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Rational Expectations and Economic Thought

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WHAT IS a rational expectations view of the world? Can such a view help advance economic understanding? How should rational expectations be placed in the history of economic thought and method? The purpose of this discussion is to help provide answers to these questions.

Alan Coddington in a review of George L. S. Shackle [67, 1966] has summarized much of the objection to economic analysis in the following penetrating way [18, 1975, p. 151]:

> If we attempt to understand economic life by supposing that in it men apply reason to their circumstances, the question naturally arises: what *can* men know about their circumstances? Or even: what *do* men know about their circumstances? Having answered these questions we could then go on to ask: what happens when men apply reason to this knowledge? In fact, economic theory has not proceeded in this manner, but the other way round. Instead of asking how reason can be applied to the knowledge that men can or do have of their economic circumstances, it asks how reason can be applied to circumstances, which are perfectly known.

It will be the contention of this paper that the rational expectations approach need not and should not assume that men apply reason to "circumstances that are perfectly known." The paper will argue that to the contrary, the rational expectations approach can provide logically consistent and empirically verifiable answers to questions about what men can and do know and how they use their knowledge.

Perhaps the justification for this paper is that both critics and some practitioners of the rational expectations approach seem unaware of these implications. The paper will attempt to draw the implications partly by a history of thought discussion and partly by surveying some recent theoretical and empirical developments.

The paper begins with a very brief history of developments in monetary economics after 1945 in order to establish the background to rational expectations. The first important applications of rational expectations to macroeconomics were directed at the rationale for discretionary stabilization policy. The general form of this critique is outlined. Criticisms of Keynesian stabilization policy have emanated from other sources as well. The paper considers the criticisms of Walrasian general equilibrium analysis made by "fundamental Keynesians" in order to show why the rational expectations paradigm can be regarded as much more than a critique of Keynesian economics and in particular represents an opportunity to reconstruct equilibrium economics given uncertainty.

In demonstrating this point the paper draws on an "Austrian" theory of expectations and discusses the links between rational expectations and the efficient market hypothesis. The rational expectations approach to the business cycle and labor market analysis are also considered. A few empirical applications of the theory are examined in order to discover whether the tests conform to the spirit of rational expectations. The paper concludes with an interpretation of the debate on stabilization policy.

A Brief History

Acceptance of the Keynesian theory of less than full employment equilibrium was undermined by persistent, unexpectedly high levels of employment after 1945 and the discovery of the real balance effect. The Keynesian assumption of rigid wages was shown to be a special case of a more general theory. As Don Patinkin explained "if the terms are understood in their usual, strict sense, the coexistence of involuntary unemployment and flexible money wages precludes the existence of equilibrium. For 'flexibility' means that the money wage rate tends to fall with excess supply, and 'equilibrium' means that nothing tends to change in the system" [52, 1965, p. 315]. Patinkin believed that unemployment "was a phenomenon of economic dynamics" and that recognition of the real balance effect "freed [economics] from the necessity of static analysis to connect decreases in employment with increases in the real wage rate" [52, 1965, p. 340].

The Keynesian approach to macroeconomic theory and policy, however, regrouped around the Phillips curve [57, A. W. Phillips, 1958]. This approach assumed that money wages and costs were generally inflexible downwards and that the adjustments to real wages thought necessary to secure full employment could be achieved indirectly via increases in the price level.

Milton Friedman [25, 1968] and Edmund S. Phelps [54, 1967; 55, 1970] pointed to the implausibility of being able to fool all the workers all the time. Workers and firms, it was argued, would wish to bargain about real wages, aware of inflation. Accordingly, the natural rate of unemployment, like the real rate of interest, would be inflation proof [25, Friedman, 1968].

One important consequence of these criticisms of the Phillips curve was that expectations and their formation could no longer be easily ignored. Macroeconomic analysis was about to escape the mold of static general equilibrium analysis into which it had been set by John Hicks [31, 1937] and Lloyd Metzler [46, 1951].

