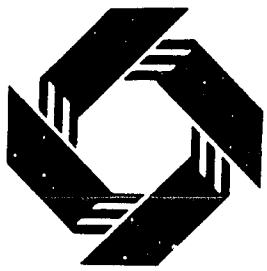

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Understanding the Structure of Village and Regional Economies

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Policy reforms in developing countries often turn on the nature and level of risk in these economies and how residents respond to this risk. While the current risk reduction mechanisms may have negative effects for the whole economy, such as increased family size or deforestation, improved insurance-welfare systems may ameliorate many of these negative effects. This research reports on efforts to understand the structure of poor, high risk village and regional economies using an iterative, theory-data-theory-measurement research process. The theory blends contract design and general equilibrium models. The data are from panel surveys in Southern India, from anthropological studies of English medieval villages and from new interviews of Northern Thailand farmers. By contrasting the relatively "thin" insurance markets of Thai villages with Southern Indian villages, possibilities for welfare improving interventions in the Thai villages are revealed. Additionally, the analysis suggests these risk reduction interventions are possible without perfect information flows.

1. Introduction

This paper takes a contract-theoretic, mechanism design approach in trying to understand the structure of entire economies. That is, markets, institutions, and allocations are to be viewed as Pareto optimal given the environments of the economies, possibly restricted by private information and incentive problems. The jump from the usual applications of contract theory, namely two or small-number-of-agent problems, to entire economies may make this endeavor seem an implausible enterprise. But for observational and theoretical reasons the enterprise is replete with possibilities for a greater understanding the determinants of contract structure in general and for the structure of selected economies in specific.

Observationally, the economies to be studied are small and well suited for contract theoretic analysis For the most part the economies are nucleated villages in which agents live, eat, and work together; indeed, though this is not necessary, the villages are often surprisingly closed in consumption and labor supply, growing and eating much of their own grain. The villages often have their own legal system, for enforcement of explicit contracts and implicit institutional arrangements. In addition, families may have been present for generations. Thus the various households of a given village may know one another well, and emigration in the face of difficulties may seem a costly remedy. Finally, the villages to be studied suffer from poor, high risk environments. In southern India, northern Thailand, and medieval England, the risk from the weather if not erratic rains, from crop diseases, and from human illnesses is high, and shortfalls in consumption can be disastrous.Thus households have a lot to lose in not coming up with efficient, information-constrained arrangements.

A second layer of the analysis considers villages as part of larger regional economies and asks again whether arrangements appear to be efficient. Some but not all of the arguments for plausibility apply at the regional level as well.

Theoretically, this paper proceeds along familiar lines, trying to explain allocations by solving for an information-constrained Pareto optimum, as in the contract theoretic literature. Indeed, this technique is much used in general equilibrium macro modeling, using the equivalence between competitive equilibria and Pareto optima. In the real business cycle literature, for example, one solves for a Pareto optimum first, and then supports it with prices and markets. Here we combine these two literatures,

solving for a Pareto optimum for an entire village or regional economy.

The starting point of the paper, in section 2, is an analysis of selected villages in southern India as complete market economies, as if there were no information problems or other impediments to trade. This theoretical benchmark is shown to deliver strong restrictions, and data from a crops research institute, ICRISAT, is available to carry out the tests. Overall, the data fit the model surprisingly well, but a few anomalies are uncovered. Specifically, households attempt crop and plot diversification, despite apparent costs, and household consumption levels seem to be determined by acquired characteristics, such as land and bullock holdings.

Section 3 attempts to carry out a similar exercise at the regional level, using an economic, ethnographic study of Trudy Epstein of two villages in a distinct, southern Indian regional economy. Again anomalies are uncovered. One of the villages suffers adversely from fluctuations in the market economy, and, again, acquired characteristics loom large in the distribution of consumption..

Section 4 retreats again to village level analysis and asks whether private information and incentive problems might help explain the anomalies. Here, in contrast to the parallel work of McCloskey, ante crop and plot diversification is balanced off against the possibility expost transfers (gifts, borrowing-lending , etc.), and the latter are constrained by information and incentive problems. Quantitative implications are stressed. The private information model of land holdings is calibrated to fit the data on fragmentation and output variability using linear programming techniques, but its predictions are shown to be sensitive to the information structure as well as certain key parameter values. The model suggests it would be difficult to keep information private in an optimal arrangement, and that consumptions would move slowly with acquired characteristics.

Section 5 attempts to found out directly whether private information is a serious impediment to trade at the level of the village economy. Specifically, it reports on field work in poor high risk villages in northern Thailand and in the ICRISAT villages of southern India. Preliminary results indicate that not everyone knows everything in Thai villages, though there are occasional individuals who are quite well informed. It also seems from preliminary results that the financial markets in these Thai villages are "thiner" than what general equilibrium, full risk sharing models would predict, that a class of relatively rich and relatively poor households could co insure one another

better, but do not do so. In contrast, the ICRISAT villages in southern India overcome information impediments to achieve something close to a full information optimum . The fact that the villages in northern Thailand do not suggests that welfare improving interventions may be possible.

§2. Village Economies as Arrow-Debreu-McKenzie Models

The starting point for this paper is the premise that Pareto optimal allocations should be a good benchmark for the study actual consumption and leisure allocations in a small village economy. Indeed, in this section, Pareto optimal allocations are not even constrained by information incentive problems. That is, in the decentralized version of the program, one is looking for complete market competitive equilibrium allocations.

Again, this may seem an unusual starting point, an unlikely benchmark, but it has proved useful for theoretical and observational reasons.

First, theoretically, one get unusually strong restriction on consumption data under the premise that full risk-bearing is achieved or, equivalently, that markets are complete. This is well known from the theoretical work of Wilson (1968), Diamond (1967), and Scheinkman (1984), and the empirical work of Leme (1984), Mace (1988), Cochrane(1989), Altonji, Hayachi, and Kotlikoff (1989), Abel and Kotlikoff (1988), and Altug and Miller (1990), among others. Briefly, if all individuals are (weakly) risk averse, discount the future at the same rate, and have common information, then consumptions and leisures should be determined by economy-wide aggregates of these, only. Further, if preferences are separable in consumption and leisure, then individual consumptions are determined by per capita, average consumption in the population, only, and must move monotonically with that average.

