Contract Economics

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Understanding the Structure of Village and Regional Economies

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1 Introduction

This chapter 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 a 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 particular.

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, although 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 a 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 chapter 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 these two literatures are combined, solving for a Pareto optimum for an entire village or regional economy.

The starting point of the chapter, 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, are 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 by 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 *ex ante* crop and plot diversification is balanced off against the possibility of *ex post* 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 that 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 find 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, although there are occasional individuals who are quite well informed. It also seems from

preliminary results that the financial markets in these Thai villages are "thinner" than 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 chapter is the premise that Pareto-optimal allocations should be a good benchmark for the study of 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 gets 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 Diamond (1967), Wilson (1968), and Scheinkman (1984), and the empirical work of Leme (1984), Abel and Kotlikoff (1988), Mace (1988), Cochrane (1989), Altonji et al. (1989), 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 of 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 numbers 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 that is not absorbed by the larger regional economy.

Observationally, the complete markets hypothesis is attractive because the data are available. That is, one is in a rare position in being able 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 villages in southern India: Aurepalle in Andhra Pradesh, and Shirapur and Kanzara in Maharastra. Forty households in these villages were sampled at four-week intervals for up to ten years. Consumption and labour 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 of distinct production technologies, varying by crop, irrigation status, and soil type. The dominant 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 dominant consumption item. There are two dominant soil types, medium-to-shallow-black and shallow-red. Judging by variance–covariance statistics on yields, soil types matter for the production of dry-land crops. The crops themselves have significant nonunitary covariance 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 location of dry-land plots matters even controlling for crop and soil type. The second class of shock is the incidence and extent of crop disease.

Crops are produced with human labor and bullock power, although input intensities vary over crops and soils. Other inputs, such as 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 percent 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. At 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 that 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 space to describe? Basically, individual consumptions show a high degree of comovement with per capita, average village consumption for all three villages. This is revealed by time-series plots of 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 that is equal to unity, at the 95 percent confidence level. The theory predicts a unitary value, at least for specific functional form.

Controlling for fixed effects across households owing 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 that 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 percent of the households. The results in logs of variables are similar, and results are also similar 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 0.06, 0.05, and 0.03 respectively, with the first two terms significant at the 90 and 95 percent confidence levels respectively. Again, the theory says that these variables should not enter at all. Nevertheless, the coefficient values, being somewhat akin to marginal propensities to consume, are small. The largest such number is a coefficient of 0.12 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 of sickness, unemployment, and all-reasons-for-not-working, only the last is significant at the 90 percent 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 that according to Cain (1981) and Walker and Ryan (1990) 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 are 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,

Dalena is a dry-land village on the fringe of the irrigated area. Although 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 Second World War they became active in grain mills, processing illegal paddy. Currently, at the time of the Epstein study, about 13 percent of the male population work 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 22 percent of Dalena's cash receipts comes from manufacturing and trading profits, and 10 percent comes from 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 comovement.

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 as severely affected; they had sufficient water for irrigated ragi and paddy crops. Again, in an Arrow–Debreu economy shocks

that 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 although many Dalena farmers have credit with their employers and clients outside the village, one doubts that this mechanism is sufficient to accomplish the required comovement.

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 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 overtaken 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 of entrepreneurship, while poor ones, especially the untouchable class, lie in 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 by 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 an attempt will be made to construct alternative, private information models to try to explain the anomalies. Private information is regarded 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 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, and 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 are 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 as those for Laxton in Orwin and Orwin (1954) and for Staffordshire in Homans (1941), reveal a striking, crazy-quilt pattern: a typical household's plots of long narrow strips are interspersed thoughout the lands of the village, typically 30 acres in 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, 0.95. One cannot 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 0.35 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 0.35, 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 0.6. 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 10 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 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, 1984a,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 12 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 12 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 3 percent of output. Specifically, costs for each person are $(d)^{0.03} - 1$. This specification is taken from McCloskey.

Each plot is subject to an unobserved idiosyncratic shock that destroys the plot's output with probability 0.035 if the household works hard, with effort at unity, and with probability 0.03 if there is no effort at all. Each plot is also subject to an aggregate shock that 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 0.5 and labor disutility enters additively with a disutility parameter of either −0.5 or −0.6. With the work disutility parameter at either value, the symmetric solution to McCloskey's autarky model, with no *ex post* 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 0.35 and the cross-plot correlation is 0.60. Thus the model is matched with the data, akin with McCloskey's exercise. The exception is the degree of fragmentation; for these parameter values the index takes on a value of 0.5 only.