Theorists have attempted to rehabilitate the Phillips curve by allowing for expectations. The expectations explicit in the "expectation augmented" Phillips curve models of wages, prices, and employment were extrapolative or adaptive expectations of prices. Expectations of inflation following Phillip Cagan [15, 1956] were assumed to be a weighted average

of past levels or rates of change of prices.[1] Given such assumptions, it was still possible for prices to rise unexpectedly rapidly and for the unanticipated reduction in real wages to stimulate output and employment. Accordingly, it appeared as if the authorities still had the opportunity to trade off extra inflation for employment.

The theory and the models built around it failed the test of accurate prediction. (See Carl Christ [16, 1975].) Both inflation and unemployment increased in the seventies, and governments seemed unable to correct the maladies.

Enter Rational Expectations

Neo-Keynesian economics and policy prescriptions were assailed by an alternative theory of expectations, rational expectations, that was consistent with the natural rate of unemployment hypothesis. Rational expectations was the invention of John F. Muth [48, 1960; 49, 1961], and the earliest applications of the idea to stabilization policy issues were made some ten years later by Robert E. Lucas, Jr., in a highly influential series of papers [38, 1972; 39, 1973].

Muth was very clear about the implications of his work. As he put it [49, 1961, p. 315]:

> To make dynamic economic models complete, various expectations formulas have been used. There is, however, little evidence to suggest that the presumed relations bear a resemblance to the way the economy works.

Muth noted that it was "often necessary to make sensible predictions about the way expectations would change when either the amount of available information or the structure of the system is changed" [49, 1961, pp. 315–16].

[1] This work has been surveyed by David E. W. Laidler and Michael J. Parkin [35, 1975]; see also Anthony M. Santomero and John J. Seater [60, 1978].

Muth went on to suggest that [49, 1961, p. 316]:

> Expectations, since they are informed predictions of future events, are essentially the same as the predictions of the relevant economic theory. At the risk of confusing this purely descriptive hypothesis with a pronouncement as to what firms ought to do, we call such expectations "rational." It is sometimes argued that the assumption of rationality in economics leads to theories inconsistent with, or inadequate to explain, observed phenomena, especially changes over time (e.g., Simon). Our hypothesis is based on exactly the opposite point of view: that dynamic economic models do not assume enough rationality.
>
> The hypothesis can be rephrased a little more precisely as follows: that expectations of firms (or, more generally, the subjective probability distribution of outcomes) tend to be distributed, for the same information set, about the prediction of the theory (or the "objective" probability distributions of outcomes).

Muth remarked at a further point in his analysis that if the predictions of economic theory were much better than the expectations of the firms, then economists would be able to profit from that knowledge by establishing firms or selling forecasts [49, 1961, p. 318]. Muth seems to be saying no more and no less than that the observed empirical regularities that serve as the basis for, or the confirmation of, economic theory also form the basis of economic action. Or, in other words, good theory is good practice. (See also Alan Walters [69, 1971]).

The implication that economic agents or economists are omniscient cannot fairly be drawn from Muth's profound insights. It suggests rather that information is costly and that it will be used efficiently. Profitable opportunities to exploit available information will be exercised in a competitive world. Rational expectations are profit maximizing expectations. If the past proves to be a very imperfect guide to the future, then theory and practice will be inaccurate.

Muth developed his argument formally for what he described as a *"specialized form of the hypothesis"* (my emphasis). He assumed that random disturbances were normally distributed, that certainty equivalents existed for the variables to be predicted, and that the equations of the system including the expectations formulas were linear. Given these assumptions, Muth was able to derive mathematically optimum forecasts and establish the properties of the forecast errors.

The application of rational expectations to macro modelling takes the following general form. The aggregate demand, supply, and market clearing equations are specified with the addition of an error term to each structural equation. The error terms represent the influence of random demand and supply shocks on the system. The distribution of the shocks is assumed normal with expected values of zero.

The characteristic feature of these models is the form of the aggregate supply equation. In conformity with the stylized Phillips curve, the deviations of aggregate supply about its normal trend or permanent value are attributed to differences between actual and expected prices.

$$y_t - y_t^n = \alpha(P_t - P_t^*) + \epsilon$$

where y_t is the actual rate of change of real aggregate output in time period t, y_t^n is the "permanent" or trend rate of change of supply, P_t the realized price level in time t and P_t^* the price level that was expected to prevail in t, and ϵ is the random shock. The coefficient α is positively signed. Economic agents are assumed to confuse an observed increase in the actual price level P_t over P_t^* with an increase in the real price of their output to which they respond by producing more.