The intuition for this result in the context of a village economy is straightforward. Suppose one risk averse household were suffering variability in its consumption due to variability in its crop yields. If a second household were bearing none of this fluctuation, it would be in a position to insure the first, at least partially, being essentially risk neutral for small changes in its own prior consumption pattern. The exact division of the risk, the predicted pattern of co insurance, would depend on the exact nature preferences and initial wealths. But it would be as if crop outputs of both households were pooled and and then subdivided. Thus household consumptions move with aggregate consumption, the latter capturing aggregate risk. Further,

controlling for aggregate risk, household crop outputs should not matter. This result can be extended to multiple households, all risk averse and all suffering variability in yields. The exact nature of the production and smoothing technologies available to them does not matter. Also, given specific functions for preferences, the derived risk-sharing formulas show how to take into account changing number of members and age-sex compositions of households even when consumption is measured at the household level. Finally, the villages need not be closed. Aggregate consumption represents the residual, aggregate risk which is not absorbed by the larger regional economy.

Observationally, the complete markets hypothesis is attractive because that data is available. That is, one is in a rare position to carry out the tests at the village level. Specifically, the International Crops Research Institute for the Semi Arid Tropics (ICRISAT) has collected a massive data set for three village in southern India, Aurepalle in Andhra Pradesh, and Shirapur and Kanzara in Maharastra. Forty households in these villagers were sampled at four week intervals for up to ten years. Consumption and labor supply data are available, as are demographic and income data.

Finally, the complete markets, full risk sharing tests are natural for these villages of southern India because the economies themselves resemble Robinson Crusoe or Arrow-Debreu economies. That is, the environments can be described in general equilibrium terms, with the specific structure based on actual observations, from knowledge gained through field research and from the data.

Considering Aurepalle in more detail, for example, there are a finite and relatively low number distinct production technologies, varying by crop, irrigation status, and soil type. The dominate crops are castor, a sorghum-pigeon pea intermixture, and paddy rice. The first is a cash crop, sold in a nearby district market, while sorghum and rice are primarily for village consumption; grain is the dominate consumption item. There are two dominate soil types, medium-to-shallow-black and shallow-red. Judging by variance co variance statistics on yields, soil types matter for the production of dry land crops. The crops themselves have significant nonunitary co variance statistics.

Two key shocks appear to determine crop yields. The first is the extent and timing of monsoon rains. Aurepalle's rainfall is erratic in amount and timing . There is also evidence, though not direct, that rainfall is not uniform even in the area constituting the lands of Aurepalle. Thus the

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location of dry land plots matters even controlling for crop and soil type. A second class of shocks is the incidence and extent of crop disease.

Crops are produced with human labor and bullock power, though input intensities vary over crops and soils. Other inputs such inorganic fertilizer and pesticide are minimal. As a first approximation, then, Aurepalle is a pure exchange economy with diverse crop-plot endowments. As a second approximation, it is an economy with relatively simple and measurable production technologies.

Households vary in land holdings, with landless laborers and small, medium, and large holders each constituting roughly 25% of the village population, 2856 people in 1975. Labor is supplied mainly to crop production in the village. Landless laborers almost always work for others. On the other extreme, members of the larger farm households work only on their own plots, if at all. Medium holders lie in between on this metric. There is relatively little temporary migration out of the village, even during the dry, rabi season. Sickness is a serious shock which can pull individuals out of the labor force for extended periods of time.

The size of households is relatively large on average; size also varies for given households over time with births, deaths, marriages, divisions of extended families, permanent migrations, and changes in numbers of household servants. Households care about the consumption and labor supply of their members, and, judging from experiments and the data, are risk averse. As a first approximation, then, we can view households as changing clusters of individuals, coping with the risk of the economic and demographic shocks described above.

How accurate are the predictions of the complete markets, full risk sharing models for Aurepalle village and for Kanzara and Shirapur villages which I have not had time to describe? Basically, individual consumptions show a high degree of co movement with per capita, average village consumption for all three villages. This is revealed by time series plots with the ten years of data, and by point estimates (with narrow standard error bands) of the correlation of individual consumption with village average consumption. In regressions taken one household at a time of age-sex adjusted per person household consumption on the village average, 31 out of 34, 29 out of 32, and 33 out of 36 households in Aurepalle, Shirapur and Kanzara, respectively, have a coefficient on village average consumption which is equal to unity, at the 95% confidence level. The theory predicts a unitary value, at least for

specific functional form.

Controlling for fixed effects across households due to varying Pareto weights or varying wealths, and controlling for aggregate risk via aggregate consumption, one can ask whether crop productions or household incomes matter for household consumptions. As noted, the theory predicts these should not matter at all. For the regression in levels in Aurepalle, profits from crop production are significant for only three households out of the 34, and labor income is significant for five. The latter is an upper bound, representing about 15% of the households, only. The results in logs of variables is similar, and results are similar also across the other villages. In the pooled cross sectional, time series regressions in levels for Aurepalle, crop output, profits from crop production, and income from all sources enter into the benchmark, risk-sharing regression with coefficients of .06, .05 and 03, respectively, with the first two terms significant at the 90% to 95% confidence levels, respectively. Again, the theory says these variables should not enter at all. Nevertheless, the coefficient values, being somewhat akin to marginal propensities consume, are small. The largest such number is a coefficient of .12 on labor income in Shirapur. The coefficient values on each of these income variables in the regressions in logs are similarly low.

Similarly, among the variables sickness, unemployment, and all- reasons-for-not-working, only the latter is significant at the 90% confidence level in the cross sectional regressions. These shocks are reasonably well insured.

