The Geneva Papers on Risk and Insurance, 13 (No 46, January 1988), 5-11

Uncertainty in Macroeconomics: A Survey of its Treatment

by George M. von Furstenberg

1. Introduction

The introduction is intended to (a) motivate interest in the subject, (b) define uncertainty as it applies in macroeconomics, and (c) outline scope and content of the detailed study with Jin-Ho Jeong that follows.

1.1. The Growing Acceptance of Uncertainty

Misleading models and forecasts, put forward with much greater assurance than warranted by the objective evidence, have deprived macroeconomists gradually of much of the influence on the political process which they enjoyed during the 1960s. The main reason for the erosion of confidence, — according to Robert Lucas, Christopher Sims, and several other leading economists who have commented on foundation issues, — is that macroeconomists have tended to minimize uncertainty, at least intellectually. This cavalier treatment of uncertainty is beginning to give way to much more explicit accounts of multiple possibilities, dependence on information structures, and the means of learning.

1.2. Statistical and Epistemological Uncertainty

In macroeconomic applications, the term uncertainty is used mainly in two senses: there is the statistical meaning of uncertainty in a measurement or value due to the *dispersion of repeated occurrences in the face of the same prediction*, and then there is the epistemological meaning of uncertainty in the opposite sense from likelihood or from strength of belief. Used in the second sense, uncertainty is a *measure of doubt about a single event being true or real.* Procedures such as t-tests address this kind of uncertainty by providing a convention for legitimating belief in uncertain stipulations. Used in the first sense, uncertainty is due to the dispersion of outcomes. Its microeconomic causes may be judged to be knowable (deterministic) or unknowable (non-epistemic) in principle. However, in all of macroeconomics, uncertainty is generally treated as probabilistic, rather than possibilistic.

1.3. Scope and Content of this Survey

Regarding the amount of prior information and structure imposed on the manifestations of uncertainty, the survey covers a middle range. It deals with uncertainty that is more than peripheral to macroeconomic phenomena on the one hand, but not beyond probability estimates and learning on the other. With respect to generation and use of information, this middle range excludes economic and econometric representations that imply that economic

agents waste information by not changing decision rules when there are clear incentives for doing so. It also excludes the opposite extreme of markets which rapidly transmit all information to all traders and result in a sequence of static general equilibria.

2. Uncertainty in Aggregation

The theme running through this section will be that, with regard to uncertainty, aggregation has two opposing aspects. It lowers uncertainty in some respects while raising it in others. This theme will be used to structure the discussion of (a) cross-sectional aggregates, (b) intertemporal aggregates, and (c) organizational aggregates.

2.1. Cross-Sectional Aggregates and Microfoundations

If putting small pieces together to make something large is part of what gives macroeconomics its name, cross-sectional aggregates are the ones most commonly thought of in that discipline. Conceptually, this first type of aggregate is formed over distinct micro-level units, such as households, and over object classes, such as currency and demand deposits which they hold. By the law of large numbers, pooling independent, homogeneous events reduces their dispersion relative to the average and thus diminishes statistical uncertainty.

This however, is not the only possible effect of pooling if events relate differently to one another. In actuality, the statistical aggregates used in macroeconomics are rarely composed of independent events. The chief reason is that common cyclical experiences and shared "news" events influence social beings who are part of a communication system and engage in signal extraction. Just as often, these aggregates fail to be homogeneous because of unequal marginal valuations attaching to their constituents or because the substitutability of the various components of an aggregate may differ with elements left outside it. Movements in heterogeneously composed aggregates may have a quite variable relation to movements in other aggregates, and this increases uncertainty while the law of large numbers would reduce it.