The models postulate further that expectations about the price level are "rational," *i.e.*,

$$_{t+1}P_t^* = \underset{t}{E}P_{t+1}$$

where $_{t+1}P^*$ are the subjective expectations of the price level and $\underset{t}{E}P_{t+1}$ is the mathematically optimum forecast of the price level at time $t+1$ conditional on all that is known about the determination of prices.

This knowledge is captured by the predictions of the model when combined with all the information available about the exogenous variables and the shocks. That is to say the model consists of deterministic and stochastic components. The expectation equation, following Muth, asserts equality between subjective or psychological predictions and the objective expectations of the theory.

The forecast error $[P_t - (\underset{t-1}{E}P_t|\theta_{t-1})]$, where $(\underset{t-1}{E}P_t|\theta_{t-1})$ is the rational expectation of P_t at time $t-1$ given all the information available at that time (θ_{t-1}), has the property that a regression of the forecast error on θ_{t-1} is zero [61, Thomas J. Sargent, 1973; 65, Robert J. Shiller, 1978]. The implication of this result is that only the unanticipated impulses acting on the system can cause actual output to differ from its permanent path.

This rational expectations view of the world has a devastating implication for conventional stabilization policy. The implicit presumption of such policy interventions is that they take the economy by surprise. Rational expectations argues that it pays economic agents to anticipate the effect of policy actions. If there is any regularity to policy action and effect, it will be discovered and form part of the information upon which economic plans are based.

Lucas has summarized these arguments most succinctly [42, 1977]. He explains that in the theory of economic policy the motion of the economy may be described by a difference equation

$$y_{t+1} = F(y_t, x_t, \theta, \epsilon_t)$$

where the function F and parameter vector θ are derived from the demand and supply functions of economic agents; y_t is the state variable; x_t, represents the behavior of the "forcing" variables of the system, *e.g.*, government fiscal and monetary policy; ϵ_t is the vector of random error terms with known distribution. As Lucas remarks [41, 1976, p. 25]:

> There is . . . no presumption that (F,θ) will be easy to discover, but it *is* the central assumption of the theory of economic policy that once they *are* (approximately) known they will remain stable under arbitrary changes in the behavior of the forcing sequence $[x_t]$.
>
> *Everything we know about dynamic economic theory indicates that this presumption is unjustified.*

Rational expectations theorists have proved that the "laws of motion" of the economy cannot be "policy invariant" [59, Prescott, 1977, p. 31]. Important pioneering contributions to this research program, in addition to the work of Lucas cited above, were made by Sargent [61, 1973; 62, 1976], Sargent and Neil Wallace [63, 1973; 64, 1975], Robert J. Barro [6, 1976], Finn Kydland and Edward C. Prescott [32, 1977], and Prescott [59, 1977].

The theoretical force of the argument has been conceded even by those who would deny the implications the rational expectations theorists have drawn for stabilization policy (see Albert Ando [1, 1978]; Stanley Fischer [21, 1977]; and Phelps and John B. Taylor [56, 1977]).

There are other theoretical developments that have been undertaken independently of the rational expectations discussions, which are proving very helpful to the rational expectations research program. As Shiller explains, the statistical theory of martingales applied to economics by Paul Samuelson and Benoit Mandelbrot led in turn to the efficient market hypotheses about the behavior of security prices [65, Shiller, 1978]. Following Eugene F. Famas definition, an efficient capital market is a market that is efficient in processing information [20, 1976]. The prices of securities observed at any time are based on a "correct" evaluation of all information available at that time. In an efficient market prices "fully reflect" available information [20, 1976, p. 133]. The similarities between the rational expectations and the efficient market hypotheses are striking and will be drawn upon further below.

Shackle on General Equilibrium Analysis

G. L. S. Shackle has long denied the Keynesian rationale for stabilization policy. His critique however is not based on the logical inconsistencies of Keynesian theory. Shackle challenges on more fundamental grounds the relevance of equilibrium analysis to the analysis of economic instability. The Shackle critique draws much, entirely appropriate, inspiration from Keynes himself.

