.

Still, the informal market in Maanajohn has its limitations. Though participants in the informal credit market also use currency, rice stocks, and livestock, and are able to smooth their fluctuations somewhat, the degree of insurance remains in doubt. Curiously, the interest rate for informal loans also varies considerably across households ranging from a zero percent loan to a sister or parents, up to 10 percent per month to nieces and nephews. Loans at interests of 3 and 5 percent to relatives, not just friends, are not uncommon in the sample, leaving the impression that interest rates are not low in the informal credit market in this village. The variations in interest rates over households might be explained by reference to informal lending as in the Pareto problem, as contrasted with formal lending in the complete markets competitive equilibrium specification. High nominal rates, however, may be inconsistent with consumption asset pricing, unless these loans are coupled with insurance premiums and indemnities, as noted above.

Beyond local credit market participants, the sample picks up 4 relatively small landholders or landless laborers who finance fluctuations by working harder, that is, individuals who are on their own and not linked up to lenders, or anyone else. Again, as in Section 6.1, this would seem to be inconsistent with an optimum with the difference here that it is the small households who remain unlinked, not the larger ones. The existence of small unlinked household lends credence to the idea that rice banks promoted from

the outside may help, that is, offer, Pareto improvement; idiosyncratic if not aggregate labor market fluctuations may be smoothed. There are also in the sample two larger households who appear isolated as in Section 6.1. And so, as with the analysis there, the informal credit market of Maanajohn appears inefficient in the allocation of consumption risk.

As far as investment of funds is concerned, Maanajohn farmers complain of a shortage of credit. Loans for fertilizer, herbicide and pesticide are available from the Agricultural Cooperative, but, as indicated in Table 7, many do not borrow for the pesticide and herbicide. All use fertilizer in some amount, either from the agriculture extension officer or the Cooperative. But 10 out of 12 say profits would go up with yet more fertilizer (3 and 2 farmers say the same for labor and herbicide, respectively). As for the reasons, 7 farmers say they don't want to brave the risk, 1 says he fears debt, 1 says credit from the Cooperative is limited, 1 says there is no place to borrow, and 1 says he just started using inputs. Almost no one has taken on the risk of new rice varieties, retaining the low but stable traditional variety, and plot diversification, quite marked in this village, seems costly. If diversification over land is a way to accommodate risk in the absence of improved institutions, this would be inefficient.

The second even more distinct village is Ba Pai in which there is little borrowing and lending in response to fluctuations. Two of the four interviewed households mention some borrowing. One of these is from some kind of fund, but conversations in the village picked up no organization whatever. The second household mentions a short one-month loan from a friend. Farmers in the village claim such lending was at 10 percent per month in response to crop shortfalls, when the farmer has an outstanding BAAC loan. Otherwise,

three of the four Ba Pai respondents have fluctuations which are absorbed, they claim, by working harder in bad years, which in this village they are able to document, or by cash savings and the sale of gold.

Of particular interest, two of the four farmers had been adversely affected by illness in their households, with shortfalls in income. The headman confirmed there is no health card system in this village, that only the very poor have access to free medical services. Indeed, he noted two or three cases of elderly in the village being abandoned by relatives, something one might have thought highly unusual for Thai society.

These observations support the hypothesis that Ba Pai is integrated into the cash economy but perhaps without much of a backup insurance system. At least the insurance system seems needed for incidences of illness. Whether or not it is needed for income fluctuations depends on the uniformity of these fluctuations. The fact that fluctuations are somewhat more uniform in Ba Pai than in the other villages of the survey suggests that accumulation and decumulation of assets may in fact accomplish much of the requisite consumption smoothing, that there would be only a small welfare loss due to an absence of insurance against idiosyncratic income fluctuations.

On the other hand, the 5 corn farmers in Ba Pai display some variation in farming techniques (see Table 6). Type of plow or hoe, depth, seed per rai, and weeding all seem to vary. There are relatively small variations in problems in timing and water. This might suggest credit is a constraining feature. There is some use of fertilizer (2 out of 4 farmers), pesticide (none), and herbicide (one). Yet only 1 out of 5 corn farmers claims to be constrained in credit. The two pepper farmers of the survey use fertilizer (two farmers), pesticide (one), or herbicide (one) and again both claim not to

be constrained in credit.

7. Modifications Suggested by Private Information Prototypes

For simplicity we consider a prototype village economy which is radically simplified on some key dimensions but which incorporates the possibility of private information. We shall then check to see if some of the observations for the village economy which are anomalous under full information can be explained in part by the introduction of private information and incentive problems.

To simplify we focus on aggregate production alone and drop the possibility of livestock and forestry activities. Further we focus on labor and nonlabor inputs, dropping all capital goods. Finally, we preclude the possibility of market labor supply so that households must work on their own plots and can not hire in labor. This makes the private information prototype to be described here close, if not identical, to some which have been studied extensively in the literature, and so the nature of solutions can conjectured without tedious, space consuming derivations.

A natural specification of uncertainly in the context of this private information environment is to suppose that each plot is special, with land type ℓ replaced by plot labeled ℓ. Suppose that each plot is subject to a specific idiosyncratic shock seen only by the household doing the farming on that plot. In addition there might be public shocks, such as the shocks for agriculture η_t^A discussed above. Public price shocks η_t^q, η_t^b and storage shocks $\varepsilon^S(j)$, $j=1,2,\ldots,\eta$ are all retained. Similarly, one might allow for some idiosyncratic sickness shock $\xi_t^H(j)$, $j=1,2,\ldots,\eta$. These shocks may also be private.