With endogenous information-constrained transfers the picture can change. The solution to the linear program is sensitive to the work disutility parameter. At 0.5 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 0.6 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. The McCloskey-like level of fragmentation again emerges as optimal, although 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 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 that 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 that 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 *ex post* consumption smoothing and to enhance fragmentation. Perhaps the medieval village economy suffered from idiosyncratic shocks that 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 undercuts 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 to 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 that 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 (Phelan and Townsend, 1991) 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 that is not attributable to differential programming weights.

In an enlarged private information model 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 USA, a large regional economy. Despite private information, optimal intertemporal ties lead to too much smoothing in the model relative to US data. The model can also only partially explain the degree of dispersion of consumption in the US population. There thus emerges 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 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 to two separate pretested questionnaires, which are now being administered to a subsample 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 Mae Jamm district, Chengmai 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 the village. But any given upland plot lies in full view of the plots of 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 2½ rai of paddy, 500 meters from the village, a ten-minute walk. His rice yields vary from 95 to 120 tang.[3] 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 that he does not know, that he does not 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 that he does know the inputs and outputs of a farmer with a plot near one of his own because that farmer is a relative, although he does not know about friends or 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, and no problems 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 (although he had described some problems on his own plots earlier). The only thing he 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, which is four kilometers west of the village, and through 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 or amount of seed, 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, or 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. I 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 that 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.

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 outputs 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 challenges the notion that households know little because there are no potential gains. The best year in the past 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 20 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-residence 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 or 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 does not 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 a quarter rai of land, and reliable measurement is more problematic. Its best year for peanuts was 1989, at 15 tang. The worst was 1988, at 6 tang. The gap in value terms in 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, although 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 40–50 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, headed by 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 (although this rice is never sold). Revealingly perhaps, H-6 claims there are no bad years, although 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 of rice in 1986 versus 57 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-residence 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 an older brother for two or three months at a time, and 800–1000 baht from two older sisters. None of these loans bore interest. A community fund also provided a loan of 1500 baht at 3 percent interest. Equally striking, the head of H-7 admits to lending in zero-interest open-ended loans in good years, to his brother at 500 baht and to his friend at 20, 30, and 100 baht.

The head of household H-7 talks to farmers who are nearby and to neighbors with whom he borrows 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 does not know the revenue from these sales, who gave the loan, if remittances were increased, or 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 3700 baht. The head of H-4 also borrowed from his uncle: 25 tang of rice worth 750 baht at 20 percent for one year and 2000 baht cash at 5 percent per month. There was also a 15 tang loan from the bank at 30 percent per year.

The head of household H-4 reports that he talks to family and friends (but not to the bank). He answers questions about the uncle for 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, although he cannot remember the total; that a loan from the BAAC was acquired, although he does not know the interest; and that the children send remittances, although he does not 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, although 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 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.

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 sufficiently costly that it 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 one another in some sort of communal smoothing arrangement. So for some environments the answer to the first question might 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 through 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 through family and friends, in the informal market, as it were. Of course this discussion begs the question of whether the environment of ICRISAT Indian villages and the environment of the Thai villages are sufficiently similar for the communal sharing arrangements of the Indian villages to be 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 that affect 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 a purchase order 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 bought with the loan. Implicitly, though, the lender was telling us that he did not actually see the fertilizer applied to the field. And a cotenant lender, in an earlier conversation, made clear he was not constantly supervising operations and conditions even on his own field.

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

This suggests one of two things for the Thai villages, assuming that the environments of the Indian and Thai villages are sufficiently similar. The first is that consumptions co-move in the Thai villages, despite appearances 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 that this is possible without requiring perfect information flows.

Notes

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1. A rai is a unit of area equal to 0.4 acres (0.16 hectares). A tang is a unit of volume or capacity equal to 20 liters.

References and select bibliography

Abel, A. and Kotlikoff, L. (1988) Does the consumption of different age groups move together? A new nonparametric test of intergenerational altruism. Unpublished manuscript.

Altonji, J., Hayashi, F. and Kotlikoff, L. (1989) Is the extended family altruistically linked? Direct tests using micro data. NBER Working Paper no. 3046.

Altug, S. and Miller, R. A. (1990) Household choices in equilibrium. *Econometrica*, 58, 543–70.

Arrow, K. (1953) Le rôle des valeurs boursières pour la répartition la meilleure des risques. *Econométrie Colloques Internationaux du CNRS*, 2, 41–7.

Bell, C., Srinivasan, T. N. and Udry, C. (1988) Agricultural credit markets in Punjab: segmentation, rationing and spillover. Unpublished manuscript.