The Walrasian general equilibrium solution to the system of demand and supply equations that summarize economic behavior represent, as Shackle puts it, the "perfect and complete adjustment of everything in the economy to everything else, a general equilibrium attained after no matter how long a time" [67, 1966, p. 227]. Time and uncertainty are assumed away by the devise of tâtonnement. Information provided by prices is costlessly obtained.

But the real world, as Shackle explains, is characterized not only by inconsistent plans but also by unexpected change. Therefore economic plans have to be put into operation on the basis of judgments about an uncertain future. Time, expectations, and uncertainty should form the essence of any explanation of economic change. To quote Shackle again, "the problem of general unemployment has taught us that economic conduct is a response not only to scarcity but also to a circumstance at least as imperious,

namely, uncertainty" [67, 1966, p. 22].

The argument is that if all future prices and events were known with certainty or with a certainty equivalent, there would be no need to postpone any dispositions of purchasing power or the sale of goods. Contracts would be established for future delivery and payment and with insurance companies, and there could be no possibility of general excess supply or demand. Such certainty is also in effect the character of Arrow-Debreu intertemporal general equilibrium. As Kenneth Arrow explains [2, 1978, p. 159]:

> An alternative interpretation of the model is to assume that the consumers and producers forecast future prices perfectly. If they use as forecasts the equilibrium values, then as the economy passes through successive dates, it will find at each one of them that supplies and demands are equilibrated at the anticipated prices.

Arrow notes that [2, 1978, pp. 159–60]:

> the crucial empirical point is that markets for most future commodities do not exist. It is an interesting and illuminating question why they do not exist, but this is not the place to examine that.

It is clear that households do not place such contracts because they prefer to keep their options open in the uncertain world they know they live in. On the other hand, because the production process takes time, the firms are obliged (*i.e.*, find it profitable) to plan production for the future. In general, consumers can avoid future contracts because they can choose a generalized form of command over future goods, money. (See Karl Brunner and Allan Meltzer [12, 1971]). It would therefore appear as if some of the circuits for the transmission of market signals assumed by general equilibrium theory are missing [37, Axel Leijonhufvud, 1969].

Shackle has been described by his most perceptive critic, Alan Coddington, as a "fundamental Keynesian," by comparison with the "hydraulic Keynesians" who dominate the text books; fundamental in that they interpret Keynes's major contribution to economics as that of emphasizing "that the basis of choice lies in vague, uncertain and shifting expectations of future events and circumstances: expectations that have no firm foundation in circumstances" [19, Coddington, 1976, p. 1260].

Shackle describes Book IV of the *General Theory* with its 30 pages on expectations and 80 pages on the interest rate as "reversing even caricaturising" the relative impact of the two kinds of influence on investment decisions. Shackle finds Keynes's *General Theory* as being in two minds.

> It turns instinctively towards stable functions, uninterrupted movements along curves, under employment "equilibrium," secular stagnation, step-by-step declension (for example, of the level of interest-rates). Yet the message spelled out by all this creaking semaphore is that intended (designed, *ex-ante*) investment is a law to itself, dependent (if at all) on too illusive and involved a skein of subtle influences, . . . to be ever captured in any intelligible, let alone determinable, equation. [68, 1972, p. 218.]

Shackle believes that Keynes made his major contribution to economic understanding by recognizing that the source of economic instability could be found in the existence of uncertainty. Shackle also argues that recognition of the role of uncertainty provides no basis for stabilizing the economy.

> Keynes's search for an understanding of business led him to the conclusion that business is essentially, irremediably non-rational, not through its defects of organization or mistaken choice of ends or of methods, but in the nature of things at their most fundamental level; it is logically inconceivable for business to be rational. But if there is no consistently operating mechanism, how can any reliable levers exist for managing it. [68, 1972, p. 163.]