In the first private information model all plot specific inputs other

than labor and all outputs are presumed to be perfectly observed by everyone. A village-wide incentive constraint will then specify consumptions of households at input dates t=1,3,... and consumption at output dates t=2,4...in such a way as to induce households to choose specified labor inputs at date t=1,3,... Efforts are, of course, utility decreasing but some assigned or induced effort is optimal, as in standard principal agent problems. On the other hand, since labor effort must be induced, too much insurance or smoothing of consumption against plot-specific fluctuations can be bad. One's intuition is that plot-specific high outputs should be associated with high consumptions. More generally, a household's consumption rewards should be high when all available information suggests that household's labor effort was high. (See Hart and Holmstrom (1985), for example). Shocks which are public such as the η_t^A can be used in the inference problem. Certainly there is nothing to preclude publicly provided insurance against such shocks to the extent that landholdings are not uniform and shocks do not have uniform impact. Idiosyncratic plot specific shocks may be insured as well, but, again, because they are unobserved these are subject to an incentive problem.

Because the insurance problem is one of inducing effort while maintaining incentive compatible insurance, one would want to retain as much control over consumption as possible. This will mean that all other nonlabor inputs are assigned. In this first model this is possible because they are fully observed. Also, the "public authority" should retain all possible control over assets, money, and community storage as in a centralized programming problem. This is so that consumption to households can be assigned as a function of observed household outputs. (The necessity of this for an optimum is stressed in Fudenberg, Holmstrom, and Milgrom (1990) and Allen (1985).) Of

course to do this assigning of consumption to outputs it must be assumed that the household specific assets and saving transactions are all observed and controlled or are prohibited. In effect the only relevant budget constraint in this first model is the aggregate village-wide budget constraint, with all inputs assigned or induced and all consumption assigned as a function of vectors of observed plot outputs over all households and as a function of publicly observed shocks. No household is faced with an individual budget constraint in this first model.

The implications of this first model are strong. First, as has been indicated, there will not be complete risk sharing. That is, consumptions will not comove entirely with aggregate consumption, and individual incomes will, in part, determine individual consumptions. This may explain some of the anomalous risk sharing behavior in the villages described earlier. Related, input use including labor will be induced or assigned consistent with the incentive problems. As transfers, the difference between consumptions and outputs, are the cause of incentive problems, one would not expect households, even with identical ω^j-weights, to be farming the same way if their plot assignments differ. Similarly one would expect variations in farming practices across households with varying ω^j-weights.

Still, despite this diversity and absence of insurance, the model imposes strong refutable implications for observations. In particular, one would not expect households to be on their own entirely, with virtually no insurance at all from the rest of the community. In Phelan and Townsend (1991) only extreme limit points have this property, and these are achieved very slowly. Otherwise some links among households will be retained. Isolated households remain anomalous even in this private information world. Related, land

are observed and no outputs are observed. Then households will be given recommended actions for the entire vector of inputs at dates t=1,3,..., subject to the incentive constraints associated with consumption rewards at all dates. The true state for households at output dates 2,4,... would be the aggregated value of outputs, as output can be bought and sold at fixed district prices. This reduces the dimension of the state vector on which insurance transfers can depend to something like (reported) gross incomes across households, not the entire vector of outputs over all plots and over all households. In an information constrained optimum, households would make announcements of these gross incomes. Thus there would be a need for communication, and incomes could become known, at least to some, in this way. Also, each household would have now a separate budget constraint at each date, stating that the value of consumption and/or input expenditures can not exceed the value of assigned transfers plus the value of income. Still, with assets, storage and savings fully observed and under control of the "central planner" there would be no intertemporal links in these household-specific date-t budget constraints. Households would not make decisions concerning such storage and assets.

This second model also implies somewhat less *ex post* information on inputs, outputs and shocks because vector of inputs and vectors of outputs are fungible at given prices within the household budgets. Still storage and savings would be known, and there would be an active role for insurance provision in the village funds. Related, borrowing and lending among households after income realizations would be optimally controlled or prohibited altogether. Again, such market or network transactions only weaken the ability to control consumption and alleviate disincentive effects. Some

of these predictions seem at odds with the isolation of individuals and the "voluntary" nature of transfers, of borrowing and lending among some households.

A third model, again in an effort to weaken the strength of these implications, is to allow unobserved storage and asset transactions. In effect, this allows every household (j) to store, and to borrow and lend with the outside district economy, at prespecified rates. If it is known in related models that this can weaken the ability of households to insure fluctuations *ex ante*, and may yield something which is equivalent to pure borrowing and lending, with all households smoothing fluctuations on their own, either with assets or with credit market transactions. This would be consistent with the way some households seem to behave but would not explain, on the other hand, why some households do not use assets to smooth and have few, if any, links to internal and external credit.

8. An Attempt at Direct Measurement of Information and Communication

To see which, if any, of these private information models might be consistent with the information structure of the village economy an attempt was made at direct measurement of the information structure (subject to sampling problems). The idea was to see in particular which households know something about one another, to see which households know in some way or another something about their inputs, outputs and shocks in production and to see what, if anything, they know of each other's assets and smoothing decisions. Before presenting the data three caveats are in order, however.

1. The theory makes a distinction between what is known *ex ante* and what is inferred *ex post*. In practice if a household does know something it is difficult to find out exactly how this information was acquired. For example,

knowing inputs and outputs does not imply that there was no *ex ante* incentive information problem.