There are a few anomalies, nevertheless. Specifically , the Pareto weights, or wealths, which are picked up in the regressions as fixed effects, consistent with the theory, are found in practice to vary with acquired characteristics. That is, computed intercept values in Aurepalle are related to operated land holdings and owned bullocks, assets which according to Cain (1981) Walker et al (1988) have shifted over time in the ICRISAT villages even within the present generation. Thus a household's average consumption level moves slowly up or down over time as these assets are accumulated or depleted. This is not consistent with a full information ex ante Pareto optimum. An explanation will require an alternative model.

A second anomaly, noted earlier, is that households in Aurepalle and the other villages attempt some plot and crop diversification, yet these efforts appear to be costly in terms of commuting times, inattention to crops, and boundary problems. If markets were complete and there were no impediments to risk sharing, then any Pareto optimal allocation could be achieved with full

consolidation of land holdings and specialization in crop production. All costs could be avoided. Again, an explanation will require an alternative model.

Before developing these alternative models, however, we note again that the Arrow-Debreu model provides a good first approximation to the consumption data. Unfortunately, the Arrow-Debreu model is regarded as sufficiently implausible that these good approximation results can be viewed with suspicion. For this reason it is worth noting that an acceptance of the Arrow Debreu model would not mean that households in these villages have collectively solved a programming problem at an initial date. Nor would acceptance imply that all necessary Arrow-Debreu securities be traded in village competitive markets. Rather, it is only that the entire configuration of individual and collective institutional arrangements is coming close to being one that supports the predicted allocations. Indeed, it is a virtue of the theory that it does not require one to scrutinize any individual market or risk-reduction arrangement. To test the theory one need only look at outcomes.

Still, one wonders how each of the villages has managed to do so well. It already has been noted that households attempt crop and plot diversification, each planting a variety of crops and holding a variety of plots of different soil types in different locations. Yet this diversification is not complete --not all households are doing the same thing and experiencing the same weather. That is, households are not holding the "market portfolio". This shows up in lack of co movement among incomes across households in the village and in relatively low correlations of individual incomes with average village income.

Similarly, households may store grain in good years, and sell livestock and other assets in bad years. But this does not show up in an overwhelming way in the data.

In fact, the substantial residual between consumption and income after the buying and selling of assets is made up by gifts and credits, by what may be termed ex post consumption transfers. In the data these are coded primarily as loans. Thus the risk reduction arrangement in the ICRISAT villages is communal. This is how the villages have managed to do so well.

A second caveat concerns over interpretation or generalization of the results on full risk sharing. There is some evidence that the Arrow-Debreu-McKenzie model would not do so well outside the villages of

ICRISAT India, though we are as yet lacking the village specific panel data necessary to carry out tests. In study of Char Golarpur in Bangladesh, Cain (1981) finds that distress land sales of small and medium holders at the time of floods has radically conditioned the distribution of income, and implicitly consumption. Similarly, Jodha (1987) finds relatively significant drops in consumptions for households experiencing drought in Rajasthan. In ongoing field work in relatively remote, poor high risk villages in northern Thailand I find some households absorb shortfalls on their own, without links to the rest of the community. That is, risk-sharing arrangements are not communal in the sense that they are in India's SAT. Acceptance of something close to Arrow-Debreu complete markets in one areas implies nothing about acceptance in another.

Subsequent sections of the paper return to the question of whether the Arrow-Debreu-McKenzie model is doing well at the village level, to the anomalies in particular. We turn first, however, to the question of how well the Arrow-Debreu-McKenzie model approximates the regional economy.

3. The Regional Economy as an Arrow-Debreu-McKenzie Model

The Arrow-Debreu-McKenzie model is also useful for understanding and evaluating the structure of regional economies. The example regional economy to be described in these terms is one studied by Trudy Epstein, trained in the early 1950's as an economist and as an anthropologist at the University of Manchester. Combining these two disciplines, she lived over two years in two villages in Mysore State of southern India, carefully measuring economic and social variables, tracing out at the micro level the effect of irrigation and the consequent development of the region.

Mysore State lies on the Deccan plateau in southern India. The eastern part consists of plains of red gravel soils, and it suffers from low and irratic rains, similar to Aurepalle village. However, tank and well irrigation have been supplanted by intensive river and canal irrigation, promoted by large-scale government-constructed dams. Still, irrigation in the region is not uniform. Some villages are irrigated and some are not. But virtually all have have been integrated in some way or another into the larger regional economy.

Epstein's region of study is the market area of twenty five mile radius

around the newly emergent district center of Mandya. Four miles southeast of Mandya lies one of the study villages, Wengala, in the center of an irrigated area. Four miles south of Mandya lies the other study village, Dalena, on the fringe of that irrigated area. These two villages appear to have been similar prior to the advent of irrigation.

Wengala represents a typical irrigated village of the region at the time of Epstein's study. Dry land crops of ragi and jowar have been replaced by irrigated paddy and sugar cane. Thirty nine percent of the lands of the village remain dry, allowing for future growth. Wetland crops are especially productive, particular cane which is sold for cash to the factory at Mandya. But wetland crops are also input intensive. First, much more labor is required than on dry land crops. This need has been met my conversion of village functionaries-- potter, washers, etc.-- to full time farmers or laborers, by permanent immigration of untouchable migrants, about seven percent of the village population, and by spot market hired labor from the district market. Secondly, more bullock power and iron ploughs are needed, as are carts for the transportation of cane; irrigation requires a capital investment of about four times that of dry land crops. Thirdly, cash inputs of fertilizer and seed are higher. Finally, irrigation requires considerable care and attention in cultivation. Water levels are crucial, and harvested cane must be transported quickly to the factory.

Wengala thus represents an irrigated village specialized in cash crop production. Exports are used to finance consumption expenditures at the weekly market in Mandya, for vegetables, clothing, and sometimes ornaments, and to finance agricultural inputs. Interactions with the district market are either anonymous, as at the weekly fair, or bilateral, as with contract sale of cane to the Mandya factory.