2.2. Intertemporal Aggregates and Time-Dependent Patterns

Intertemporal aggregation, just like cross-sectional aggregation, may reduce uncertainty in some respects while it increases it in others. To the extent intertemporal aggregation creates or refines knowledge about present actors, structures and events it reduces uncertainty. As time passes and observations are added, more is revealed and outlines are sharpened, much as they would be by increasing sample size in cross-sectional aggregation. Technically, filters that separate noise at various frequencies from signals at the same or other frequencies can be more discriminating if they have more observations to work with. Such benefits are clearly not available from increased experience if policy regimes and system structures change or it the process generating the past data should take a series of irregular and non-recurring values that do not form any predictive patterns. For instance, wide classes of difference and differential equations, pertinent for stock adjustment and other reactive processes in economics, yield chaotically unstable trajectories. If internal propagation is characterized by such trajectories, then the future evolution of a model solution cannot be anticipated from its patterns in the past.

While non-predictive patterns prevent intertemporal aggregation from reducing uncertainty, other elements of intertemporal aggregation may actually increase it. Flow data are constructed as time integrals whose limits are determined not by economic but administrative considerations. Whether they should be analyzed at high or low frequencies to reveal economic relations is often not clear from theory. What is certain is that findings normally depend on the frequency selected, as the traditional distinction between short-term (disequilibrium) and long-term (equilibrium) effects makes clear. At some frequencies, spurious patterns may emerge. For instance, it has been shown that when continuous processes are reduced to data sampled at administratively convenient points in time, time aggregation can make an inherently unidirectional relationship appear to exhibit feedback.

2.3. Organizational Aggregates and Decision Structures in Systems

Organizational aggregates are derived from formal and informal procedures for combining the weighted contributions of several "levels","factors", or "causes" to a decision sequence that produces some outcome or resolution. Forming them involves laying down contingency plans and decision sequences designed to reduce uncertainty. Nevertheless, highly detailed procedures and institutionalized structures may be unable to cope with uncertain processes of emergence and of interaction among subsystems. Furthermore, the effectiveness of incentive schemes by which principals attempt to achieve their objectives through agents in large organizations may change endogenously over time. The same may hold for an entire organization as its goal and methods are found out and countered by opposing interests. Indeed, the processes of organizations are so complex and uncertain, that the major decisions they yield, such as OPEC price shocks, are frequently treated as exogenous in macroeconomic models.

Nevertheless, the influence of organization on macroeconomic outcomes is pervasive. How decision-making units are organized and linked within a system, how they are selected, what screening functions they apply to projects and ideas of uncertain merit or profitability, and how much they insure against mistakes of one type or another affects the errors within the system, as well as how these errors are aggregated and compensated. The architecture of economic systems thus reflects societal attitudes toward risk and experimentation, its weighting of type I versus type II errors, and its exposure to uncertainty and innovation.

3. Uncertainty in Estimation

In recent years, macroeconomic theory has been communicated increasingly in the form of recommendations of improved econometric techniques. This section surveys these recommendations and explains the directions in which they point. Specifically, it considers how learning about (a) multiple solutions, (b) transitions between equilibria or regimes, and (c) uncertain parameters and structures have been treated in econometrics. Accounting for learning and decision making under uncertainty are necessary in empirical work because agents cannot be assumed to be endowed with as much certain prior information as various theories have presupposed.

3.1. Multiple Equilibria, Disequilibrium and Switching Regimes

Among the newer theories, the rational expectations hypothesis goes farthest in regarding agents as informed. It equates the average of subjective beliefs of agents about a state to the equilibrium consistent with economic theory. However, because expectations about not only current (contemporaneously unobservable) but also future variables must be formed, a feedback from the future to the present causes rational expectations to be compatible with an infinity of solutions. Although procedures have been advanced for finding the solution that will best fit the behavior of economic agents, these procedures have had only limited success in reducing the uncertainty associated with a multiplicity of solutions and of transitions between them. Outside rational expectations equilibrium with market clearing, techniques for estimating transitions and switches between disequilibrium regimes have been advanced to account for how "regimes" (say, of persistent excess supply and demand in particular markets) are generated and transmuted.