2. The theory as described above suggests controlled communication by households to and from a central planner,not necessarily among households themselves, though indeed a lot might be inferred. If a given household knows little about his neighbor, this may suggest only that information is not costless. One needs in general to trace out the entire network of information and communication across all households to really test the information theory described here. An exception is the existence of households who talk to no one. This is almost uniformly not consistent with the first two models.

3. The data appear at times to be consistent with subnetworks of individuals who know inputs and outputs of one another and are linked together via financing and credit arrangements, not unlike what the theory might suggest for the village as a whole. However, no theory of such subnetworks is offered in this paper.

The results, though mixed, seem to pick up a rough correlation between shared information, on the one hand, and the existence of informal markets or quasi-formal organizations, on the other, setting aside for the moment the issue of causation. One extreme data point is generated by Ba Pai. On the plot questionnaire 5 out of 7 farmers claim not to know inputs, crop operations, and outputs of farmers with nearby plots (see Table 8). Six out of 7 claim not to know about relatives, and 6 out of 7 not to know about friends. When pressed, all try to answer questions about a relative or friend, all with a nearby plot, and are able to name quantities or crop-plot conditions 45% of the time. On the household questionnaire, 2 out of 4 claim to talk to someone, and those taking know relatively little. Recall, of

course, that Ba Pai seems to be the most fragmented village of the survey in terms of credit and insurance.

Yang Pieng provides another extreme data point, with an information structure consistent with its organizations and credit markets. On the plot questionnaire 11 out of 16 claim to know about farmers with nearby plots (see Table 8). Eleven know something about a relative, 8 know about friends, and 2 know about people they lend to. All but 2 answer questions about someone with a nearby plot and the knowledge score is 59%. On the other hand, on the household questionnaire, 2 of the 3 larger isolated farmers are not talking. But, again, 3 of the 4 smaller interactive farmers are talking. Two of these smaller farmers say they know something about persons they borrow from or lend to. All persons who are talking to someone else are able to provide example information about that other person's assets, rice storage, and credit transactions.

Between these two extremes lie other villages. Maanajohn, with its informal credit market produces 8 out of 12 households on the plot questionnaire who know about farmers with nearby plots, and 9 out of 12 who know something about relatives (see Table 8). Curiously, only 2 know about friends. The knowledge score is a surprisingly high .83, but again 8 out of 12 answer questions about relatives, not friends. On the household questionnaire, 6 out of 7 farmers who are active in credit markets are talking to someone, more often than not with someone they borrow from or lend to. Two larger isolated farmers do not talk at all. On the other hand, 3 of the 4 small isolated farmers are also talking. Still, many farmers who are talking claim to know little or nothing. Only one or two seem reasonably well informed of livestock, rice storage, and borrowing-lending transactions. One

thus draws the impression that there may be more communication about plot operations than is necessary to support the existing informal credit market of this village, though knowledge of household smoothing is limited. Information may not be the only constraint on some credit market transactions within this village.

We are thus left with the conclusion that full information in a typical village economy is not automatic. The lack of information in a village could in principle act as a constraint on credit-insurance markets. Yet information has been acquired in many villages, often enough to support a variety of credit market transactions. Indeed, on occasion, information is acquired even though it seems not used. The problem of inference, then, is that information is endogenous, if not costly, acquired from a variety of sources for a variety of uses.

8. Conclusion

One draws the conclusion from the full information and private information models that the theory is useful in understanding the operation of village credit markets and quasi-formal village organizations. Certainly risk is a salient feature of these environments, inducing rather large fluctuations in household incomes. Given this, households struggle to smooth either by increased labor supply or by assets, livestock and storage facilities. Household specific consumptions probably do not move one to one with household specific incomes. In most but not all of the villages income fluctuations are not uniform across households and this is consistent with the rather heavy use of credit from the local informal market or from quasi-formal village institutions. Further, informal credit market terms and arrangements with quasi-formal institutions often display implicit if not explicit risk

contingencies allowing loans to be deferred or forgiven in the event of low incomes or idiosyncratic shocks. All of this is predicted by theory.

What is not predicted by full information theory would be the extent to which household consumptions are at least partially influenced by household specific income shocks, including sickness shocks, without intermediation via implicit or explicit insurance arrangements in the village. That is, markets or mechanisms seem incomplete along a variety of dimensions. Private information theories offer a partial remedy for some of the anomalies but not all of them. In particular the fact that some households remain relatively isolated from their neighbors, some of these households being rich and others poor, both failing to participate in local credit insurance markets, remains at odds with both theories. Further, the measurement attempted in the survey on information and communication suggests that information is endogenous with credit-insurance market participation and that both may be codetermined by factors left out of the models.

In particular, some villages appear more organized than others, jointly taking into account local informal credit markets and quasi-formal village institutions. Perhaps a few examples make the point and give direction for future research and policy efforts.

