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Uncertainty in Market Analysis

INTRODUCTION

Uncertainty has always been a factor in agricultural markets and an important attribute of agricultural market analysis. In fact, uncertainty is a major factor in economic life in general.

An uncertain event is usually defined as one which has several possible outcomes. By this definition uncertain events are not only those which will occur in the future and have different possible outcomes, but also those for instance which have already occurred and whose state is difficult to observe, such as the exact size of a crop. It is thus crucial to define clearly what is meant when one speaks about uncertainty.

In this paper the aspects of uncertainty that are important in agricultural market analysis will be emphasised: The effort will be to clarify the ways in which uncertainty modifies the standard models of market analysis, and to pinpoint current gaps in our knowledge and frontier research issues.

THE NATURE OF UNCERTAINTY IN MARKET ANALYSIS

Before we proceed it might be useful to distinguish between what will be termed analysable uncertainty versus non-analysable uncertainty. Consider a random variable. Suppose we identify what we or others think are the possible outcomes of that random variable, namely those states that have some probability of occurrence (which might even be zero), irrespective of whether this probability is objectively determined or subjective. Analysis using this random variable will then be based on the underlying definition of the state space which probability theory considers as given before analysis proceeds. Analysable uncertainty will be defined as the union of underlying state spaces of all random variables that enter the analysis.

The conclusions and predictions of the analysis will be conditional on the analysable uncertainty. In economics, however, where the human factor is an important element in the system, the underlying states of nature cannot be considered fixed. A good example might be the 1973–4 world food crisis. Analyses of those events abound, but a key element in the evolution of the grain market in these years was the drastic change in

the economic behaviour pattern of an important market participant, the Soviet Union, a change that was not thought probable before 1973, namely was not considered as a member of the state space of the underlying market related uncertain variables. As such this event belongs to the group of what will be termed here non-analysable uncertainty.

In economics, as well as in other sciences, the definition of the appropriate state spaces of the relevant random variables is an empirical and many times subjective matter. When the state spaces of these random variables change, the whole analysis on which a market model is based must be changed to accommodate the new possible states. Hence, we have what might be termed a structural change of the uncertainty in the model. Notice that this is quite different from mere changes of the probabilities assigned to some fixed outcomes in the state space, e.g., via Bayesian updating. Here, the membership of the state space is itself altered.

While it seems clear that the only kind of uncertainty that can be studied is what has been termed here analysable uncertainty, an important question that arises is whether in market analysis uncertainty enters largely in an analysable or a non-analysable fashion. A second important question is whether the analysis made based on analysable uncertainty is robust in the face of structural changes as alluded to above. Finally, a third question relates to the speed and ease with which structural change in the underlying uncertainty can be identified and hence brought into the analysis.

Identification and estimation of structural changes are very difficult tasks. Econometricians have made some attempts to deal at least with time varying and random parameters in models (for a review see ch. 10 of Judge *et al.*) but very little work has been done on identifying structural changes in the uncertainty of the system, of the type alluded to above.

Market analysis usually comprises examination of demand, supply, inventory and government behaviour. Uncertainty enters in the analysis of all these aspects but in different forms. What can be classified as uncertainty (whether analysable or not) depends on the particular viewpoint examined and might not be termed uncertainty if looked at from a different level of analysis. For example, when one looks at the farm level, the uncertainty facing an individual farmer might be mostly environmental, with an ensuing yield variability for given land, farming practices etc. However, if we examine aggregate supply, which entails a large number of farmers, uncertainty is not only environmental. If, for instance, the aggregate land cultivated to the crop stays constant, but its distribution among the geographically feasible production land changes, e.g., because of farm changes of product mix, then from the aggregate viewpoint uncertainty of yield might increase. Thus, uncertainty is closely related to the scale of analysis and to the information assumed available about the underlying variables.

The last observation, also brings up the distinction between informational uncertainty about the present versus uncertainty related to the future. Suppose that in a particular year we try to analyse the production of a particular crop. After the harvest is completed the size of the crop is

theoretically known. From the particular viewpoint, however, of an agency trying, for instance, to order imports, the size of the crop might be an uncertain variable and might stay so throughout the year albeit with decreasing bounds of ignorance. The uncertainty at that level of analysis is an informational one. Suppose, on the other hand, that there is perfect information about the size of the crop as soon as the harvest is complete. It is, nevertheless, impossible to predict accurately the crop in the next period, no matter how much information about the present state of the world is available.