Binswanger, H. and Rosenzweig, M. (1986) Behavioral and material determinants of production relations in agriculture. *Journal of Development Studies*, 32, 503–9.

Cain, M. (1981) Risk and insurance: perspectives on fertility and agrarian change in India and Bangladesh. *Population and Development Review*, 7, 435–74.

Carroll, C. and Summers, L. (1989) Consumption growth parallels income growth: some new evidence. Unpublished manuscript.

Cochrane, J. (1989) A simple test of consumption insurance. Unpublished manuscript.

Debreu, G. (1959) *Theory of Value: an Axiomatic Analysis of Economic Equilibrium*. New York: Wiley (for Cowles Foundation).

Diamond, P. (1967) The role of a stock market in a general equilibrium model with technological uncertainty.

Epstein, T. S. (1962) *Economic Development and Social Change in South India*. Manchester: Manchester University Press.

Green, E. (1987) Lending and the smoothing of uninsurable income. In E. Prescott and N. Wallace (eds), *Contractual Arrangements for Intertemporal Trade*, Minneapolis: University of Minnesota Press, 3–25.
Grossman S. and Hart, O. (1983) An analysis of the principal agent problem. *Econometrica*, 51, 7–45.
Hayashi, F. (1987) Tests for liquidity constraints: a critical survey. In T. Bewley (ed.), *Advances in Econometrics – Fifth World Congress*, Cambridge: Cambridge University Press.
Harris, M. and Raviv, A. (1979) Optimal incentive contracts with imperfect information. *Journal of Economic Theory*, 20, 231–59.
Harris, M. and Townsend, R. (1981) Resource allocation under asymmetric information. *Econometrica*, 49, 33–69.
Holmstrom, B. and Hart, O. (1987) The theory of contracts. In T. Bewley (ed.), *Advances in Econometrics – Fifth World Congress*. Cambridge: Cambridge University Press, 71–155.
Homans, G. C. (1941) *English Villagers of the Thirteenth Century*, Cambridge, MA: Harvard University Press.
Jodha, N. S. (1978) Role of credit in farmer's adjustment against risk in arid and semi-arid tropical areas of India. Mimeo, ICRISAT.
Kochnar, A. (1989) An empirical investigation of rationing constraints in rural credit markets in India. Unpublished manuscript, University of Chicago.
Koopmans, T. C. (1947) Measurement without theory. *Review of Economic Statistics*, 29, 161–72.
Leme, P. (1984) Integration of international capital markets. Unpublished manuscript, University of Chicago.
Mace, B. (1988) Consumption volatility: borrowing constraints or full insurance. PhD dissertation, University of Chicago.
McCloskey, D. (1976) English open fields as behavior towards risks. *Research in Economic History*, 1, 124–70.
McCloskey, D. and Nash, J. (1984) Corn at risk, the extent and cost of grain storage in medieval England. *American Economic Review*, 74, 174–87.
Menchiv, J. P. (1989) Female-headed/family-supporting households in India: who are they and what survival strategies are possible for them? Unpublished manuscript.
Mirrlees, J. A. (1975) The theory of moral hazard and unobservable behavior, part I. Mimeo, Nuffield College, Oxford.
Myerson, R. (1979) Incentive compatibility and the bargaining problem. *Econometrica*, 47, 61–74.
Myerson, R. (1982) Optimal coordination mechanisms in generalized principal-agent problems. *Journal of Mathematical Economics*, 10, 67–81.
Myerson, R. (1986) Multistage games with communication. *Econometrica*, 54, 323–58.
Orwin, L. S. and Orwin, C. S. (1954) *The Open Fields*. Oxford: Clarendon Press.
Painter, S. (1964) *Medieval Society*. New York: Cornell University Press.
Phelan, C. (1990) Incentives, insurance and the variability of consumption and leisure. Dissertation, University of Chicago.
Phelan, C. and Townsend, R. (1991) Computing multiperiod information-constrained optima. *Review of Economic Studies*, 58, 853–81.