Mae Wak appears as the most well-organized village of the survey. There is a strong headman at the top, one who seems to have earned the respect of all the villagers. He in turn speaks well of the villagers and says they make decisions through a series of committees. There is an internal committee responsible for signs, voter registration, identity cards and marriage licenses; a development committee for the repair of bridges, fences and roads and for education about rice banks, new varieties, and equipment, arranging

seminars from local agricultural officials; a committee for health responsible for sanitation, medical supplies and children welfare, arranging checkups for village members; a committee for saving, responsible for overseeing the funds of the village organizations noted earlier; a social group responsible for livestock, the fish pond, use of vaccines, and the work of village members; and a committee for peace and security. There is, in addition, a youth group and a senior citizen's group, a weaving group, and a day care center. Of course Mae Wak's financial funds have been noted throughout the text: these include the rice banks, the savings investment funds, the housewife fund, the medical fund, the pig fund, and the fertilizer fund. More to the point, the headman claims that beyond the flexibility provided by the rice bank and fertilizer fund there is no problem in getting repayment of any loans. He likened this to a moral principle. The village as a whole is like a body with a good heart. Mae Wak has won all sorts of awards as a model village of development. The success of its organizations may be exaggerated, but the overall picture is indeed one of a tightly run village.

Sop Wak, down the road, offers an interesting contrast with Mae Wak. On the surface the structure is similar, with a series of overlapping committees dating back to the initiation of these groups under an army counter-insurgency program some 6 to 8 years ago. Nominally most of the funds exist in this village, but in fact there are problems. Perhaps the most serious of these is default, with several people defaulting on rice bank loans in the year prior to the survey. One of these households had left the village, leaving some relatives behind. The rice bank committee was currently negotiating with other defaulters. Default needs to be distinguished from the rolling over of loans, a practice which is not uncommon in Mae Wak and Sop Wak. Similarly,

the investment fund in Sop Wak suffers from two problems. One is getting members to contribute regularly, as promised, and the second, like the rice bank, is default. As a result of earlier defaults, the current rules in Sop Wak restrict a member's borrowing to 90 percent of investment principle, needing four cosigners of the loan willing to assume responsibility for repayment. As for repayment from past defaulters, the response from the committee was straightforward, "What are we to do? These are our friends."

The headman in Sop Wak is a nice, elderly gentleman who of late is much involved in the temple construction project, of great interest to the village. However, other organizing activities may be neglected. There were occasional complaints from other villagers of inactive leadership. The gap in leadership is filled to some extent by the assistant headman, a younger, more dynamic personality. But his ability to take the initiative is limited.

Other villages can be similarly classified. Yang Pieng, featured in the text, is well organized, though perhaps missing some beneficial exchange opportunities, as suggested in the text. Ban Pong and Ba Pai appear disorganized, one suffering from an apparently negligent if not corrupted headman and the other from lack of any organization at all.

The survey data and field research thus offer guidance for nongovernment and government organizations. As well organized villages with active headmen, Mae Wak and Yang Pieng would be easier to work with in conversations about potential internal improvements. These villages might also be selected as key villages in efforts to build an integrated regional financial system. Ban Pong an Ba Pai seem to have organization problems which need to be addressed before internal improvements are suggested. Alternatively, policy makers might offer substitutes to internal village structures in efforts to effect

improvements.

More generally, one needs to understand better what if any additional factors might explain the otherwise anomalous variations across households within villages and across villages within regions. Potential candidates include human capital, organizational capital, expectations, and limited legal systems. These features need to be incorporated into the models described in the text and better measured in extended surveys.

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Table 1

Names and Village Characteristics

Ampeur/Village	Number of Households	Principal Crops	Close to District or Outlying	Land Fragmentation	Quasi-Formal Organizations	Informal Credit	Enforcement Capital Problems
MAEJAM							
Bon Nah	130	Rice, Soybeans	Close	Yes	Yes	Yes	NA
Sop Wak	53	Rice, Soybeans	Mid	Yes	Yes	Yes	Yes
Mae Wak	60	Rice, Soybeans	Mid	Yes	Excellent	Yes	No
Maanajohn	328	Rice, Soybeans	Outlying	Yes	No	Yes	Yes
OMGOI							
Ban Pong	57	Rice, Tomatoes	Close	Some	Yes	No	Yes
Ban Luang	136	Rice, Tomatoes	Close	Some	Yes	Yes	NA
Yang Pieng	212	Rice, Tomatoes	Outlying	Some	Excellent	Yes	No
LEE							
Ba Pai	600	Corn, Peppers	Close	No	No	No	No
Gong Wah	130	Rice, Soybeans	Outlying	No	Yes	Yes	No
Mae Lan	NA	NA	Mid	NA	NA	NA	NA

Table 2A
Landholdings and Estimated Incomes
Maanajohn

Household Code Number	Household Size (Adults Children under 18)	Land (in Rai)	Wet Season Gross Income (Rice)	Dry Season Gross Income (Soybeans)	Crop Expenses	Livestock Income	Dry Season Labor Income	Other	Total in Baht	Income Per Adult (only) in Dollars
H-11	2	9	13,500	10,000	630	1,000			23,850	477
H-12	3 + 2	1-1/4	2,400	1,350	937	1,000	1,500		5,313	71
H-13	3 + 2	5	9,000	5,250	740	400	1,800		15,781	210
H-14	2 + 2	6	9,690	1,875	930				10,575	211
H-15	4 + 1	2-1/2	3,000	1,050	530	340			3,860	38
H-16	6 + 1	12	14,000	750	5,690	900	1,500		25,460	169
H-17	5 + 4	6	11,100	9,000	4,545	1,600			17,155	137
H-18	3 + 2	4	3,600	2,625	1,010	900			6,115	81
H-19	4 +2	5	10,560	3,750	4,560	1,800			11,550	115
H-20	5	2	9,400	1,275	1,240	200			8,035	64
H-21	3 + 2	21	10,500		1,920	900	7,200		16,680	222
H-22	4 + 4	3	3,600		325		600		3,875	38
H-23	3 + 3	2	2,400		275		7,200		9,325	124