Finally, uncertain future events can be split among those that occur only once and those that recur in a fashion that permits the estimation of actuarial tables. The effects arising out of the construction of an irrigation project are uncertain only until the completion date, while the size of rainfall in September in a region is a variable that permits the construction of frequency tables.

From the above discussion it seems that we can say in summary, that uncertainty relates to the state of knowledge about particular events, whether in the present or the future. At each point in time and for each problem, uncertainty can be defined as the extent of ignorance about the underlying variables of the problem.

SUPPLY AND DEMAND UNDER RISK

All market analysis models contain equations for supply and demand. Yet, while substantial amount of research has been done into behaviour under risk there is still no agreement as to the most appropriate ways of incorporating uncertainty into these models.

Modelling decision-making under uncertainty is by now old art. There is an array of hypotheses about behaviour, such as maximisation of expected profit, or expected utility, the safety first or maximin principle, stochastic dominance rules and others (for a good review, see Anderson 1979). Much effort has also been devoted to measuring people's attitudes toward risk and whether one or the other model, especially the expected utility model, fit well with people's behaviour (for reviews, see ch. 7 of Newbery and Stiglitz, 1981 and Arrow, 1982). The results have been mixed and useful in the sense that they have led to the statement of even more new theories and hypotheses about decision-making under uncertainty such as Kahneman and Tversky's (1979) prospect theory.

However, most of this research has not had significant impact on market analysis models. Most currently used market models still use supply and demand curves that are functions of only the price level. The only mildly significant evolution seems to have been the modelling of market supply curves with multiplicative versus additive disturbances. This, however, has not added too much to what we already know about uncertainty in market analysis.

It seems that a fruitful way in future research would be to attempt to incorporate explicitly higher order moments of the probability distribu-

tions of uncertain variables in specifications of aggregate supply and demand curves. A simple example below will illustrate the potential effects.

Assume a closed economy market model for one commodity, where the supply and demand curves are linear with additive disturbances. Assume that supply is negatively influenced by the variance of price. Assume, as in a rational expectations world, that the underlying average price and the price variance are known by market participants. Suppose a government agency decides to stabilize price by instituting a buffer stock that is based on a rule which is based on a buy–sell formula symmetric about the known mean price. Such a stock rule, however, will accumulate supplies forever. The reason for this somewhat unexpected result is that when the price variance is reduced by the operation of the stock, producers will increase their average production, thus leading to a decline in average market price *ceteris paribus*. If the stabilizing authority has not considered this higher moment effect it will eventually be forced either to stop or to modify its rule.

Research in this area is still young, but a good start has been made by the work of Just and Pope (1979).

NATURAL VERSUS INDUCED UNCERTAINTY

How is uncertainty in a market affected by different policies? What are policies that reduce uncertainty and should they be pursued? Should markets be left uninterfered with or should they be controlled in order to reduce uncertainty? Answers to these questions are not easy and they are sometimes ideologically charged.

Before, however, any attempt is made to answer these questions it seems logical to assess the degree to which what is classified as uncertainty is induced by policies or is natural and irreducible in the sense that it would occur in the absence of any intervention. To answer this challenge is not easy, as almost any policy meant to affect a certain aspect of a market will usually have some unintended side effects.

For instance, much research has been done in recent years to investigate the impact on price variability of restrictive trade policies, Josling (1977), Shei and Thompson (1977), Bale and Lutz (1979) and more recently Sarris and Freebairn (1983) have shown, theoretically and empirically, that many restrictive trade policies have adverse impacts on world price variability.

All these models, however, dealt with the side effects of policies primarily intended to affect the volume of trade. Similarly policies affecting farm size, input markets, income distribution etc. will all have some side effects influencing the uncertainty of a market model. It is useful to assess the size of these effects. However, if none of these policies were meant to affect the variable of interest, then they should be considered as part of the background of the problem and attention should

be concentrated on the policies directly affecting the market variables of interest.

The idea will be illustrated through a discussion of price stabilization. The concern with undue price instability in many primary commodity markets is long-standing and the literature that has evolved around the issue of price stabilization is large and growing. Most of the discussion, however, (for an early survey, see Turnovsky, 1978), has concerned the benefits from price stabilization. Issues such as the feasibility of price stabilization, the costs of price stabilizing policies, the implementation of price stabilization policies have received secondary attention (a notable exception is the comprehensive book of Newbery and Stiglitz, 1981).