Postan, M. M. (1972) *The Medieval Economy and Society*. Harmondsworth: Penguin.
Pounds, N. J. G. (1974) *An Economic History of Medieval Europe*. New York: Longman.
Prescott, E. and Townsend, R. (1984a) General competitive analysis in an economy with private information. *International Economic Review*, 25, 1–20.
Prescott, E. and Townsend, R. (1984b) Pareto optima and competitive equilibria with adverse selection and moral hazard. *Econometrica*, 52, 21–46.
Radner, R. (1981) Monitoring cooperative agreements in a repeated principal-agent relationship. *Econometrica*, 49, 1127–48.
Raftis, J. A. (1957) *The Estates of Ramsey Abbey*. Toronto: Pontifical Institute of Mediaeval Studies.
Rashid, M. (1990) Rural consumption: the evidence from Pakistan. University of Chicago Working Paper.
Rogerson, W. (1985) Repeated moral hazard. *Econometrica*, 53, 69–76.
Rosenzweig, M. (1988) Risk, implicit contracts and the family in rural areas of low-income countries. *Economic Journal*, 98, 1148–70.
Rosenzweig, M. and Stark, O. (1989) Consumption-smoothing, migration, and marriage: evidence from rural China. *Journal of Political Economy*, 97, 905–26.
Ryan, J. G., Bidinger, R. D., Pushpamma, P. and Rao, P. P. (1985) The determinants of individual diets and nutritional status in six villages of Southern India. Research Bulletin no. 7, ICRISAT.
Ryan, J. G. and Ghodake, R. D. (1980) Labor market behavior in rural villages of South India: effect of season, sex, and socioeconomic status. Mimeo, ICRISAT.
Schehtman, J. (1976) An income fluctuation problem. *Journal of Economic Theory*, 12, 218–41.
Scheinkman, J. (1984) General equilibrium models of economic fluctuations: a survey of theory. Unpublished manuscript, University of Chicago.
Shaban, R. A. (1987) Testing between competing models of sharecropping. *Journal of Political Economy*, 95, 893–920.
Singh, R. P., Binswanger, H. P. and Jodha, N. J. (1985) Manual of instructions for economic investigators in ICRISAT's village level studies. ICRISAT, revised May.
Spear, S. and Srivastava, S. (1987) On repeated moral hazard with discounting. *Review of Economic Studies*, 180, 599–618.
Titow, J. Z. (1972) *Winchester Yields*. Cambridge: Cambridge University Press.
Townsend, R. (1979) Optimal contracts and competitive markets with costly state verification. *Journal of Economic Theory*, 21, 265–93.
Townsend, R. (1982) Optimal multiperiod contracts and the gain to enduring relationships under private information. *Journal of Political Economy*, 90, 1116–86.
Townsend, R. (1987) Economic organization with limited communication. *American Economic Review*, 77, 954–71.
Townsend, R. (1988) Information constrained insurance: the revelation principle extended. *Journal of Monetary Economics*, 21, 411–50.
Townsend, R. (1990) *The Medieval Village Economy: a Study of the Pareto Mapping and General Equilibrium Models*. Princeton, NJ: Princeton University Press.

Udry, C. (1989) Rural credit in Northern Nigeria: testing the role of credit as insurance. Mimeo, Yale University.
Walker, T. S. and Ryan, J. G. (1990) *Village and Household Economies in India's Semi-arid Tropics*. Baltimore: Johns Hopkins University Press.
Wilson, R. (1968) The theory of syndicates. *Econometrica*, 36, 199–32.
Yaari, M. E. (1976) A law of large numbers in the theory of consumer's choice under uncertainty. *Journal of Economic Theory*, 12, 202–17.

Comments by Armen A. Alchian

Townsend's report of a study of consumption behavior in villages of India and Thailand is informative and interesting. Yet, its professed scope and analytic procedures appear to me like using a powerful IBM 3090 computer to sum my strokes in a round of golf. What creates that impression is the frequent reference, or appeal, to Arrow–Debreu–McKenzie general equilibrium models. That made me search my library to refresh my memory of the details and nuances of those models. But that was, I soon discovered, unnecessary. My understanding, and I admit to some uncertainty, is that one of the things Townsend was testing for was consumption smoothing over periods of transient fluctuations of income. Another was the dependence of individual smoothing of consumption on aggregate community income rather than on an individual's transient fluctuations. Neither require the powerful, general Arrow et al. model. The continued reference to it made me wonder whether the investigation was to test that model's deeper implications or to test the well-known standard consumption smoothing implication. I do not believe it is the deeper added implications of the Arrow et al. model that are being tested.

First, the smoothing implication is obtained from the simple, old Fisherian intertemporal trade-offs in capital and interest theory. With borrowing and lending a person will trade to a preferred position. And given the convex preference function, two transiently disparate points, movements will be toward an internal equilibrium, by a process of lending or borrowing with various types of debt instruments or real goods. Alternatively, the analyst could resort to the permanent income or constant wealth life-cycle models to derive the same implication. I am not denying that the Arrow et al., or the Friedman permanent income, or the Modigliani life-cycle models are useful. I merely emphasize that the proposition is well known and implied by the simple model. By embedding his useful research in the more abstruse models, Townsend will, I fear, give it less impact.