Dalena is a dry land village on the fringe of the irrigated area. Though it lies along a canal, its land is elevated and is not suitable for canal irrigation. Thus less intensive, dry land crops still predominate.

But Dalena is substantially integrated into the regional economy as a supplier of labor, trading services, and entrepreneurship. At the advent of irrigation, Dalena farmers became laborers and contractors for the public works department; these occupations persist. During the war they became active in grain mills, processing illegal paddy. Currently, at the time of the Epstein study, about thirteen percent of the male population works in Mandya in the sugar factory and as clerks and drivers. Others work in the

spot district labor market; there has been some permanent emigration. And others specialize in bullock and cart trading, purchasing these in more distant districts for local resale or rental.

Dalena thus represents a semi-agrarian village specialized in the supply of regional services. About twenty-two percent of Dalena's cash receipts come from manufacturing and trading profits, and ten percent comes form non agricultural wages. It is integrated into the region under a variety of spot and contractual relationships.

How good are the predictions of the Arrow-Debreu-McKenzie model for the regional economy in which Wengala and Dalena lie? Unfortunately, no data set comparable to ICRISAT's is available, but much can be gleamed from Epstein's discussion and the statistics she gathered.

First, it is clear that spot labor markets tie villages like Wengala and Dalena together. The higher wetland crop outputs are partially paid out as wages and rentals, and to that extent there is a "transfer" of consumption goods. Further, one might expect fluctuations in outputs to be shared somewhat. Still, one can only guess at the extent of regular and systematic co movement.

Second, Epstein does describe the responses of Wengala and Dalena to large outside shocks, and she comments on crop choice, land holdings, and the attitudes of the villagers. In 1949 a severe drought caused most of the cane crop to fail. In that year the cane factory, which financed most of the inputs on contract to Wengala, wrote off crop season loans as bad debts; in effect this was an incoming "transfer", as the theory predicts. But when a drought threatened at the outset of 1956, the factory made clear that no loans would be written off. As the factory is the primary source of district credit for Wengala, the extent of smoothing must thus have been limited in especially bad years.

Similarly, Dalena may have suffered substantially when a drought closed down the sugar factory, so that laborers had no work and cart and bullock traders were idle. All returned to the dry land village economy. Yet Wengala farmers were not so severely affected; they had sufficient water for irrigated ragi and paddy crops. Again, in an Arrow-Debreu economy shocks which hit one village or industry but not another should be shared across all households.

Third, and related, Epstein reports that Dalena farmers live in fear of fluctuations of the regional economy. Indeed, they are said to continue to value their dry land plots even as they spend much time out of the village.

Presumably, these plots represent a residual diversification possible for them, a fall-back option to try to absorb regional shocks. One draws the impression, though, that these are inadequate. And though many Dalena farmers have credit with their employers and clients outside the village, one doubts this mechenism is sufficient to accomplish the required co movement.

A fourth source of inference about the validity of the Arrow -Debreu-McKenzie model is Epstein's meticulously gathered data on consumptions and incomes. If Wengala and Dalena were to lie in an integrated Arrow-Debreu economy, the distributions of consumptions in the both populations should be determined by initial wealths or Pareto weights, and consumptions should all grow at the same rate.

Yet there is contrary evidence. First, Dalena's average consumption numbers for a selected year are higher than for Wengala, 36 compared to 33. Apart from permanent migration, if the two villages started with the same wealths and same weights, one translation of Epstein's premise, then they should have stayed at equal consumptions. More troublesome for the theory, in Dalena, where market relationships have over taken traditional caste and patron relationships, there is a much greater dispersion of consumption and income in the village than in Wengala. Relatively well to do villagers in Dalena have reaped the rewards to entrepreneurship, while poor ones, especially the untouchable class, lie abject poverty. As Epstein puts it, prestige can be acquired in the market. Some, but not all, of Dalena's villagers are educating their sons so that the next generation might have a still greater advantage in the market economy.

In contrast, traditional relationships have been reinforced in Wengala, despite the advent of irrigation. The distribution of consumption is not uniform, but the relatively well to do are those who were large magnates at the time of initial irrigation. Wengala enjoys substantial expenses at the time of marriage, and it is not inconceivable that these redirect consumption from rich to poor, consistent with an ex ante Pareto optimum in which holders with irrigated land were favored too much.

In summary, Wengala itself may be well approximated by an Arrow-Debreu-McKenzie economy, despite the fact that the village is integrated into the larger regional economy. On the other hand Dalena is not so well approximated, and neither is the larger regional economy of which Wengala and Dalena are village members.

It thus seems that Epstein's southern Indian regional economy is not well

integrated. Recent work of Rashid (1990) suggests that Pakistan is not well integrated at the national level. Thus either the complete markets theory must be abandoned, along with a rush to policy remedies, or one must entertain the idea that in practice there are impediments to trade which alter the prediction of the model.

4. Private Information in a Theory of Fragmented Land Holdings and Consumption Anomalies

In this section of the essay an attempt will be made to construct alternative, private information models to try to explain the anomalies. Private information is regard as a plausible key impediment because of the basic intuition that full insurance is inconsistent with incentives, if there is an information problem, and because so much of the contract theoretic literature is built up around this impediment. Here we to begin at the level of the village economy.

A hallmark of villages in poor, high risk environments is the fragmentation of land into diverse plots, differentiated by soil and location, often planted in diverse crops. This was first made evident to me by some stimulating work of Donald McCloskey (1976) on medieval villages in England. I hasten to add, however, that dispersed plots is a phenomenon that pervades much of the contemporary world, including the ICRISAT Indian villages and those I survey in northern Thailand, as I have already noted. In what follows I shall try to explain English medieval holdings, but the models are applicable to India and Thailand as well.

