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AGRICULTURAL ECONOMICS, INTERDEPENDENCE AND UNCERTAINTY*

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Interdependence has always been central to economics but assumes pressing importance for agricultural economists as they deal with industrialising agricultures. Continued unresolvable uncertainties, when properly recognised, also add to the challenge of relevant work in agricultural economics. The related roles of interdependence and uncertainty are illustrated through examples from the progress of agricultural technology and enhancement of food security.

Let me reveal at the outset my two interrelated themes. First, as Holmes (1981, p. 7) has reminded us in his 1980 Giblin Memorial Lecture: 'The greatest economic fact is interdependence'. Here I foreshadow a concern that agricultural economists are too blinkered in staking out their territorial claims. A wider, what might be termed a 'systems', view is desirable, perhaps imperative.

Second, however, is the notion that it is possible only to 'know' so much and, especially as a wider perspective is embraced, uncertainty principles operate to constrain our struggle toward relevance and betterment of the human condition. I will use the term *uncertainty* to encompass several approximate synonyms. For instance, Emery and Trist (1965) have argued that the deepening interdependence between economic and other facets means, *inter alia*, that economic organisations (be they farms or farm organisations) are increasingly enmeshed in regulations and complex dynamic changes. These they summarise as increases in relevant uncertainty or *turbulence*. Again, the term *risk* (in spite of Anderson, Dillon and Hardaker's (1977) treatment of it as an exact synonym) might, for enrichment of our language, better be reserved for situations where there is concern for the consequences of uncertainty.

Uncertainty Principles

It is not a new idea that uncertainty is all-pervasive and that its implications need to be appreciated. Indeed, at least one agricultural economist, Galbraith in *The Age of Uncertainty*, has turned the thought to considerable royalty benefit. Yet, I can't resist coining yet another General Uncertainty Principle: *Learning inspires self-recognition of ig-*

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norance or uncertain understanding. My impression is that, the more we learn, the more we are aware of our limited knowledge – notwithstanding occasional bravado among academic expositors, government advisers and sundry consultants.

General systems thinking is a fertile field for a hybrid discipline such as ours to browse in. Steering a course through the contrary notions that, unless simplifications can be made, required computation increases at least as fast as the square of the number of equations and may easily become infeasible, but that large numbers are required for statistical mechanics to deal adequately with unorganised complexity, Weinberg (1975, p. 20) proposed a cogent variant of Murphy's Law. His Law of Medium Numbers is: *For medium number systems, we can expect that large fluctuations, irregularities, and discrepancy with any theory will occur more or less regularly*. Elsewhere (Anderson and Hardaker 1978) we have argued that some farm systems are of this ilk, but I am convinced that most systems of interest to agricultural economists are 'medium number' systems.

What relevance has all this for the agricultural economist? I hold (Anderson 1972) that, inevitably, scientists (ourseves included) can work only with models of systems. This led me to my (Anderson 1976, p. 229) variant of Mihram's (1972, p. 15) Uncertainty Principle of Modelling: *Systems are sensed and measured as essentially stochastic and modellers should recognise this accordingly*. In short, agricultural economists are at risk of deluding themselves and their clients unless they explicitly handle the inexorable uncertainty in agricultural economics, especially the risk aversion and responsiveness to uncertainty of farmers and others (Just 1974; Anderson, Dillon and Hardaker 1977).[1]

As always, tradeoffs are inherent and judgments unavoidable in decisions as to desirable complexity and stochasticity in models. We may occasionally be acting with propriety to pretend that an outcome (such as a rate of return on an investment) is certain but, if it is more properly represented as a (computable) probability distribution of outcomes, the chances are that we are offending the canon of *full disclosure of information and its quality*. False pretensions of certainty amount to a specialised 'Nirvana' fallacy (Demsetz 1969) and are especially prevalent in assessments of economic efficiency (Dillon and Anderson 1971; Pasour and Bullock 1975).

Relatedly, our clients face many difficulties in assessing information, particularly as encapsulated in a model, through the strangely neglected phenomenon of opaqueness. The difficulty is obvious, albeit seemingly not recognised, with informal 'mental' models but is more subtle with formal complex models. It is not easy to appreciate a model of any complexity. Just a few distributed lags and nonlinear relationships do wonders for opaqueness! Unfortunately, stochastic variables do nothing to ease the burden.