Second, an apparently stronger or wider implication is that everyone in the community will smooth consumption over aggregate societal transient income fluctuations, as well as over (not rather than?) individual transient income fluctuations. Again this is an implication of the Fisher model in

which people borrow and lend current income rights in a *common* market. If one person's transient income fluctuated opposite to everyone else's or was constant, that person would be a lender while others are borrowers, and the reverse would occur at other times. The common interest rate, as a measure of consumption time preference of all participants, implies the same consumption pattern, though not the same absolute amounts. Hence the transient fluctuations in aggregate income are ameliorated, with everyone responding to the same pattern, with more or with less borrowing depending on the differences in personal transient income fluctuations.

I now seek some clarification of the meaning of the variability and fluctuations in income over which consumption is supposed to be smoothed. Seasonal patterns in agriculture could be an example. We know summer is followed by winter. We know a growing season (during which "income" is earned) is followed by an interval of no income in the winter. A summer income is not taken as an increase in wealth, because it is predictable. But an "unusually" good crop, a deviation above the expected, is taken as a wealth increase and should affect the level of consumption permanently to some degree. Similarly, a stock price fluctuates, but every rise and every fall is a wealth change, a permanent wealth change in the sense that the expectational value of wealth is affected. A rise is not expected to be followed by an offsetting fall. A rise is not treated as a temporary event. Its effects persist forever, although they are swamped (not eliminated) by later changes. My conjecture is that many shocks, changes, deviations, variations – whatever one calls them – are not purely transient reversible events. Good luck does not augur an increased probability of later bad luck. Fluctuations that are permanent, like stock price or crop fluctuations, constitute changes in wealth – though admittedly they are small because the length of future persistence of the shock is short.

The point is that it appears that the variability – I conjecture – is comprised of Martingale-type changes: successively independent additions to income that permit some greater saving and hence increment-wealth with a permanent, though admittedly small, rise in consumption. If these occur for individuals in the community, then it follows, I believe, that individual consumption patterns will not be the same for everyone. Or as Townsend states it, everyone's consumptions are "determined by per capita average consumption in the population, only, and must move monotonically with it." That is the implication of one model, but I am not prepared to accept it in preference to one in which some of the "variations" in wealth are those of a random sequence of independent, rather than negatively correlated, draws from a stationary distribution.

In any event, the observations reported by Epstein and by Townsend appear to me to be more consistent with independent shocks, in which smoothing would not be determined solely by the community aggregate. Furthermore, not everyone receives the same independent shocks, so their wealths do not change together. Smoothing of those wealth changes is not implied. Only if the shocks are of the transient, reversing, later offsetting kind, will the consumption patterns be the same for all, with smoothing as well.

I was unable to decide what the McCloskey–Phelan models are supposed to do here, except demonstrate the conflict between the incentive effect of shared ownership and the effects of segregated property ownership on incentives and willingness to share. The examples of McCloskey and Phelan, it appears to me, illustrate the problem rather than provide new implications.

Passing beyond these gratuitous remarks, it appears that in the small villages consumption is smoothed, imperfectly. However, the only measures of consumption referenced are those of Epstein. What those data were like is not indicated, nor how they were collected or how consumption was measured. I do not regret that I had no time to spare from other activities to get Epstein's book and see what I could learn there. Nevertheless, I am willing to believe that some smoothing occurred, though not perfect, whatever perfect means.

So we end up with the conclusion that some sharing does occur, so that consumption fluctuations are not perfectly correlated with individual income fluctuations, nor perfectly correlated with the group's aggregate income. What was interesting, informative, and, I believe, the more significant part of the research was the ways in which incomes were borrowed, loaned or transferred during the fluctuations. Details of the ways in which individual effort and behavior would affect output in the studied villages and the ways in which behavior was detected and the sharing accomplished could reveal institutions and devices similar to or different from those in wealthier areas. Just as steel gets produced despite a cost, so information is produced and used despite its cost. A model of costless information is about as useful a starting point as one in which steel is produced costlessly. The chapter's contribution is not in testing whether the costless information model is pertinent, as it certainly is not.

I cannot avoid the temptation to remark that the extent to which a costless information and costless transaction model is employed by economists in general as a sort of standard of comparison or extreme is startling to me. The reason is that zero-cost implications seem not to have been fully discerned. The analogy would be a world of costless production costs, a situation I find impossible to comprehend. And for a situation of costless information and contracting, there would be no written contracts. Indeed, what is meant by a contract in such a world, of no lawyers and perfect security of property rights (contracts to respect property rights are costless to enforce!), boggles the imagination. Certainly, the implications of that

unimaginable world have not been appreciated by those who identify "perfect" markets with costlessness of "contracts."