Table 2B
Landholdings and Estimated Incomes
Yang Pieng

Household Code Number	Household Size (Adults + Children under 18)	Land (in Rai)	Wet Season Gross Income (Rice)	Crop Expenses	Livestock Income	Dry Season Labor Income	Other (Forest)	Total in Baht	Income Per Adult (only) in Dollars
H-34	6 + 1	25	10,200	1,000	2,400			11,600	77
H-35	3 + 4	4	6,000		750			6,750	90
H-36	2 + 2	2	3,600	570				3,030	58
H-37	2 + 3	3	4,500	600		2,000	400	6,300	126
H-38	2 + 2	4	3,600	175			500	3,925	79
H-39	2 + 1	0	3,000		700		800	4,500	90
H-40	2 + 2	10	18,000				1,000	19,000	380
H-41	2 + 1	0	2,100		600	7,500	1,500	11,700	234
H-42	2 + 1	0	1,500		300	3,500	400	5,700	114
H-43	2 + 1	2	3,120	45	300	6,000		9,375	187

Table 2C
Landholdings and Estimated Incomes
Ba Pai

Household Code Number	Household Size (Adults and Children under 18)	Land (in Rai)	Wet Season Gross Income (Rice)	Crop Expenses	Livestock Income	Dry Season Labor Income	Other	Total in Baht	Income Per Adult (only) in Dollars
H-50	1 + 2	1-3/4	2,562	210	0	8,000		10,352	414
H-51	2	2	0	1,120	0	7,000		6,880	138
H-52	2 + 2	8-3/4	640	4,320	0	13,620		9,940	198
H-53	7 + 2	10	7,200	2,175	0	16,500		21,525	123

Table 3A

Plot Characteristics
Maesajohn

Household Code	Landholdings (in Rai)	Distance and Direction From Village	Commuting Time	Crop - Wet Season, (Dry Season)	Soil Type	Slope	Upland/Lowland	Irrigation Status
P-10	5	3 Km N	1/2 hr.		Good	Slight	Upland	Stream
	3	3 Km N	1/2 hr.		Good			
	6	3 Km N	1/2 hr.		Good			
P-11	5	1 Km NW	20 Min.	Rice (Soybeans)	Bad	Steep	Paddy	Stream
P-12	5	3 Km N	>1 hr.	Rice (Soybeans)	Ok	Slight	Paddy	Stream
	5	3 Km N		Rice			Upland	
	8	2 Km N		Rice			Upland	
P-13	4	6-7 Km N	2 Hrs.	Rice (Soybeans)	Good	Slight	Paddy	Stream
	7	6-7 Km N		Rice (Soybeans)			Upland	
	4	1 Km S		Mangoes				
P-14	8	3 Km NE	1/2 Hr.	Rice	Bad	Modest to Steep	Upland	Stream
P-15	5	200 m S	10 Min.	Rice (Soybeans)	Ok	Modest	Paddy	Stream
	2	200 m S	10 Min.	Rice (Soybeans)	Ok	Modest	Paddy	Stream
P-16	1	1 Km S	15 Min.	Rice (Soybeans)	Ok	Flat	Paddy	Rain and Stream
	2	S		Rice (Soybeans)				
P-17	7	1.5 Km N	30 Min	Rice (Soybeans)	Ok, Black	Flat	Paddy	Rain and Stream
	5	3 Km N		Rice (Soybeans)			Upland	
P-18	0	500 m S		Rice (Soybeans)			Paddy	
	5	2 Km N		Rice (Soybeans)				
	3	500 m S						
	15	2.5 Km N	1 Hr.	Soybeans (All Year)	Ok	Slight	Upland	Rain Fed
P-19	2	4 Km N	1 Hr.	Rice (Soybeans)				
	1-1/2	5 Km N	1 Hr.	Rice (Soybeans)	Ok	Slight	Lowland, Paddy	Stream
	2	8 Km N	1-1/2 Hr.	Rice (Soybeans)				
P-20	4	8 Km W	>1 Hr.	Rice (Soybeans)	Ok	Flat	Paddy	Stream
	3	3 Km SE		Rice			Lowland	
P-21	7	2 Km N		Rice (Soybeans)	Good	Slight	Upland	Stream
	3	2 Km N	1/2 Hr.	Rice (Soybeans)				