The questions relevant to the discussion here are the following. First, starting from a market where many other policies are present, is it always possible to reduce price variability with buffer stocks or other policies aimed directly at this purpose? Second, will it be more efficient or cheaper to remove or alter other policies designed for other purposes?

In almost all the literature there has been a presumption that stabilization is feasible. Sarris (1982), however, as well as Newberry and Stiglitz (1981), have shown that in the presence of well functioning private arbitrageurs, price stabilization is infeasible. It is imperfections in private markets that make price stabilization feasible and desirable. If this is the case, then the question arises whether it is less costly and more efficient to aim policies at indirect price stabilization via, for instance, improvements in the marketing system rather than institute costly buffer stocks.

Related to this issue is the question of whether it is possible that because of natural market uncertainties, price stabilization policies could lead to opposite effects. Turnovsky (1978b), in fact, has shown that when observation errors are present, it is quite possible that a price stabilization policy can have destabilizing effects. In such a case of course, the best action would be to do nothing.

Related to this issue is the question of behaviour modification by policies. For instance, if a risk insurance programme for farmers is instituted then it might make farmers more careless about their crops hence modifying the underlying supply behaviour and making it more risky (this and several other related issues are discussed in Binswanger 1985).

MARKET IMPERFECTIONS AND UNCERTAINTY

The issue of market imperfections has a long history in the economics literature. Every discussion of market imperfections, however, must necessarily start from a definition of what constitutes a perfect market. The age-old textbook model of a perfectly competitive market under certainty, namely one with many small market participants none of which can influence price has been extended in recent years to include issues of uncertainty. Two key elements have been introduced in the traditional

model, a complete set of contingent markets and perfect and equal information about the current state of nature by all market participants.

A perfect market of the type envisaged above would not, of course, be without any fluctuations. Unpredicted events would always occur but market participants would almost instantaneously adjust to them. A market operating under the above assumptions would be efficient in the sense that all information about the present state of nature would be incorporated into current market variables such as price.

Enormous amounts of research in the last 20 years have gone into investigating whether markets are efficient (see the early survey of Fama, 1970, for capital markets and Labys and Granger, 1970, for commodity markets) with mixed results. By and large the markets that have been analysed are the large organised ones for which data is readily available. This, of course, immediately biases the analysis in favour of efficiency. Even for these markets, however, recent research shows that there is ample room for imperfections (see, e.g., Kyle, 1984).

That real world markets depart from the theoretical ideal is no news, especially since it is well known that complete sets of contingent markets do not exist and information is costly to acquire and not universally available. It is of great practical interest, however, to decide how close real world markets are to the theoretical ideal and whether policies to intervene in some market aspect are worth the cost.

For instance, is it less costly and more efficient for the government to provide more and better information in order to stabilize a market or is it better to intervene directly? In many developing countries the latter course has been chosen. This could be due to the fact that markets in those countries are not as well organised and are strewn with marketing imperfections, such as local monopolies, inadequate transportation and communication facilities etc. In countries with a developed infrastructure, on the other hand, market intervention is likely to be more efficient if it is done indirectly via, for instance, introduction of more contingent markets, better information etc.

Research in the relation between market imperfections and uncertainty is rather scant, but the subject is fairly ripe for intense study. An *a priori* hypothesis that could be studied is whether residual (as opposed to government induced) uncertainty and instability in a market is a decreasing function of the development of market infrastructure. Answers to such questions would then provide the basis for evaluating alternative policies. For instance, the building of food security stocks in a remote region might be a cost-efficient policy if the road and communication network were very rudimentary and any production shock would have to be absorbed locally. Similarly the efficacy of provision by the government of satellite-based information to the market about world-wide crop developments would depend on the general development of the market information network.

EXPECTATIONS AND MARKET UNCERTAINTY

Expectations formation is a significant part of market analysis. Many years of research have produced essentially two types of general hypotheses about aggregate expectations formation: the well known adaptive expectations model (of which naïve expectations is a special case) and the rational expectations model. While most models of market analysis use one or the other hypothesis, not much has been done to clarify which model is more relevant and under what market conditions. The assumption of rationality while theoretically convenient has rather drastic implications about the effectiveness of market intervention policies. In fact, under most cases it can be shown that when expectations are rational, market stabilisation policies are ineffective. This line of research, of course, has developed mostly in the macroeconomic literature on the effectiveness of monetary policy (see the volumes by Fischer, 1980, and Lucas and Sargent, 1981), but the arguments apply *a fortiori* to market analysis research.