This fundamental Keynesian position does not necessarily encourage an attitude of benign neglect of what may be re-

garded as the inevitable fluctuations of a market economy. It can be used to justify much more than tinkering with the mechanism. Brunner and Meltzer argue that the *General Theory* was mainly a case for the socialization of investment [13, forth.]. Coddington considers Joan Robinson's theory of capital to be fundamentally Keynesian. Coddington explains Shackle's own approach to economic analysis in the following terms [18, 1975, pp. 151–52]:

> But what if an accommodation of real (novelty and uncertainty-bearing) time *and* the reasoning faculty of the economic actor are both essential to our understanding of economic life? If these two ideas are fundamentally antagonistic to one another, it follows that any attempt to capture one of them in a formal scheme will tend to exclude the other. . . . Shackle . . . recognises a third possibility, which is to embrace a mode of formulation which rejects formalisation as the ideal of clarity and rigour.

Shackle's attempts to abandon strict logic has not found many friends in the economics profession. The fate of another, perhaps better known, attempt at disequilibrium analysis is instructive. The general disequilibrium, quantity constrained, analysis associated with Robert Clower [17, 1965], Axel Leijonhufvud [36, 1968], and Robert Barro and Herschel Grossman [10, 1971] ran into the dead end of ad hoc assumptions and indeterminate outcomes.[2]

Lachmann on Expectations

It will be useful for our purposes to consider at some length the views of Ludwig Lachmann, one of the leading modern Austrians, on expectations and the integrating role played by market prices. It will be apparent that Lachmann anticipates some of the flavor of rational expectations. Lachmann also points to a crucial difference between his own and Keynes's view of the stock exchange.

[2] For a similar interpretation of these developments, see Michael Parkin [51, 1978].

Lachmann regards the formation of expectations as [33, 1956, p. 23]:

> nothing but a phase in this continuous process of exchange and transmission of knowledge which effectively integrates a market society.

Therefore the first task of a theory of expectations is [33, 1956, pp. 23–24]:

> to describe the structure of the mental acts which constitute the formation of expectations; its second task, to describe the process of interaction of a number of individuals whose conduct is orientated towards each other.

> For anybody who has to make a decision in the face of an uncertain future the formation of an expectation is *incidental* to the endeavour to diagnose the situation in which he has to act, an endeavour always undertaken with imperfect knowledge. The business man who forms an expectation is doing precisely what a scientist does when he formulates a working hypothesis. Both, business expectation and scientific hypothesis serve the same purpose; both reflect an attempt at cognition and orientation in an imperfectly known world, both embody imperfect knowledge to be tested and improved by later experience. Each expectation does not stand by itself but is the cumulative result of a series of former expectations which have been revised in the light of later experience, and these past revisions are the source of whatever present knowledge we have. On the other hand, our present expectation, to be revised later on as experience accrues, is not only the basis of the action plan but also a source of more perfect future knowledge. The formation of expectations is thus a continuous process, an element of the larger process of the transmission of knowledge.

> We have said that the formation of expectations is incidental to the diagnosis of the situation as a whole in which one has to act. How is this done? We analyse the situation, as we see it, in terms of *forces* to which we attribute various degrees of strength. We disregard what we believe to be *minor forces* and state our expectations in terms of the results we expect the operation of the *major forces* to have. Which forces we regard as major and minor is of course a matter of judgment. Here the subjective element of interpretation is seen at work. In general, we shall be inclined to treat forces working at random as minor forces, since we know nothing about their origin and direction,

> and are therefore anyhow unable to predict the result of their operation. We treat as major forces those about whose origin and direction we think we know something. This means that in assessing the significance of price changes observed in the past for future changes we shall tend to neglect those we believe to have been due to random causes, and to confine our attention to those we believe due to more "permanent" causes.

Lachmann is concerned with the possibility of inconsistent interpersonal and intertemporal expectations and their resolution. He takes consolation from the thought that the effects of a series of unsuccessful expectations will be elimination from the market. Moreover Lachmann argues that the market system has evolved institutions that resolve the potential conflicts.

Lachmann regards the function of forward markets as that of spreading

> knowledge not about what is or has been, but about what people think will be. In this way, while the future will always remain uncertain, it is possible for the individual to acquire knowledge about other people's expectations and to adjust his own accordingly, expressing his own views about future prices by buying or selling forward, thus adding his own mite to the formation of market opinion as expressed in forward prices. In other words, forward markets tend to bring expectations into consistency with each other. They are on the side of the stabilizers. [33, 1956, pp. 67–68.]