Beyond clients taking opaque information on trust, analysts should seek to expose their models sympathetically and, if possible, provide sen-

[1] For examples, other than those of Anderson (1976), of biases occasioned by mishandling uncertainty as certainty, see Danthine and Donaldson (1981) and Dasgupta and Stiglitz (1981). Further biases may arise from persistent uncertainties in operational methods for dealing with uncertainty. In this regard, for example, Kahneman and Tversky (1982) imply that economists might profit from better acquaintance with psychology.

sitivity analyses (Anderson 1974, pp. 20-3) so that at least the consequences of variations in opaque (i.e. uncertain to the beholder) models can be acknowledged. A sympathetic exposition will, as Simon (1973) counsels, exploit essential hierarchic structures and the usefulness of higher-level structures, rather than the possibly incomprehensible detail of 'microscopic' structures. Listings of computer programs may help little!

Regrettable parallels may be drawn between my advice to agricultural economists that they must deal with uncertainty, and advice from a politician that life isn't intended to be easy and from a physician that one has an incurable disease. But some progress is being made. Enlightened practice seems most prevalent, for example, in research rather than in general professional practice, and in production and resource economics, price analysis and marketing, rather than in trade, development and, especially, policy work.

This brief catalogue of principles could be closed by a further reference to the judgmental dilemma faced by modellers such as agricultural economists. Herewith Lee's (1973) Iron Law of Mathematical Models: *The more a mathematical model captures reality, the less likely it is to be capable of practical application.* Reflect on the practicability of many ambitiously realistic doctoral dissertations in our discipline. However, a happier closing note can be struck by quoting from Kenkō's fourteenth century classic *Tsurezuregusa* (Keene 1967, p. 7): 'The most precious thing in life is its uncertainty'.

Interdependence

The 'greatest economic fact' is also anything but new. It can be deliberated from diverse viewpoints. First take professional interdependence. A diaspora of international agricultural economists prevails, united by a cross-cultural theme and linked by excellent and improving systems of professional communication. But is this disciplinary communication at the expense of better contact with kindred disciplines in the natural and social sciences?

To my knowledge, only in China now is there a gulf deliberately maintained between 'political'/policy agricultural economists and production/farm management economists, an academic and bureaucratic separation common in many countries, including, for example, the U.S.A., pre-1920.[2] The approach of a united profession certainly has its appeal but I do worry that there has been reduced contact particularly with agricultural scientists. I am less pessimistic about our links with other economists, as I think many people in both camps share my confidence that we have much to offer each other. However, as earlier suggested, we have tended to be too narrow in our outlook and too partial in our analyses, be they equilibrium or other—but see, the broadening perspectives of Gregory (1976), Miller (1976), Stoeckel (1979), Campbell (1980, Pt 7) and the columns of Modest Bert Kelly.

[2] Perhaps this may yet change. It is probably a partial consequence of the particular Western technique that China imported this century to clear away the debris of her stable but suffocating tradition of bureaucratic elitist rule. A related problem is the virtual separation of research and teaching functions in Chinese agricultural economics. I anticipate that we outside China can do much to assist in rehabilitating their professional from the effects of a 'lost' professional generation.

Hopefully, the aphorism that 'the future will be like the past, because in the past, the future was like the past' (Weinberg 1975, p. 141) does not apply here.

What Day (1981) calls the 'indirect industrialisation of agriculture' is an interdependence of our times that is important but perhaps has not received due attention. This linkage, although a predominant feature of developed agricultures, is an accelerating aspect of all agricultures (Just, Schmitz and Zilberman 1979).[3] If we fail to perceive linkages correctly, the interdependencies of the world agro-industrial complex presage suboptimisation (van Gigch 1974, p. 282) and crises, in an inherently uncertain pursuit of growth (Abramovitz 1981). Shall we master our uncertain environment through successful epochs of challenge and achievement, the Taoist Yin and Yang of economic development? I illustrate the cautious optimism that I feel through two examples.

A plastic moral

My first case study of interdependence is tackled at the farm level. Those who saw *The Graduate* may recall the patronising drunken line 'I'm gonna give ya just one piece of advice, son . . . Plastics?' I have often reflected on this during my days of agricultural plumbing and have wondered what lessons may be buried for students of technical change in agriculture.

Agricultural economists have given considerable attention to the general topic of technical change over recent decades but usually have approached the subject in rather an abstract way. Here I examine particular technical changes for their origins and impacts. Products from the petrochemical industry are taken as archetypical, modern industrial inputs used in agricultural industries.