Table 3B

Plot Characteristics
Yang Pieng

Household Code	Landholdings (in Rai)	Distance and Direction From Village	Commuting Time	Crop (Wet Season Only)	Soil Type	Slope	Upland/Lowland	Irrigation Status
P-35	5	S	2 Hrs.	Rice	Bad	Slight	Paddy	Rain Fed
P-36	7	2 Km N	-	Rice	Bad, Sandy	Slight	Upland	Rain Fed
P-37	3	300 m S	5 Min.	Rice	Bad	Slight	Paddy	Rain Fed
P-38	3	2 Km S	1 Hr.	Rice	Bad, Sandy	Slight	Paddy	Rain Fed
P-39	5	2 Km N	-	Rice	Bad, Sandy	Slight	Paddy	Rain Fed
P-40	1	500 m E	15 Min.	Rice	Ok, Sandy	Slight	Paddy	Stream
	1-1/3	600 m E	15 Min.	Rice				
P-41	5	4 Km S	1 Hr.	Rice	Good, Black Clay	Flat	Paddy	Stream
	3	4 Km S	1 Hr.	Rice	Ok, Sandy	Slight		Stream
P-42	4	1 Km N	1 Hr.	Rice	Good, Bad	Flat	Paddy	Rain Fed
	3	500 m S		Rice				
P-43	9	2 Km S	1/2 Hr.	Rice	Ok	Flat	Paddy	Stream
	9	4-5 Km E		Rice				
P-44	8	1 Km N	15 Min.	Rice	Bad	Slight	Upland	Stream
P-45	4	1/2 Km N	10 Min.	Rice	Ok	Slight	Lowland	Rain Fed
	5	4 Km S		Rice				
P-46	3	1 Km N	30 Min.	Rice	Ok, Sandy	Flat	Paddy	Stream
P-47	7	4 Km SE	1 Hr.	Rice	Ok, Sandy	Flat	Paddy	Stream
P-48	5	S	15 Min.	Rice	Bad, Sandy	Slight	Paddy	Rain Fed Stream
P-49	5	1 Km S	10 Min.	Rice	Bad	Slight	Upland	Stream
P-50	5	3 Km S	1 Hr.	Rice	Ok	Slight	Paddy	Stream

Table 3C

Plot Characteristics
Ba Pai

Household Code	Land-Holding in Rai	Dist.-Direction From Village	Commute Time	Crop	Soil Type	Slope	Upland Lowland	Irrigation Status
P-60	2	2 KM W		pepper	red	upland	slight slope	rain fed
P-62	3	1/2 KM N	30 min.	pepper	sandy	upland	flat	rain fed
P-63	15	1 KM W	6 min.	corn	red/rocky	upland	flat, slight slope	rain fed
P-64	3	4 KM W	4 hrs.	corn	bad/rocky		slight slope	rain fed
P-65	8	3 KM W	30 min.	corn	bad/rocky	slight	flat, slight slope	rain fed
P-66	7	7 KM W		corn	red	upland	flat	pump from stream
	2	1-1/2 KM		soybeans, peppers	clay	upland		
P-67	4	7 KM E	2 hrs.	corn	rocky	low	slight slope	rain fed

Table 4A

Fluctuations in Harvest Yields
Maanajon - Rice (in tang)

Household Code Number	Best Year	Harvest Amount	Worst Year	Harvest Amount	Fluctuation in Percent
P-10	1988	200	1985	180	.11
P-11	1988	200	1985	110	.58
P-12	1988	300	1987	200	.40
P-13	1987	500	1988	460	.08
P-14	1989	550	1985	350	.44
P-15	1986	220	1988	90	.84
P-16	1987	150	1986	105	.35
P-17	1988	430	1987	410	.05
P-18	1988	136	1987	38	1.13
P-19	1986	320	1985	20	1.76
P-20	1986	240	1985	220	.08
P-21	1988	400	1987	200	.66

Table 4B

Fluctuations in Harvest Yields
Yang Pieng - Rice (in tang)

Household Code Number	Best Year	Harvest Amount	Worst Year	Harvest Amount	Fluctuation in Percent
P-35		100		60	
P-36		250		100	
P-37		150	1986	40	1.16
P-38	1988	100	1986	60	.50
P-39	1988	120	1986	70	.53
P-40	1985	420	1987	240	.55
P-41		300	1985	200	.40
P-42	1988	115	1986	50	.79
P-43	1987	450	1982	250	.57
P-44	1987	120	1988	80	.40
P-45	1988	180	1986	100	.57
P-46	1988	70	1984	50	.33
P-47	1986	255	1987	180	.34
P-48	1986	150	1988	70	.73
P-49	1988	130	1985	70	.60
P-50	1985	250	1986	100	.86

Table 4C

Fluctuations in Harvest Yields

Ba Pai - Corn (in tang)

Household Code Number	Best Year	Harvest Amount	Worst Year	Harvest Amount	Fluctuation in Percent
P-63	1988	460	1987	230	.67
P-64	1988	50	1986	26	.67
P-65	1987	138	1988	116	.17
P-67	1988	120	1986	40	1.00

Table 5A
Sources of Fluctuations
Maanajohn

Household Code	Rank order of Risk Source			Why Good Year	Why Bad Year	Too Much Water in Good Year (How Many Years)	Too Little Water in Bad Year (How Many Years)
	Water	Crop Disease	Insects				
P-10	2	1	3	No disease	Disease, insects	No	Yes-1 year
P-11	1	2	3	No disease	Disease	No	Yes-almost all years
P-12	3	1	2	Use fertilizer	Fertlizer, insects, late water	No	Yes-1 year
P-13	3	2	1			No	No
P-14		1	2	More fertilizer	Less fertilizer	No	No
P-15	3	1	2	More fertilizer	Disease	No	No
P-16	1	3	2	Fertilizer	No fertilizer, lack of water	No	Yes-1 year
P-17	1		2	Fertilizer	Less fertilizer	No	Yes-1 year
P-18	1	2	3	No disease	Disease	Yes-4 years	No
P-19	2	1		Fertilizer, water, no disease	Disease	No	No
P-20	2	1		Water	Rained at harvest	Yes-each year	No
P-21	2		1	More fertilizer	Less fertilizer	No	Yes