3.2. Updating Parameter Estimates During Transitions

If a multiplicity of equilibria, or disequilibrium regimes characterize actual economies, these economies will frequently be in a state of transition which economic agents may seek to monitor. How could information be acquired and used during this transition when it is understood that economic agents can not jump instantly from any state in which they may find themselves to rational expectations equilibrium? To update parameter estimates, agents may use informationally demanding Bayesian approaches with priors that anticipate eventual equilibrium or less demanding learning approaches (based on "classical" reestimation with additional data). In either case, their knowledge is summarized in model parameters which are time-varying.

3.3. Learning Behavior in Stochastic Macroeconomics

No econometric model can be considered firmly given by theory. Hence the usefulness of macroeconomic data has to be established by taking careful account of the absence of completely defined models. When prior restrictions are not well supported by theory, direct learning from empirical macrodata is still possible. Alternatively, when there are competing theoretical models, each of possible relevance in some states, weighted combinations of the predictions of such models may be estimated. The weights themselves may be systematically time-varying and continuously updated as part of the estimation procedure. This process would represent "learning" about the changing degrees to which the (zero) coefficient restrictions of various models apply. Another approach to learning about uncertain structural models is to use a mixture of data-based unrestricted, and more efficient restricted, reduced-form estimators. Several of these techniques could lead to a more responsible, and obviously more systematic, approach to policy design under model uncertainty than economic advisers equipped with their favorite model have taken in the past.

4. Uncertainty in Private Arrangements

Among the many uncertainties facing individuals, there are some hazards, such as to life, which are treated more as acts of God than as managed outcomes that are sensitive to the play of economic incentives. In such situations, mean and variances of past events, with

some allowance for drift, can be related precisely to the demand for, and supply of, insurance. In other situations, moral hazard or costly pooling make self-insurance more likely for both households and business. Examples are (a) employment contracts, (b) saving and inventories, and (c) precautionary balances and reserves.

4.1. Employment and Earnings

Many characteristics of employment and labor contracts that are important for the functioning of labor markets and unemployment in the aggregate derive from microeconomic information and insurance functions. Labor contracts are designed in part to reveal information about a worker's suitability and intentions to a particular employer. Implicitly, they also provide information about the employer and its willingness to absorb some of the risks associated with demand fluctuations. Seemingly arbitrary "Keynesian" features, such as nominal wage stickiness, can acquire insurance rationales and microfoundations in certain situations. Casting employers as principals and workers as agents may be peculiar in a world in which employers are hired managers. Nevertheless, these managers must deal with asymmetric information and devise compensation schemes that are compatible with the incentives they seek to set. Potential employees, in turn, must engage in search and in the interpretation of signals conveyed by job offers, both of which involve investment decisions under uncertainty.

4.2. Saving and Investment

Uncertain future earnings and profits, finite life times, and the possibility of bankruptcy and default all have important macroeconomic ramifications. For instance, treating future earning and hence taxes as uncertain for individuals, though not for society as a whole, may be enough to destroy "Ricardian equivalence" between debt and tax-financed government spending. Finite lives and infinitely-lived governments have the same implication, because less than unitary subjective survival probabilities raise the private above the social discount rate. Finally, the possibility of bankruptcy and default has led to credit rationing, the effects of which again are to make deficit financing more favorable to personal consumption than tax financing of the same amount of government spending.

The effects of *uncertainty about events* are frequently more difficult to pin down than the effects of the *uncertain events* just described. Thus generalized uncertainty has been said to increase money demand, but whether it increases or decreases saving and investment depends on exactly how uncertainty enters the relevant optimization models.

4.3. Finance, Futures and Insurance

Financial markets can be seen in several relations to uncertainty. They are affected by it but also contribute to it in financial crises. On the other hand, the informational and operational efficiency of financial markets may help dissipate uncertainty by putting an immediate price on news events. The rapid extensions of futures and options markets to ever more financial and commodity contracts permit increased hedging. The intertemporal extensions of today's price change when that price feeds forward not only through fix-price delivery contracts but also through its relations with futures and options prices. Beyond this, insurance of diverse hazards has led to many forms of prepayment for contingencies by individuals and businesses, thereby modifying the impact of whatever contingency may occur.