I started this comment by saying the paper was interesting and informative. It was interesting to me in that it provoked reminiscences of my childhood as a member of a large loosely extended family including uncles, aunts, and cousins (to various degrees), though, of course, not living together. Sharing by loans, gifts, and type of work offered, were related to not completely private information about diligence, effort, and consumption attributes of various "members." Farming especially was conducive to work sharing or lending because of the variety of tasks in which help could be given. Sharing took place not merely by grants of consumption rights, but by working on relatives' farms to smooth out idiosyncratic disasters. And at the same time, the extent to which information about other persons' actions, motives, effort, diligence, etc., was incomplete and yet extensive was impressive (though I never knew how reliable it was). After all, within a small family, do the parents know what their children are doing, or the wife know about the husband?

What was interesting was Townsend's description of the techniques of smoothing. Smoothing is a result of capital markets, however informal they are. Townsend's contribution, as I see it, is in showing us how pervasive capital "markets" are for smoothing, even where no capital markets exist in a formal contractual sense. I trust that on his next visit, if one there be, to Southeast Asia, he will be able to add to that lore.

Comments by Thráinn Eggertsson

Townsend's fascinating chapter is a challenge to all of us who claim that the Walras–Arrow–Debreu general equilibrium perspective is of little use in the study of comparative institution (see, for example, Stiglitz, 1989; Eggertsson, 1990). We should have learned that in science the path is uncertain and no one can foretell where light may shine.

The first general equilibrium model considered by Townsend, the complete markets model with risk-sharing, predicts certain comovements in consumption. The model tells us, for instance, that, household output or income does not affect household consumption, if we control for household wealth and aggregate consumption. Townsend reports that a careful test of the model using an extensive data set for three agricultural villages in an arid region of south India reveals that the consumption of individuals shows a high degree of comovement with per capita average village consumption. However, the data do not fit perfectly the predictions of the theory; the author reports mild consumption anomalies in the village economies, such as a weak unexplained relationship between household income and household consumption. Furthermore, according to another study, relatively large consumption anomalies are found in the village of Dalena, where market relationships have replaced traditional caste and patron relationships. In other findings it is reported that average village consumption predicts household consumption more accurately than average consumption in a region consisting of several villages. Finally, reference is made to theoretical and empirical work by Phelan, who has used US consumption data. Phelan's work suggests that the complete markets model can explain only partly the behavior of consumption in the United States. Even the application of a private information model fails to explain consumption anomalies in the USA fully.

I find these results interesting. First, they support the notion that the allocation of resources in traditional economies, especially in stationary economies, may be relatively efficient. If markets are missing in such economies, presumably because of high transaction costs, various individual and collective arrangements take the place of markets. If the households live on the brink of starvation, various forces work to select efficient

arrangements.[1] Arguments along these lines are found, for instance, in Posner's (1980) classic study of primitive societies, but is is nice to see that results from sophisticated empirical studies of agricultural villages in the Third World support these conclusions.

My second point concerns the relationship between, on the one hand, the degree of consumption anomalies and, on the other, specialization, technical change, and the development of markets. It seems quite possible that the realization of optimal outcomes as predicted by the complete markets model has a rather weak correlation with the prevalence of market exchange in the economy. In order to test this notion it would be interesting, for instance, to compare the degree of consumption anomalies found in a test of the general equilibrium model on data from the Indian village of Aurepalle and on data from a small (or large) town in the United States.

Perhaps the cost of achieving full insurance (and other outcomes of the full information model) is relatively high in mature industrial economies where economic agents are very specialized, experience rapid technological change, and trade across integrated markets that cover large areas. One can imagine general equilibrium models with private information where it is rational for agents in such an environment to introduce collective non-market risk-reducing arrangements; if you like, some version of the welfare state.

Townsend makes an important point when he states that one virtue of the complete markets model with risk-sharing is that it "does not require one to scrutinize any individual market or risk-sharing arrangement. To test the theory one need only look at outcomes." However, in my opinion the reverse side of the coin is that the complete markets model is not an abundant source of interesting research questions for the study of comparative institutions. Obviously we will find consumption as well as other kinds of anomalies in all economies. The question is what to do next. The usual complaint about the general equilibrium approach is that it has nothing to say about organizations and institutions. If consumption anomalies are found in a study of US consumers, the general equilibrium approach does not suggest that we take a look at any particular institution, organization or market practice. When consumption anomalies are discovered in agricultural villages in Asia or in medieval England, the model does not tell us whether the anomalies are caused by the scattering of plots or whether scattering of plots is an ingenious way of correcting consumption anomalies. However, Townsend is well aware of the conventional criticism of the general equilibrium approach and seeks to bypass the limits of the approach by combining the theory of general equilibrium with the mechanism-design and contract-theoretic literature in order to forge a theoretical apparatus for understanding economic organization. These theoretical constructs are used in the chapter's fourth section to explore a

classic issue in economic history, the economic rationale for open fields and scattered plots.