While Lachmann recognizes the limited scope of forward trading, he regards the Stock Exchange as an example in "continuous futures."

> The Stock Exchange is a market in "continuous futures." It has therefore always been regarded by economists as the central market of the economic system and a most valuable economic barometer, a market, that is, which in its relative valuation of the various yield streams reflects, in a suitably "objectified" form, the articulate expectations of all those who wish to express them. All this may sound rather platitudinous and might hardly be worth mentioning were it not for the fact that it differs from the Keynesian theory of the Stock Exchange which is now so much *en vogue*. [33, 1956, p. 68.]

Working Hypotheses become Rational Expectations

Rational expectations takes a vital further step in the treatment of expectations by assuming that the "working hypotheses" that form the basis for expectations are equivalent to the presumptions of economic theory. Expectations may accordingly be modelled and theories tested.

In this way and by extending the maximizing assumption to the use of information, the rational expectations approach meaningfully extends the use of what Coddington describes as the reductionist method as applied in timeless general equilibrium analysis.

> The central idea [of reductionism] is the *reduction* of market phenomena to (stylized) individual choices. [19, 1976, p. 1258.]

It is this method that enables the connection to be made between "equilibrium states of market phenomena and the choice logic from which these states could be generated" [19, 1976, p. 1259].

Coddington makes the distinction between the existence of "knowledge deficiency" and the provision of "knowledge surrogates." He suggests that what is ordinarily covered by the blanket term "uncertainty" has two aspects. Knowledge deficiency covers "risk, uncertainty, mistakenness, ignorance, deception and delusion." There are he suggests, however, knowledge surrogates in the form of "conjecture, expectation, perception, learning, adaptation and so on" [18, 1975, pp. 152–53].

The fundamental issue is whether or not market prices may be regarded as serviceable "knowledge-surrogates" [18, Coddington, 1975, pp. 155–56]. There is as indicated previously an enormous amount at stake for economic analysis. The reductionist program must be built around equilibrating forces.

Of great relevance to this issue are the

numerous tests of the efficient market hypothesis. If markets are efficient, then price changes on those markets should follow an approximately random walk. If price changes are unrelated to previous prices, then all the forces known to affect prices are assumed to have been incorporated in ruling market prices. Efficient prices are equilibrium prices conditional on all information available when prices are established. A proof of efficient use of information in markets is a proof of rational expectations [29, Michael Hamburger and Elliott Platt 1975; 58, William Poole, 1976].

William Poole reports that [58, 1976, p. 467]:

> The validity of the rational-expectations hypothesis as applied to prices in active auction markets has been extensively tested. Numerous investigators have analysed an enormous amount of data using many different statistical techniques, and no serious departure from the predictions of the hypothesis has been found. Thus, there is very strong evidence in favor of the hypothesis.[3]

Critics of Rational Expectations

It has been argued above that the rational expectations approach does not assume that men need apply reason "to circumstances that are perfectly known." Arrow draws a different interpretation. It is ironic that he should criticize rational expectations because of its similarity to his own general equilibrium theory.

> It is true that the rational expectations hypothesis implies that the outcomes on future markets are well anticipated, but it is hard to see why this should be true. The very concept of the market and certainly many of the arguments in favor of the market system are based on the idea that it greatly simplifies the informational problems of economic agents, that they have limited powers of information acquisition, and that prices are economic summaries of the information from the rest of the world. But in the rational expectations hypothesis, economic agents are required to be superior statisticians, capable of analyzing the future general equilibria of the economy. [2, 1978, p. 160.]

Albert Ando adopts a similar position. He refers to the work of Lucas and Sargent as "classical equilibrium theory" and the theory of an "economic stationary state" generalized to "a suitably stochastic case" [1, 1978, pp. 16–17]. Herbert A. Simon in his Nobel Prize lecture advanced a similar argument [66, 1978]. It is however incorrect to assume that rational expectations regards errors in forecasts as insignificant or absent. The implication of rational expectations is rather, that the forecast errors are not correlated with anything that could profitably be known when the forecast is made. Or in other words *while markets may be wrong, they are not wrong without good reason.*

The other main thrust of the criticism made by Arrow is that while stock markets may be efficient, the markets for commodities and labor are not.