5. Uncertainty in Policy Formation

Uncertainty that provides a compelling reason for learning by the private sector also motivates policy by the public sector while at the same time limiting, or casting doubt on, what such policy can accomplish. Stabilization policies and the internal working and defense mechanisms of an economy are all affected by uncertainty: (a) Uncertainty about parameters (policy multipliers) and structures influences both the design and the extent of instrument use. (b) The major sources of disturbance expected in an economy determine the shock absorption facilities in place and hence its structure. (c) Indexation arrangements, regulations and rules modify the impacts of stochastic disturbances when there is inadequate information or insufficient response time to allow fine-tuning to each of the different types of disturbances.

5.1. Variability and Modelling Economic Control

Over the last twenty years, second moments have become central to signal extraction and in taking stochastic macromodels beyond certainty equivalence. The simplest stochastic systems were linear and had only additive error terms associated with each equation which were contemporaneously and intertemporally (serially) uncorrelated. Such models could be solved by certainty equivalence, thereby reducing the control problem to one that was essentially deterministic. This changed as soon as uncertainty in policy multipliers was recognized. More instruments should then be used but to a much smaller degree than under certainty equivalence. Another factor contributing to uncertainty from the viewpoint of the policymaker is that control is being applied in economics not to a model of nature, but in confrontation with calculating agents exercising memory, learning, and reasoned foresight.

5.2. Policy Surprises and Other Macroeconomic Disturbances

Classifying shocks by sector of origin is tricky and uncertain. For instance, it is hard to conceive of real shocks without a financial counterpart and vice versa. Indeed, in any major disturbance worthy of macroeconomic note a number of things tend to happen, though not necessarily in a sequence so inevitable that it could be tightly ordered from cause to effect. Furthermore, the frequency and severity of disturbances are not independent of the safety nets in place, and the propagation system is transformed under the influence of past and statistically expected shocks. Both the persistence of the original disturbances and the propagation mechanism combine to determine the persistence of macroeconomic fluctuations in ways difficult to disentangle.

Although the rational expectations hypothesis has unified the modeling of expectations and of the structure of the economic system, there is little agreement among the estimates of monetary and fiscal surprises provided by different researchers over the same data period. Furthermore, the policy shocks emphasized in the research of the 1970s have tended to be deemphasized recently as a major cause of economic fluctuations. Uncertain shifts in tastes and technology that are difficult to measure and essentially impossible to control are now often viewed as chiefly responsible for economic instability.

5.3. Indexation as a Way of Absorbing Uncertainty

Indexation arrangements are safety devices designed to cope with a number of shocks to degrees depending on what damage they might cause and what it costs to reduce the welfare losses otherwise expected. This partial endogeneity of indexation arrangements can be

used to advantage. Observing the changing patterns of indexation might provide information on the extent of the disturbances anticipated from various quarters and the costs and benefits of modifying their impact through indexation.

Rules, regulations, and credible operating targets can reduce uncertainty about the processing of certain disturbances just as much as indexing. While the disruptive effect of some disturbances is thereby eliminated or reduced, that of others may be intensified. Partial indexation arrangements have therefore been suggested to provide for optimal or near-optimal adjustment to real shocks while undercutting the ability of policy shocks to affect real outcomes. Thus there is a dynamic interplay between forms of contracting, policy and indexation. The latter can be used to reduce certain forms of policy to irrelevance. In other cases, policy can take advantage of some forms of nominal contracting and staggering for which adequate microeconomic explanations may nevertheless be found.

6. Concluding Observations

Uncertainty can be used positively. It can represent opportunity in both practice and macroeconomic theory. The concluding section of the study that follows will show where uncertainty has been dealt with increasingly constructively in macroeconomics. It will point to trends emerging in this regard that could help rehabilitate macroeconomics from the cavalier disregard of uncertainty that had brought it discredit in the 1970s.