The focus of this very interesting section is on McCloskey's explanation of fragmentation in the common fields of medieval England. McCloskey believes that scattering represents behavior toward risk: the strips were scattered to insure the cultivator against crop failure. However, it is important to note that this form of insurance only stabilizes the household's share in the aggregate output of the village, and does not insure against fluctuations in aggregate output. McCloskey concludes that open fields were inefficient for the narrow purposes of cultivation and estimates that scattering reduced average output by some 10 percent.

Townsend constructs an impressive and complex model with private information and, in a simulation exercise, matches scattering against another form of insurance, pooling of output and transfers. Pooling is costly in a world of private information and moral hazard, as it affects work incentives.

My first comment on this section is that it clearly shows that the general equilibrium approach, when adjusted to allow for private information, has interesting things to say about comparative institutions. However, I am not as ready as Townsend to read much importance into the precise outcomes of the simulation exercises, which are based on a model of two households using a host of rather arbitrary assumptions about output variability, costs of fragmentation, work and risk aversion, the nature of idiosyncratic and aggregate shocks to the production functions, and so on. In other words, it is quite interesting if the model can reproduce dispersed strips but insignificant if it fails to generate exactly the same degree of scattering as McCloskey found in his villages.

My second point is that Townsend's private information model may provide an excellent opportunity to explore an alternative explanation of scattering, which has been advanced by Fenoaltea (1976, 1987), McCloskey's adversary in the common-fields debate. Fenoaltea points out that scattering is a poor substitute for storage as an instrument for reducing risk because only storage and not scattering can insure consumption against fluctuations in aggregate output. I would guess that the poor performance of scattering *vis-à-vis* pooling of output in Townsend's private information model must to an important degree be due to the inability of scattering to insure against aggregate shocks.

Self-insurance by storage appears to be a real alternative to dispersed plots. In fact, we note that the farmers can stabilize their share in the village's annual output and avoid the cost of scattering by trading with each other. Intra-village trade in grain is not likely to involve very high transaction costs. Also note that the storage of grain was practiced in medieval England in order to smooth consumption over the production

cycle, and, of course, the grain used for seed was stored. Furthermore, it seems likely that storage and/or trade in grain were used to smooth the consumption of small cultivators, whose output in an average year was only just above the starvation level. Otherwise, moderate aggregate shocks would have brought frequent starvation to small farmers.

McCloskey argues that insurance through storage was of no significance in the medieval village. First, there are no records of the storage of grain from one year to another, says McCoskey. Second, storage was economically unviable as a risk-reduction arrangement because it was extremely costly. Fenoaltea disputes both of these arguments convincingly enough to be taken seriously. McCloskey argues that most of the high cost of storage was the interest rate, which he estimates at about 30 percent: "Scattering was the cheapest way to insure because the interest rate in the Middle Ages was high" (McCloskey, 1988). However, high interest rates are also an opportunity cost of an insurance system based on fragmentation, which leads to a 10 percent reduction in average output.

It would be quite interesting if Townsend's model could be used to manage a competition between these two contending explanations, storage and scattering, in an attempt to establish which alternative would be chosen by optimizing cultivators, given a reasonable range of values for the parameters. If the outcome is a corner solution with storage as an absolute winner, we need a new explanation of fragmentation, and perhaps also an explanation for the absence of storage in the medieval village, if McCloskey's reading of the records is correct after all.