Plastics have become so widely used in our lives that we take them for granted. The particular product I focus on is high-density polyethylene (HDP) water pipe. It has virtually replaced the traditionally used, relatively expensive, galvanised steel pipe in agricultural water applications, ranging from pastoral water supply through to pipe-based irrigation systems. It reaches a high point of new technique in latter-day trickle irrigation systems. For my present purpose, however, I will address the use of HDP in stock watering systems. We might think of this case as the other side of the extruded synthetic polymer 'coin' which brings cost savings rather than product competition to wool growers.

To help appreciate the magnitudes involved, on each of Australia's 74 000 grazing properties (Tucker 1981) there was, in 1978, an average of 1.38 km of stock water supply pipe, with averages ranging from 5.42 km in the Pastoral Zone (33.5 km in the Northern Territory sector of this Zone) through 1.68 km and 0.65 km in the Wheat-Sheep and High Rainfall Zones, respectively.[4] Replacement of the galvanised and other steel pipes by HDP pipe proceeds apace, with the percentages of HDP length to total length being 68, 83 and 86 for these Zones, respectively. Piping represents 4.54 per cent of the depreciated capital stock of all stock-water

[3] It is ironic that Australian agriculture, a mere precocious youth in the international agricultural family, should be so 'mature' in its contribution to national output and so inextricably linked to the chemical-manufacturing complexes of the industrial world.

[4] I am grateful to BAE officers, Peter Kerr, Roger Clement, Bill Shaw and Don Barker, for their assistance in taking out these AAGIS data.

related improvements ($9400 for the average Australian grazing establishment in 1978). Current annual expenditure on HDP by Australian graziers amounts to about $3m.

With this backdrop, an economic interpretation can be tackled in two parts. First, there is a simple price reduction effect in using the plastic technology, implying farmers will use more of it, as they are never slow to adopt new, especially cheaper, techniques. Second, there is a technological or quality effect (easy repair, resistance to corrosion and damage etc.) that can be broached by following Griliches's (1957) seminal work on specification bias in production analyses. Employing his device of 'auxiliary' regressions, his simplification of Cobb-Douglas production, his treatment[5] of disregarded quality differences (here in water services), and embellishing the model with a trend variable to capture 'neutral' technological changes, gives most of the required material. I complete the scenario with a presumption, based on evidence such as the above, that all the 'auxiliary' coefficients in the 'quality' regression are positive, particularly trend. The uncertain results from this model—they are only expectations—can then be enumerated for inadequate accounting of water pipe quality. Scale returns will probably be underestimated. Marginal returns to expenditures on water (and perhaps other) services will be overestimated and, most significantly, rates of disembodied technical changes will be greatly overestimated. Analysts (e.g. Duloy 1959; te Kloot and Anderson 1977; Anderson and Griffiths 1981) who, through data limitations for example, are unable to unscramble quality changes in inputs, will necessarily commit such sins of biased estimation.

My purpose in this empirical excursion is to moralise about the nature of technical change in agriculture. There is a tendency for observers of this undeniably important phenomenon to ascribe technical progress to the resourcefulness and innovativeness of farmers and to a successful harvest from public investment in agricultural research. Granted, these are often sources of incontrovertible significance, but not in my case study (which has its origins firmly in basic and applied chemistry and industry) or, indeed, in a multitude of analogous innovations emanating from non-agricultural industries (cf. Sveikauskas 1981).

I hope my central moral is apparent. Agriculture, for its sustenance and progress, is increasingly interdependent with industries that have often been treated as 'them'. To advance through tomorrow's predicaments, we need mutual recognition that 'they' are 'us'. The trend toward more general equilibrium analysis in institutions like the BAE and the IAC is reassuring in this regard. A corollary is that the cries of horror at inflation rates in agricultural input prices need to be tempered, to the extent that unaccounted quality improvements of the embodied types I have been discussing are ignored in computing indexes of prices paid (Griliches 1960; Peterson and Hayami 1977).

A homily on famine

Lest my first case of interdependence seem a choice biased toward too optimistic an outlook, let me balance it with a case fraught with suffering and danger, especially if we get things wrong, or possibly even if we are

[5] For brevity, details are suppressed here but see Griliches (1957, p. 14) for explanation of his model.

just unlucky. The history of famines is long and, tragically, the final chapters are far from being written (Saouma 1981).