Table 5B
Sources of Fluctuations
Yang Pieng

Household Code	Rank order of Risk Source			Why Good Year	Why Bad Year	Too Much Water in Good Year (How Many Years)	Too Little Water in Bad Year (How Many Years)
	Water	Crop Disease	Insects				
P-35	1	2	3	Rain	Rain	Yes-1 year	No-1 year
P-36	1	2	3	Rain	Water	No	No
P-37	1			Rain	No water	No	No-1 year
P-38	1	2	2	Good water	Not enough water	Yes-each year	Yes-each year
P-39	1	2	3	Water	Insufficient water	No	No-1 year
P-40	3	2	1	Water	Insufficient water	No	No-1 year
P-41	1	2	3		Dry	No	Yes-almost every year
P-42	1	3	2	Using fertilizer	Lack of water	Yes-almost every year	Yes-every year
P-43	2	1	1	Rain	Disease	Yes-2 years	Yes-2 years
P-44	1	2	2	Water	Not enough water	No	Yes-5 years
P-45	1	2	2	Rainfall	Not enough rain	No	Yes-3 years
P-46	1	2	3	Water	Not enough water	Yes-1 year	Yes-1 year
P-47	1	3	2	Good water	Disease	Yes-1 year	Yes-almost every year
P-48	1		2	Rainfall	Rainfall	No	Yes-1 year
P-49	1	2	2	Water	Not enough rain	No	Yes-every year
P-50	1	2	2	Rain	Insects	Yes-2 years	Yes-3 years

Table 5C
Sources of Fluctuations
Ba Pai

Household Code	Rank order of Risk Source			Why Good Year	Why Bad Year	Too Much Water in Good Year (How Many Years)	Too Little Water in Bad Year (How Many Years)
	Water	Crop Disease	Insects				
P-60				Rain	Rain	Yes	Yes
P-62				Water	Rain	Yes	No-2 years
P-63	1	3	2	Sufficient water and fertilizer	Insects, insufficient water, fertilizer	No	No-almost every year
P-64	1	3	2	Good rain	Bad rain	Yes-every year	No-every year
P-65	1	2	2	Sufficient rain and water	Insufficient rain and fertilizer	Yes-every year	Yes-every year
P-66							
P-67	1	2	2	Good rain	Bad rain	Yes-every year	Yes-every year

Table 6A

Variations in Agricultural Production

Yang Pieng (Rice)

Household Number	Plow Type	Depth	Plow Timing Problems	Type of Seed	Amount Per Rai	Too Much Water	Germination Problems	Short Stems	Water Problem of any Kind	Times Weeded	Person Days Per Rai	Weed Damage	Rain at Harvest
P-35	Tractor	5.5 cm	No	M-Y	.80	No	No	Yes	Yes	2	6	Yes	Yes
P-36	Tractor	1/2 Elbow	No	M-Y-L-O	.43	No	No	No	No	2		No	Yes
P-37	Buffalo	11 cm	No	M	1.33	No	No	No	No	2		Some	Yes
P-38	Tractor	10-15 cm	No	M-Y		Yes	Yes	Yes	Yes	2	5.8 - 8.3	Yes	Yes
P-39	Tractor	Don't Know	No	M	1.0	No	Not Much	Not Much	No	2		Little	-
P-40	Tractor	15 Cm		M-Y	4.5	Yes	Yes	Some	Yes, Too Little Water	2	10	Yes	Yes
P-41	Tractor	10 Cm	No	M-Y	1.0	Yes	No	Yes	Yes	1	1.25	Yes	Yes
P-42	Tractor	10 Cm	No	M-Y-L	.43	Yes	Yes	No	Yes	2	1.71	Yes	Yes
P-43	Tractor	20 Cm	No	M-Y	.28	Yes	Some	No	No	2	.33	Yes	Yes
P-44	Tractor	25 Cm	-	M-Y-L	.38	No	Yes	No	Yes, Too Little Water	2	.75 - 1	Some	Yes
P-45	Tractor	10 Cm	Yes	M-Y	.78	No	Some	No	No	2	3.33	Some, Bad Health	Yes
P-46	Buffalo	10 Cm	No	M-Y-L	.83	No	Yes	Yes	Yes	2	5	Yes	Yes
P-47	Tractor	15 Cm		M-Y-L	.85	Yes	Yes	Yes	Yes	1	2	Yes	Yes
P-48	Tractor	-	No	M-Y	1.4	No	No	Not Much	No	2	4	Not Much	Yes
P-49	Tractor			M-L-Y-O	1	No	Very Few	Yes	Too Little Water	3	7	No	Yes
P-50	Tractor			M-L-Y	.6	No	Yes	No	Yes, Too Little Water	2	.6 - 2.4	Yes, Wait, Sick	Yes

M = Muenon
Y = Yellow
L = Lia
O = Other

Table 6B

Variations in Agricultural Production
Ba Pai (Corn)

Household Number	Plow Type	Depth	Plow Timing Problems	Type of Seed	Amount Per Rai	Too Much Water	Germination Problems	Short Stems	Water Problem of any kind	Times Weeded	Person Days Per Rai	Weed Damage	Rain at Harvest
P-63	Tractor	20-25 cm	Yes	Sawan 2	2.8 KL	No	Yes	Yes	Yes	1	4	No	No
P-64	Hoe	10-15 cm	No	Sawan 3	.17 Tang	No	Yes	Yes	Yes	2	3.33	-	Yes
P-65	Tractor	-	No	Sawan 3	1.88 KL	Yes	Yes	Yes	Yes	3	6	No	Yes
P-66	Hoe	10-15 cm	-	Sawan 3	.38 Tang	No	No	No	No	3	7.5	No	Yes
P-67	Tractor	25 cm	Yes	-			Yes		Yes Too Little	3		Yes	