It is not easy to assess empirically whether expectations follow one or other major models. It is not even easy to assess conclusively whether different expectations hypotheses theoretically reduce or not the variability of market variables such as prices (for a comparison of a market model with rational v. adaptive expectations, see Turnovsky 1979).

An interesting and as yet untackled question is whether the development of a more organised market changes the structure of expectations formation. Another question also unresolved but interesting for market analysis is whether the evolution of more organised markets and more efficient expectations formation in one part of the world helps or not the markets in another part of the world. Finally, the issue of whether different expectations hypotheses reduce or not market uncertainty should be further investigated within more complete market models.

INFORMATION AND MARKET UNCERTAINTY

The issues surrounding market information raise extremely interesting research questions many of which are still not resolved.

To begin with, does improved market information reduce market uncertainty? The answer is not clear because while one could argue that improved information to all market participants would make their trading strategies more rational, it would also make traders much more alert to changes in market conditions and the ensuing rush to capitalise on market news could lead to overreactions and increased market instability.

Does differential access to information lead to informational monopolies? Kyle (1981) has shown that indeed such things are possible. What is the impact of informational private monopolies on market uncertainty? Is there an informational externality and what is the best way to correct

it? Interesting work along similar lines by Figlewski (1978) points out that a market with traders possessing diverse information will lead to wealth redistributions and might not be efficient. On a different line Grossman (1976) investigates how information from informed traders is 'revealed' to uninformed ones through the market.

Research in this area is very young. As markets evolve, however, and technological developments make information cheaper and more accessible, issues such as the above are bound to receive increased attention.

MARKET INSTITUTIONS AND UNCERTAINTY

Markets evolve over time and different institutions are introduced to account for technological developments and market needs. The institutions most analysed in the recent literature have been the organised futures markets, perhaps because data is most readily available for these and also because they provide examples of contingent markets of which there exist very few.

There is, nevertheless, a fairly extensive literature analysing the efficiency of the marketing system (for a survey see French 1977), but it has not dealt very much with the issue of uncertainty. This is unfortunate because uncertainty in a market is directly related to the efficiency of the marketing system. It seems that renewed effort in coming years should go in this area as it is related to general development policies. It is this author's belief that there is a significant trade-off between policies designed to deal directly with uncertainty and policies designed to improve the functioning of the marketing system. These trade-offs have not been analysed at all until now.

Returning now to the institution of futures markets, the literature is enormous and growing to the point where there is now a specialised journal devoted only to futures markets studies. The growth in futures trading is probably not unrelated to the technological revolution in information processing and communications. However, one of the basic questions concerning the impact of futures markets on price stability of the cash markets has not been conclusively resolved. While theoretical work has advanced to the point where under certain assumptions one can show that futures markets stabilize the cash markets (Sarris, 1984; Kawai, 1983), empirical work has lagged. However, much more needs to be done before one gives the green light for the enactment of more futures markets. Furthermore, it seems that all work regarding futures markets has dealt with closed models. However, the existence of futures markets in a developed country while influencing the world market of a commodity can have unknown impact on a developing country which for instance has currency controls and hence cannot allow its traders to participate.

SUMMARY AND CONCLUSIONS

The brief discussion above has highlighted the many unresolved questions that exist in the field of uncertainty in market analysis. While much progress has been made in recent years, uncertainty remains a clouded and important issue. In fact the onset of the 1973 world food crisis led many people to believe that market uncertainty was growing. This is certainly probable, although not much work has been done to corroborate it.

The perusal of the huge literature and the diverse aspects that have been examined leave one somewhat uneasy, in the sense that not many solid policy recommendations are forthcoming. Introducing uncertainty in market models is an art of positive economics that has not as yet been perfected, and hence the policy conclusions are not very solid. One of the major questions that remains is whether policies designed to deal with some issues under certainty are relatively robust when uncertainty is introduced. The answer to that question seems to be a well qualified yes. Thus, price supports, trade restrictions etc., while influenced by and in turn influencing the system's uncertainty, are not seriously modified in their qualitative impact (albeit the quantitative impact might be large) on the economic system. It is policies directly designed to deal with uncertainty, such as price stabilizing buffer stocks, commodity agreements, futures markets etc., that are heavily influenced by the precise nature of the uncertainty and how it is introduced in the system. This area of research has only recently started and it appears that since the need for these policies has increased, it is an area of much promising future.

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