The kindest imaginable view of famine is something of a Darwinian competitive notion that evolution and growth seemingly respond to environmental adversity. This is the same sort of idea that 'too much' intervention under the rubric of 'stabilisation' will destroy initiative, responsible planning and progress. However, famines are too local in impact to assist any evolutionary process, and too destructive of human resources ever to inspire growth. Famines are unambiguously 'bads' and should not be permitted in an enlightened age. If civilisation is aptly defined as 'an endeavour to create a state of society, in which Mankind will be able to live together in harmony' (Toynbee 1972, p. 44) and, if we foster claims to being civilised, we must purge starvation and related suffering from our experience. Of course, there are other social ills—such as wars—that should similarly be purged, but these tend to fall beyond the purview of agricultural economics. Or are they out of our range when food and trade 'wars' are becoming so frequent?

An intriguing branch of sociobiology has been contributed to by economists on the nature of altruism (e.g. Becker 1976; Hirshleifer 1977, 1978; Landes and Posner 1978). Argument has been framed primarly at the level of behaviour among reactive individuals. For my present context, much more aggregative levels are required. In observing the international experience of food emergency assistance, examples of reciprocal altruism and 'recognition' altruism are readily enough identified. However, the international altruism to which we must aspire is what I would identify as 'civilised'. International food security must be a necessary condition to invoke the requisite stable basis for moves toward a civilised world state. International agencies and individual, especially rich, countries have clear responsibilities, and roles, in initiatives for enhanced security.

This is not the place to overview the conflicting literature on world food production and demand. Whether one believes the doomsdayers or the more optimistic observers, uncertainty principles are indubitably relevant in coming to grips with the tenuousness of food adequacy. Investigation can be pitched at various levels. At the overtly interdependent level of global supply and demand, analysis of stockholding and trade must clearly be based on the study of random events.

Famines are essentially regional affairs, like the droughts and wars with which they are so often associated. They can occur at times of abundant global grain harvest and stocks, and there may even be ample food in the affected region or country. Famine is essentially a consequence of poverty (ILO 1977; Sen 1981). A significant number of people find themselves with insufficient resources to exchange for sustaining food. Through natural or other calamities, slumps in real income prevent people from acquiring their basic nutritional requirements.

Applying uncertainty principles can help us conceptualise and measure the 'food risk' faced by various communities, and thus alert us to potential and emerging crises. Effective intervention by concerned, and hopefully altruistic, outsiders must be triggered early through timely monitoring by authorities closely attuned to local conditions (Currey 1981). Food risk, as a conjugation of environmental instabilities reflected

in lowered agricultural incomes, epitomises the central roles of uncertainty and interdependence in agricultural economics.

Conclusion

Agricultural economics is, for me, a dismal science only rarely.[6] Lewis (1958), among others, has apprised us of our duty to remind the community of unpleasant realities and to scold those who press pre-emptive claims upon resources to preclude rational choice among alternatives.

But what is 'rational choice' in a turbulent, interdependent, agro-industrial complex of rapid technical change, unpredictable fluctuations of fortunes for all concerned, and prevalent disequilibria? Undoubtedly, it is decision making under uncertainty and, to this end, uncertainties should be recognised, measured and confessed—an additional and possibly anxiety-inducing task that may not be relished by agricultural economists, in spite of its potential for face saving.

However, rational decision making is ensnared in the briars of bounded rationality on the part of decision makers, of the burgeoning challenge to recognise crucial interdependencies, and of the continued difficulties of grappling with ill-structured, uncertain, multiattributed alternatives. These gritty matters have yet to be dealt with appropriately in agricultural economics curricula.[7]

We, as agricultural economists, must thus be humble about what we can do and say (cf. Kristol 1981), but I think this needn't be dismal. However, we must continue to chip away at our challenges, including the provocative problems I have sketched. Here is ample and fascinating promise that our professional energies can be fruitfully harnessed for some time to come.

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[6] Especially when a manuscript is rejected for publication but also when I reflect on admonitions from the leaders of the profession, such as this sample from Schultz (1964, p. 1014): '. . . despite . . . the narrowness of our economic base, our specialty is neither trival nor obsolete. But our future is nevertheless clouded by an over-emphasis on the material aspects of agirculture and thus a neglect of the value productivity of human agents and the welfare of farm people.'

[7] It is not merely a matter of exposing agricultural economics students to courses on general equilibrium analysis, disequilibrium econometrics, and the economics of uncertainty. There is the greatly neglected field of 'refresher' courses in agricultural economics, and the facilitation by employing organisations of 'staying abreast' (see Theil 1963).

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