Fenoaltea's explanation of scattered strips is that the common-fields system was efficient for the narrow purpose of cultivation: it was an arrangement to increase output. He argues that fragmentation is a rational choice in poor, stationary regions where the soil and the weather are extremely variable across a small area. To maximize the output of a village requires assigning labor and other variable inputs to tasks and locations where their marginal productivity is highest, but the optimal allocation of these resources varies unpredictably due to rain, temperature and other factors. If the village is run as a single farm, internal agency costs are prohibitively high. If there are individual cultivators, each holding one consolidated block of land, output maximization in the village will require frequent and costly transactions in the labor market that involve serious problems with incentives. However, according to Fenoaltea, the common-field system combines the advantages of large-scale farming with the relatively low agency and incentive problems of family farming by assigning each cultivator, big or small, individual shares, each collection of strips ideally representing the whole range of available quality of land. With some ingenuity, it seems that Fenoaltea's thesis about scattering could also be given a trial run in a private information model and compared with the alternative hypothesis. In sum, it appears that the augmented general equilibrium approach can become a valuable tool in the study of comparative economic institutions.[2]

In the chapter's final section Townsend reports on field work in villages of northern Thailand and south India, where he has done his own measurements. I find this effort both interesting and laudable, but the reading of this last section leaves me with one strong impression: the general equilibrium approach does not provide a very helpful theory for interpreting, ordering and discarding facts. In the study of comparative institutions, the general equilibrium approach, it seems, is not a fountainhead of new research questions. The research question guiding the field work is basically whether agents in a small community enjoy full information. The investigation establishes that, even in a small Asian village, not everybody knows virtually everything, there is limited communication among the agents, and there is a large scope for moral hazard and incentive problems. Furthermore, it is learned that the efforts of cultivators involve a large number of qualitative margins that are difficult to measure and control.

I do not think that the founding fathers of the general equilibrium approach intended that the assumption of full information should be taken literally as a description of the real world, even of small villages. What we need is a theory that explains how organizations and institutions emerge in response to costly information. To my eyes, Townsend's excellent chapter reads as a tour through the history of economic analysis, a tour that is headed towards a new theory of institutions.

Notes

1 The notion of an environmental adaptation by the economic system comes from Alchian (1950).

2 McCloskey's estimate of the output loss caused by scattered strips is found by measuring the increase in rent with enclosure. McCloskey assumes that the increase in productivity only affected rent and not the income of other inputs, and the rent is supposed to have at least doubled. Here is another topic for a general equilibrium model: "If the doubling of rent with enclosure reflected a productivity increase tied specifically to the change in organizational form, then the cost of choosing open fields over enclosed farms was borne by the landlord, and not at all by the tenants." The (insurance) benefits of enclosures to the landlord must have been worth half his income (Fenoaltea, 1987, p. 34).

References

Alchian, A. A. (1950) Uncertainty, evolution and economic theory. *Journal of Political Economy*, 58, 211–21.

Eggertsson, T. (1990) *Economic Behavior and Institutions*. Cambridge: Cambridge University Press.
Fenoaltea, S. (1976) Risk, transaction costs, and the organization of medieval agriculture. *Explorations in Economic History*, 13, 129–51.
Fenoaltea, S. (1987) Transaction costs, Whig history, and the common fields. Manuscript, Institute for Advanced Study, Princeton University.
McCloskey, D. N. (1988) The open fields of England: rent, risk, and the rate of interest, 1300–1815. In D. Galenson (ed.), *In Search of Historical Markets*. Cambridge: Cambridge University Press.
Posner, R. A. (1980) A theory of primitive society, with special reference to law. *Journal of Law and Economics*, 23, 1–53.
Stiglitz, J. E. (1989) Incentives, information, and organizational design. *Empirica*, 16, 3–29.

6

Contracts and Incentives: the Role of Contract Terms in Assuring Performance

Benjamin Klein

This chapter presents a probabilistic framework for "opportunism" analysis. "Hold-ups" are not based on asymmetric information or deceptive behavior, but are assumed to occur when a sufficiently large unanticipated event destabilizes a contractual relationship between two equally knowledgeable transactors. Within this framework, contract terms chosen by transactors are explained as attempts to minimize the expected "hold-up" probability. Rather than being used to create optimal incentives on some specified court enforceable characteristic or proxy for performance, as in the principal-agent/mechanism design literature, contract terms are chosen within this framework merely to "get close" to desired performance. Transactors rely on their reputations (or, more generally, their private enforcement capital) to move behavior the remainder of the way toward desired performance. By reducing and shifting "hold-up" potentials to more accurately coincide with likely future conditions, contract terms economize on private enforcement capital and define an optimal self-enforcing range of the transactors' contractual relationship.

1 A probabilistic "hold-up" framework

The "opportunism" framework presented in the work of Williamson and in my work with Alchian has, I believe, made an important contribution to our understanding of the role of contracts (Williamson, 1975, 1979, 1985; Klein et al., 1978). It has forced economists to recognize that long-term contracts are not used primarily to allocate "state-of-the-world" risks among transactors according to their relative preferences for risk and their relative abilities to insure against the risk.[1] Instead, it is now understood that contracts can often be explained more satisfactorily as devices that