Maps of land holdings for English medieval villages before enclosures, such those for Laxton in Orwin and Orwin (1954) and for Staffordhire in Homans (1940), reveal a striking, crazy quilt pattern; a typical households's plots of long narrow strips are interspersed though out the lands of the village, typically 30 acres into 30 to 60 separate, nonadjacent strips. Using the amount of land held in each plot relative to the total, one can compute an index of fragmentation on a scale of zero to unity. The value of this index for Laxton is extremely high, .95. One can not help but look at the map of Laxton and wonder why villagers would have put up with the apparent inefficiency.

Statistics on yields of grain in such villages are available from the accounts of the estates of the Bishop of Winchester, from 1209 to 1350. These

vary by location and sample dates, but a coefficient of variation in yields of .35 is roughly the right order of magnitude; this number already adjusts downwards via crop diversification arguments the higher variability of yields for particular grains taken one at a time. At a level of variability of .35, a household would have suffered a shortfall of less than half of average output every 12 or 13 years. Medieval England did suffer from famines at roughly that frequency.

Similarly, from the spatial dispersion of the estates and the data on yields it becomes apparent that correlations across plots fall dramatically with distance. McCloskey adopts a cross-plot summary statistic of .6. If the risk was large, it was not uniform across plots.

McCloskey's thesis is that a typical villager in the poor high risk environment of medieval England held spatially dispersed plots in order to reap the risk reduction advantage of low cross plot correlations. Villagers are supposed to have done this despite an estimated loss of ten percent of average output associated with commuting times, boundary disputes, and other inefficient practices. Other risk reduction devices were either inefficient or supposed not be used. Grain storage from year to year is notably sporadic in the data and can plausible be taken to be zero. Insurance and credit arrangements, e.g. gifts, borrowing-lending, etc., among villagers are supposed by McCloskey to be nonexistent.

If arrangements are endogenous, however, and nothing else is done to alter the model, we run into a salient anomaly. With full information and no problems with contract enforcement nothing would prevent villagers from consolidating plots, avoiding the costs of fragmentation. Ex ante crop and plot diversification would not be needed; it could be replicated in a Pareto improving fashion by specialization and suitable credit-insurance arrangements.

Of course the more village output is pooled via these arrangements the less would be the incentive of a given household to work hard, to be diligent in crop production. Indeed, if individual labor effort and all shocks are were unobserved, then we would have the classic moral hazard, incentive problem of the agency, principal-agent literature. This suggest a model in which both ex ante plot diversification and ex post credit-insurance transfers play a role. Plot fragmentation is costly, but it does help with the incentive problem.

Does an explicit private information model of the medieval village economy rescue McCloskey's explanation of dispersed strips? In particular is

it possible to match the data on output variability, cross-plot correlations, and degree of fragmentation for plausible values of risk aversion, work aversion, costs of fragmentation and aggregate-idiosyncratic shocks, allowing endogenous, information constrained insurance-credit arrangements?

Linear programming methods making use of fractions or lotteries, developed in Townsend (1990), drawing on Prescott and Townsend (1984, a,b) can answer these questions for specific prototypes. To be stressed is that the matching exercise is quantitative, not just qualitative. Orders of magnitude are important.

Imagine in particular that the village consists of two households and that the task is to divide up twelve plots on the circumference of a circle constituting the village land. Complete consolidation corresponds with each household having six plots, all contiguous, so there are two boundary markers in the field. Complete fragmentation corresponds with alternating ownership of plots and twelve boundary markers in the field. More mild diversification possibilities lie between these two extremes. The costs of fragmentation are such that every doubling of the number of boundary markers, #d, costs three percent of output. Specifically, costs for each person are $(\#d)^{.03}-1$. This specification is taken from McCloskey.

Each plot is subject to an unobserved idiosyncratic shock which destroys the plot's output with probability .035 if the household works hard, with effort at unity, and with probability .30 if there is no effort at all. Each plot is also subject to an aggregate shock which hits one plot at random and destroys the output of a random number of adjacent plots as well. The probability of hitting from one to twelve plots is highest at six but falls off gradually on both ends. These idiosyncratic and aggregate shocks, and the consequent choice of actions, produce the over level of risk, the coefficients of variation of outputs. Further, the aggregate shock has an idiosyncratic-like aspect; it produces serially correlated yields across plots. The other, plot-specific idiosyncratic shock is needed because without it output reveals too much. Without it there would be little or no incentive problem. Indeed, retaining an incentive problem in the context of this model turns out to be a somewhat delicate task.

Households are risk averse in consumption at power .5 and labor disutility enters additively with a disutility parameter of either -.5 or -.6.

With the work disutility parameter at either value, the symmetric solution to McCloskey's autarky model, with no expost transfers, is that each

household should hold two noncontiguous holdings, three plots per parcel. This configuration with the other parameters is such that the coefficient of variation in outputs from the holdings is .35 and the cross plot correlation is .60. Thus the model is matched with the data, akin with McCloskey's exercise. The exception is the degree of fragmentation; for these parameters values the index takes on a value of .5 only.

With endogenous information-constrained transfers the picture can change. The solution to the linear program is sensitive to the work disutility parameter. At .5 the solution is full consolidation, so that each household owns one half the circle, six plots per parcel. Thus we fail to rescue McCloskey's solution. Households do suffer more variability in their outputs under consolidation than under the fragmented autarky solution. But these outputs are smoothed by sizable ex post transfers. The information structure along with the rest of the environment allow these.

At disutility parameter .6 there is a more acute incentive problem. The above described level of ex post smoothing of consumption would cause a problem with effort. Thus under consolidation transfers would be less and households would suffer increased variability in consumptions. Thus the McCloskey-like level of fragmentation again emerges as optimal, though there are numerous transfers nonetheless. Indeed, transfers are facilitated at the fragmentation solution because differences in outputs across the two households are more easily attributed to differential effort.