Table 7A
Inputs and Sources of Finance

Yang Pieng (Rice)

Input\Source	Market	Agriculture Ext. Officer	No Response	Did Not Use
Fertilizer	5	4	1	6
Pesticide	0	1	0	15
Herbicide	3	0	0	13

Table 7B

Inputs and Source of Finance

Maanajohn (Rice)

Source\Input	Market	Agriculture Ext Office	Coop	Wholesaler	Never Use
Fertilizer	1	4	7	0	0
Pesticide	1	1	3	1	6
Herbicide	0	0	5	0	7

Table 7C

Inputs and Source of Finance

Ba Pai (Corn)

Source\Input	Market	Agriculture Ext Office	Coop	Wholesaler	Never Use
Fertilizer	1			1	2
Pesticide					5
Herbicide	1				4

Table 8A

Communication and Knowledge
of Plot Operations and Inputs

Maanajohn

Household Code Number	Know About Within Sight Plots - Identity	Know About Relatives - Identity	Know About Friends - Number	Know About Persons Borrow From	Know About BAAC Partner	Know About Person Lend To	Person Named for Quizz - Within Sight?	Information Score
P-10	No	No - Son & Daughter, 4-5 People	No	No	No	No	Cousin-Yes	.81
P-11	Yes, Son-In-Law, Daughter	No	-	-	-	No	Neighbor - Yes	.64
P-12	Yes, Internal	Yes - Daughter-in-Law, Son, Daughter, Son-in-Law	No	No	No	No	Cousin - Yes	.96
P-13	Yes, Sons and Daughters	Yes - 3 Sons, 1 Daughter	No	No	No	No	Brother - Yes	.91
P-14	No	2 People	-	-	-	-	Neighbor - Yes	.71
P-15	Yes, 2 Sons, 3 Nephews	No	Yes	No	No	No	Neighbor - Yes	.96
P-16	No	Yes - Brother	Yes, 2-3 Persons	Yes	No	No	Relative - Yes	.96
P-17	Yes, Relatives	Yes - 2 Sisters, 1 Uncle	No	No	No	No	Sister - Yes	.91
P-18	No	Yes - Cousin	No	No	No	No	Sister - Yes	.92
P-19	Yes, 6 People	Yes - Daughter, Son, Son in Law	No	-	-	-	Relative - Yes	.93
P-20	Yes, 1 Relative, 1 Friend	No	No	No	No	No	Brother - Yes	.87
P-21	1 Son	Yes - Son in Law	No	No	No	No	Friend - Yes	.35

Table 8B

Communication and Knowledge
of Plot Operations and Inputs

Yang Pieng

Household Code Number	Know About Within Sight Plots - Identity	Know About Relatives - Identity	Know About Friends - Number	Know About Persons Borrow From	Know About BAAC Partner	Know About Person Lend To	Person Named for Quizz - Within Sight?	Information Score
P-35	Yes/Internal	Yes	Yes	No	No	Yes	Relative/Yes	.72
P-36	Yes	No	-	-	-	No	Neighbor/No	.97
P-37	Yes	Yes	Yes	No	No	No	Relative/Yes	.62
P-38	No	No	No	No	No	No	Neighbor/Yes	.23
P-39	-	-	-	-	-	-	Neighbor/Yes	.32
P-40	No/Other Relatives	Yes/Father, Mother	Yes, 2	No	No	Yes	Relative/Yes	.56
P-41	Yes/Friend	No	No	No	No	No	Neighbor/Yes	.40
P-42	Yes/Relatives	Yes/Son, Daughter	No	No	No	No	Mother/ Yes	.71
P-43	Yes/Internal	Yes/Brother	Yes, 2-3	No	No	No	Uncle/Yes	.78
P-44	Yes/Internal	Yes/2 Brothers, 1 Sister	Yes, 2-3	No	No	No	Friend/ Yes	.97
P-45	No/Son and Employees	Yes/Sisters-In-Law	No	No	No	No	Friend/Yes	.35
P-46	No	Yes/Daughter	No	-	-	-	Neighbor/Yes	.33
P-47	Yes/Other Relatives	Yes/Father, Mother, Cousin	Yes, 3	No	No	No	Relative/ Yes	.66
P-48	No	No	No	No	No	No	Friend/ Yes	.72
P-49	Yes/Not Much	Yes/Father	Yes, Many	No	No	No	Neighbor/No	.26
P-50	Yes	Yes - Son, Daughter	Yes, 2	No	No	No	Relative/Yes	.79

Table 8C

Communication and Knowledge
of Plot Operations and Inputs

Ba Pai

Household Code Number	Know About Within Sight Plots - Identity	Know About Relatives - Identity	Know About Friends - Number	Know About Persons Borrow From	Know About BAAC Partner	Know About Person Lend To	Person Named for Quizz - Within Sight?	Information Score
P-60	Friend	No	-	No	No	No	Friend	.04
P-61	Yes/Friend	No/Cousin	Yes	No	No	No	Relative, Yes	1.00
P-62	No	-	-	-	-	-	Relative, Yes	.56
P-63	No	No	No	No	No	No	Relative, Yes	.50
P-64	No	No	No	No	No	No	Yes	.18
P-65	No	No	No	No	No	No	Neighbor, Yes	.68
P-66	No	-	-	-	-		Neighbor, Yes	.20