It thus seems that if we are to rescue McCloskey-like levels of fragmentation, the disincentive aspect of the model must be of great importance. That is, the disutility parameter λ must be high. Alternatively, the gain to diversification must be large; the risk aversion parameter α must be high. Still, it is not clear one can simultaneously vary parameters λ and α in such a way as to continue to match the data on yields. A third possibility that would enhance fragmentation in medieval England is that the costs of fragmentation were lower than has been supposed in the numerical simulations.

Apart from these parameter values we should focus on the information structure. The private-information constrained optimum described above assumes that individuals apply uniform effort on all plots. Also, they see in addition to their own effort only ownership-aggregated outputs of both households, not plot specific outputs over all plots. Seeing plot specific outputs, or noisy signals of some of the shocks or efforts, would help in the

matter of inference. Indeed, it seems this kind of information would increase the tendency for ex post transfers to replace ex ante diversification, holding risk aversion, work aversion, and costs of fragmentation fixed. McCloskey-like, high fragmentation solutions appear to be in jeopardy.

In summary, the amended information models suggest only modest plot fragmentation, with insurance achieved by substantial community transfers. This is more reminiscent of the ICRISAT villages in India's semi-arid tropics than the medieval village in England, given the latter's high degree of fragmentation and supposed lack of communal sharing arrangements.

Something is needed to prevent output from revealing too much in medieval England, to prevent expost consumption smoothing and to enhance fragmentation. Perhaps the medieval village economy suffered from idiosyncratic shocks which were of greater importance than are the idiosyncratic shocks in the villages of India's SAT. These idiosyncratic shocks would make inferences more difficult and make the incentive problem more acute. But in this regard a tension emerges. The greater the importance of idiosyncratic shocks, plot by plot, that is the less correlated are shocks overall, the less a household would gain from ex ante fragmentation. This under cuts the ability of the model to explain observed patterns of fragmentation, holding risk aversion, work aversion, and costs of fragmentation fixed. So although private information is needed to sustain the solution with fragmentation (if the latter is costly), too much private information can also lead to an under prediction of fragmentation!

Thus far we have focused on whether private information might help explain the high degree of land fragmentation prevalent in medieval England. Success in this regard has been less than immediate. On the other hand we may have been successful on another dimension. Private information may help in explaining the mild consumption anomalies of economies which do not experience a high degree of land fragmentation, economies such as Aurepalle village.

The inference that private information may help in explaining consumption anomalies is drawn from joint work with Christopher Phelan (forth) on multiple-period information-constrained optima and from some work Phelan (1990) has done on his own with US consumption data. In particular Phelan models an economy with no aggregate shocks and with a continuum of households suffering independent idiosyncratic unobserved shocks to

production functions. He shows in this context that contemporary consumptions respond only mildly to contemporary outputs, with the effect spread out arbitrarily far into the future. This makes deviations from full insurance small but delivers, at the same time, a dispersion of consumption in the population not attributable to differential programming weights.

In an enlarged private information model with with crop production one might guess that profits from crop production would influence consumptions somewhat and that land holdings would explain consumption differences across households beyond the influence of fixed effects. This seems, on the face of it, to be consistent with one of the major anomalies in the consumption data stressed in section 2. A private information model of Aurepalle village economy thus looms large as a reasonable abstraction

Curiously, Phelan's private information model fails to deliver the degree of intertemporal variation in consumption observed in the US, a large regional economy. Despite private information, optimal intertemporal tie ins lead to too much smoothing in the model relative to US data. The model can only partially explain also the degree dispersion of consumption in the US population. There thus emerge a hint that private information models of the regional economy may not be enough to explain consumption anomalies. More work pursuing this line is needed.

5. Measuring Information Impediments in the Village Economy

The extent of private information in a village or regional economy remains problematical, both from the standpoint of theories attempting to explain the anomalies of land fragmentation and slow moving consumptions and from the standpoint of a priori plausibility. To address the premise of private information issue directly I decided to do my own measurement in the field, specifically in nucleated villages in poor, high risk regions of northern Thailand and also in the Indian ICRISAT village of Aurepalle.

Preliminary field work in Thailand has led two separate pretested questionnaires which are now being administered to a sub sample of farmers in three villages in each of four regions. I report here on a careful reading of the completed questionnaires for farmers in the villages of Ban Bon Nah and Sop Wag in MaeJamm district, Chiengmai State. I also report on some parallel conversations with farmers in Aurepalle village.

In the villages in Thailand farmers hold either lowland paddy plots or

upland plots growing dry rice, soybeans, or peanuts. Sometimes they hold both. Thus holdings are diversified over space and crops. Paddy lands lie in relatively flat valley areas, with all the farmers' plots adjacent to one another. Indeed, visually, plots are hard to distinguish from one another. Upland plots are sloped with intermittent cropping, sometimes relatively distant from village. But any given upland plot lies in full view of the plots of a neighboring farmers, and one necessarily crosses plots of different farmers on the hike to one's own plots.

Plot owner P-3 in Ban Bon Nah is a farmer with 2 1/2 rai of paddy, 500 meters from the village, a ten minute walk. His rice yields vary from 95 to 120 tang. He reports that yields of a neighboring farmer, with plots next to his, are different from his, due to the use of more fertilizer, but he is uncertain what the differences in yields will be in any given year. When asked whether he knows the specific amounts of inputs and outputs of neighboring farmers, he reports he does not know, that he doesn't talk to them. Indeed, he reports that he talks about crop operations only to relatives in his immediate, in-resident family.

Plot owner P-1 offers a contrast. He is a farmer with two paddy plots, one a half kilometer from the village, the other five kilometers from the village. He reports he does know the inputs and outputs of a farmer with a plot near one of own because that farmer is a relative, though he does not know about friends nor other people. The claim about the relative was verified though detailed questions. For the relative's plot person P-1 knows the variety of seed, where acquired, and the amount used. He knows by name the owner of the plough that was used for rental, the amount paid, and the depth of tillage. He says there were no problems with water subsequent to planting, no problem in germination. He gives the exact amount of fertilizer and pesticides used and where acquired, and gives the exact amount of the harvest. He says all operations were done in a timely fashion and there were no problems (though he himself had described some problems on his own plots earlier). The only thing does not know is the exact amount of the herbicide.

Finally, we come to plot owner P-8 in Sop Wag. This farmers says he talks with relatives (a son, daughter, and cousin), with four neighbors, and with people from whom he borrows. He volunteers to answer questions about the plot of a nonrelative who has a plot four kilometers west of the village, one which farmer P-8 passes on the way to his own, about twenty minutes away. He knows the amount paid for plough rental and the depth of ploughing, that there

was too little water after planting, that the plot was weeded two or three times by hired labor with knives, and the amount of herbicide. But he does not know the exact variety of seed or the amount, the name of the plough man, if the action was timely, the exact number of hired labor days in weeding, the amounts or types of fertilizer or pesticide, nor the amount of the harvest.

What can we conclude, tentatively? One hypothesis is easily overturned: it is not true that everybody knows virtually everything in a small village (despite the delicate private information modeling problems alluded to earlier). Indeed, some farmers appear isolated, to know relatively little even about neighbors with adjacent plots. Apparently, information is not something one just happens to know by passing a plot on a regular basis or working next to it

Two explanations for this lack of information come quickly to mind. The first is that the incentive information problem is more severe than simple models might imply. The second is that farmers know little because they have no demand for the information. We shall take up each of these explanations in turn.

The potential importance of private information and the scope for incentive problems in farming become clear from intensive conversations with farmers about what is involved in crop production. Specifically, Rolf Mueller, chief economist at ICRISAT, and I have talked with a prominent landowner in Aurepalle for about two hours, finding out about his crop operations and problems in farming a paddy plot in the previous season.

The interview makes clear that a variety of inputs and actions determine crop output. Further, output would appear to be sensitive to modest variations in the amount and timing of these inputs. Thus there are a variety of ways in which one can be negligent in farming. Further, negligence would seem to be hard to see directly by anyone not on the plot. Of course theory tells us that this may not be enough for incentive problems; for the scalar case, at least, one input and one output, unobserved shocks are also needed to prevent full inference of labor effort from crop output. Still, the interview points toward random variables which are key determinants of crop output yet difficult to see directly by anyone not on the plot.

Again, one can conclude from this interview that the scope for moral hazard and incentive problems is large and that the amount of information needed to prevent these problems is enormous. It is apparent also that we need to construct more elaborate prototypes with multiple inputs, multiple stages,

and timing effects in order to think more clearly about actual incentive problems. Is the model with multiple inputs, multiple stages, and timing effects and with a few modest idiosyncratic shocks somewhat akin to the single input, single output case with important idiosyncratic shocks? An answer to this question is needed to evaluate the land fragmentation prototype analyzed above.

Still, even granting that information about the shocks, inputs, and outputs of agricultural operations is at best costly to acquire, one wonders if there is any reason for any villager to make the effort, if there is any demand for information flows among the households. For example, a landowner with a risk neutral tenant would not concern himself with inputs and output of the tenant in an optimal arrangement. The tenant could absorb all risk, paying the landowner a fixed constant; absorbing the residual output, the tenant would make all the decisions. Similarly, suppose many risk averse farmers were on their own but were growing the same crops and experiencing the same shocks. Then there would be no need for insurance or credit transactions among them. There would be no need to keep track of how others are farming. Finally, even in the absence of uniformity, if farmers had more or less efficient self-insurance devices, rice-storage for example, there might be little demand for active community arrangements.

The second Thai, household questionnaire can be brought to bear on these questions, for it solicits from individual farmers the magnitude and timing of the fluctuations they experience as well as how they responded to shortfall years.

Household H-8 in Sop Wag challengers the notion that households know little because there are no potential gains. The best year in the last five for H-8 was 1987 with 200 tang of rice from four rai. The worst was 1988 with 130 tang on the same land. Household H-8 reports that its primary response to this rather dramatic shortfall was to work harder; the secondary response was to borrow. Yet the head of H-8 reports no difference in days work for himself nor for his wife in good years and bad years; as with many villagers, his memory may be poor and he has no records. The loan was twenty tang from a bank, for which he repaid 24 tang. This does not cover the rice gap, or even half of it, and other devices appear not to be used. There is no year to year carry over of rice, and rice is never sold for currency. Remittances from an out-of-resident son are reported as a means of finance, but these are constant. Livestock is bought and sold, namely two pigs every five months, but

H-8 reports that the timing has nothing to do with good years and bad years. Household H-8 reports no help from friends nor relatives.

We are left to conclude that this household bore some of the crop fluctuation in consumption expenditures if not in the labor market. This might have been avoided if H-8 had been linked up to others. But the head says he doesn't talk to anyone outside the household about crop outputs, profits, or incomes, and he receives no help in gifts and loans.

To some extent this story has a parallel with household H-3 in Ban Bon Nah. The difference is that H-3 has only quarter rai of land, and reliable measurement is more problematic. Its best year for peanuts was 1989 at fifteen tang. The worst was 1988 at six tang. The gap in value terms is 550 baht. The head of household H-3 also reports that as a wage laborer his best year was 1989 at 1100 baht, and his worst was 1988 at 200 baht. This increases the gap to 1450 baht, though later he reports his wages in the dry season at 2522, irrespective of the year. The claimed primary response of the head, nonetheless, is that he works harder in bad years. The second response is that he gets help in gifts and loans. For the latter the head lists a small loan from his younger brother at forty to fifty baht, with open-ended repayment. This does not make up half the income gap. This household head reports that he talks to his brother-in-law but knows nothing about anyone.

On the other side of the ledger in terms of smoothing, but not communication, is household H-6 in Sop Wag, a relatively well to do farmer with a radio and his own tractor. (No one is rich in these villages). H-6 appears to be on its own, smoothing with livestock and with currency from crop sales. Its best year in crop output was 1987 with 350 tang of rice from five rai and with unspecified soybeans from four rai. The current 1989 yield was 300 tang of rice, a rice gap in value terms of 1500 Baht (though this rice is never sold). Revealing perhaps, H-6 claims there are no bad years, though he gives as a reason his use of fertilizer. In fact, household H-6 buys and sells ample livestock: cows, pigs,and chickens. The numbers are large enough to smooth the gap and to be an independent source of risk. Further, currency from the sale of soybeans, 2400 baht, is used to buy food and equipment, and H-6 says he has enough cash on hand to last an entire year! Thus H-6 has ample own-smoothing devices. On the other hand, household H-6 neither borrows nor lends, and the head reports he talks to no one.

A contrast in terms of communal smoothing and communication is offered by household H-7 in Sop Wag. Household H-7 smoothed a crop fluctuation of 100

tang rice in 1986 versus fifty-seven in 1985 by working harder and with gifts and loans from relatives. As for the work, the head of H-7 was able to document a difference in days worked and wages both for himself and for his in-resident sister, enough to make up the gap of 1010 baht. And, in contrast to the above cases, the head of H-7 borrowed 200-300 baht per month from older brother, for two or three months at a time and 800 to 1000 baht from two older sisters. None of these loans bore interest. A community fund also provided a loan of 1500 baht at three percent interest. Equally striking, the head of H-7 admits to lend in zero-interest open-ended loans in goods years, to his brother at 500 baht and to his friends at twenty, thirty, and 100 baht.

The head of household H-7 talks to farmers who are nearby and to neighbors with whom he borrow and lends. He agrees to answer questions about good years and bad years for other people. Specifically, H-7 gives the crop yields of a friend and knows that in a bad year the friend sold livestock and got a loan. Yet he doesn't know the revenue from these sales, nor who gave the loan, nor if remittances were increased, nor if consumption was diminished.

Household H-4 in Ban Bon Nah is a similar case. It had a crop gap of 1100 baht which was more than filled in by increased hours in the forest, valued at of 3700 baht. The head of H-4 borrowed as well from his uncle, 25 tang of rice worth 750 baht at 20% for one year and 2000 baht cash at 5% per month. There was also a fifteen tang loan from the bank at 30% per year.

The head of household H-4 reports he talks to family and friends (but not to the bank). He answers questions about the uncle for who whom he works in labor exchange. He knows the amount of the harvest in a bad year; that there was no carry over of grain in the bin; that livestock was sold for 10,000 baht; that the wife and children planted soybeans for daily wages, though he can't remember the total; that a loan from the BAAC was acquired, though he doesn't know the interest; and that the children send remittances, though he does know the amount.

One draws from these case studies the sharp impression that farmers who borrow and lend from each other also talk to one another, though knowledge of household finances is far from perfect. Curiously, smoothing devices seem more than ample for these farmers. They also appear more able to answer questions about labor supply, a sign of education. In contrast are those households in the same village, both the poor and the relatively well to do, who smooth

adverse shocks with increased labor or buffer shocks on own their own. Both these types of households are relatively isolated. In a costless information world with no incentive problems these two types of households might fill in the market.

However, the plot questionnaire reminds us that information is not costless, that there is ample scope for incentive problems. This raises two related questions. The first is whether it is possible nonetheless to fill in the otherwise thin market, to induce borrowing and lending if not more sophisticated insurance arrangements among these poor and modestly-well-to-do households, with the requite information flows. The second is whether information is good, perhaps close to perfect, among agents who have entered into such arrangements, or whether even for these agents information is sufficient costly that is not gathered or communicated all the time.

These questions can be answered for villages in another environment, specifically for Aurepalle village and the other two ICRISAT villages in India. Again, it appears from the ICRISAT data that most households in the villages have managed to become linked up to another another in some sort of communal smoothing arrangement. So for some environments, then, the answer to the first question may be yes, it is possible to link up people in some kind of market. Further, we know in Aurepalle how this is done: most credit transactions take place though a small number of lenders, a striking hierarchical pattern. In the other ICRISAT villages, Shirapur and Kanzara, most credit and gift transactions are coded as taking place though family and friends, in the informal market as it were. Of course this discussion begs the issue of whether the environment of ICRISAT Indian villages and the environment of the Thai villages are sufficiently similar that the communal sharing arrangements of the Indian villages are feasible for Thai villages.

As to the second question, how good are the information flows among households in a credit relationship, this again can be answered for Aurepalle village from the conversation with two of Aurepalle's lenders.

How diligent are the lenders in finding out about about the crop operations and inputs of their client borrowers on lands they do not own? The answer is, fairly diligent. In particular the lenders enumerated the list of key factors which affects crop yields: timely planting of the nursery, correct water level, the weather, pests, weeding, and the amount of seed and fertilizer. They try to keep track of these things, paying attention to the water level in wells, whether pumps are on, and whether fertilizer is

purchased.

One lender made a point of telling us that they know who can be trusted. One client borrower who financed fertilizer through the lender, a typical practice, was given an invoice to be presented for pickup at a district store owned by a friend of the lender. In this way, the lender knew the fertilizer was brought with the loan. Implicitly, though, the lender is was telling us he did not actually see the fertilizer applied to the field. And a lender, co tenant in an earlier conversation made clear he was not constantly supervising operations and conditions even on his own field.

Thus it seems information flows are not perfect even in a village the consumption data of which resembles those of the Arrow-Debreu-McKenzie complete markets model. This is consistent the the mild consumption anomalies in Aurepalle, as reported in section 2, and the fact the Aurepalle villagers care about diversified land holdings, as analyzed in section 3.

This suggests one of two things for the Thai villages, assuming the environments of the Indian and Thai villages are sufficiently similar. The first is that consumptions co move in the Thai villages, despite appearance to the contrary from the questionnaires . The second, which seems more likely, is that welfare improving interventions are possible in the Thai villages, making up something of the thin financial market. The analysis suggests this is possible without requiring perfect information flows.

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21

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78