Arrow argues as follows [2, 1978, p. 162]:

> Economic theory and policy-making may have unduly minimized stocks and anticipations; but one can err in the opposite direction. Economic theory implies that price anticipations are relevant in decisions about capital formation but not in flow decisions. In allocating consumption today, the future price of a completely perishable good is irrelevant (strictly speaking, this is true only if consumption bundles of different periods are separable in utility). An extreme example of a perishable commodity is labor-time. The laborer is durable, but the hours he can work are not. Hence, there is essentially no reason for anticipations of future wage increases, correct or incorrect, to affect the present supply of labor. Yet one finds models which argue that statistical unemployment is wholly or partly a voluntary withholding of labor because of unduly optimistic expectations!

Arrow remarks further: "the future wage level is important in estimating fu-

[3] For a more recent discussion of the relation between efficient markets and rational expectations, see Frederic Mishkin [47, 1978] and James Pesando [53, 1978].

ture income and hence present wealth. But unlike the case of durable goods, there is no market pressure driving expectations of price changes in a particular direction" [2, 1978, p. 163]. A rational expectations explanation of labor market behavior will be presented below.

It is however not at all obvious why prices in markets that are not well organized stock markets are any less efficient, in the sense that *obviously unexploited* opportunities to profit persist over time. The force driving prices in all markets, including labor markets, is the search for profits. Pure profits in the sense of Knight are earned by knowing or guessing better than the market. The market prices of resources fully reflect expected "normal" profits from their utilization in the production process.

Moreover economists do not usually seek an explanation of general economic instability in the markets for perishable goods. The prices of perishables, because of their nature, adjust rapidly to clear the market. The source of persistent excess supplies is more usually sought in labor markets precisely because the labor market is so obviously a quantity rather than a price-adjusting market. It should furthermore be recalled that Keynes's fundamental attack on classical economics was directed at the supposed irrationality of stock markets and so investment decisions.

Arrow reveals a misunderstanding of rational expectations by the following statement [2, 1978, pp. 161–62]:

> But once we go down the path of permitting inferences to be drawn, there are more and more subtle possibilities. One may regard a strong government monetary policy to be significant, not merely for itself but because it is an indication of the government's determination to do something about the current depressed situation. On this basis, the reaction might be much stronger than would be justified by the objective facts. Arguments of this kind were popular at one time with regard to rediscount rate policy on the part of central banks; it was the signalling effect rather than the objective impact on the economy that was dominant.

It was rather the consistency of the signal with the objective facts that was useful to the traders in securities. Bankers and businessmen do not need to know economic theory. They can however take advantage of rules of thumb. But rules of thumb will remain serviceable only if the structure of the economy remains unchanged. It was economists and central bankers who came to confuse the signal (interest rate changes) with the substance, which was balance-of-payments-dependent money supply changes. But this is another long story. Meltzer interprets the classical gold standard in similar terms [45, 1977].[4]

Some Econometric Tests and Applications of Rational Expectations

As Prescott noted expectations cannot be measured directly; they have to be inferred [59, 1977]. One example of treating expectations inferentially is to be found in Lucas's original investigation of unemployment inflation trade-offs across countries [39, 1973]. Lucas attempted to test the rational expectations model of the natural rate of unemployment by examining the relation between unemployment and the variance of price changes across countries. Lucas found there was a short-run Phillips curve only if no attempt was made to take advantage of it.

Another application has been made by Jacob A. Frenkel in an explanation of the

[4] It is perhaps appropriate to reflect on the famous (apocryphal) story of Rothschild and the Battle of Waterloo. It was well understood that a victory for Napoleon would be bearish for British stock. It was also assumed that the House of Rothschild would be the first to know the outcome of that great and terrible battle. Rothschild in due course appeared at the Exchange and gave his broker the signal to sell. We may all hope to have a suitably profitable occasion to destroy our credibility.

demand for money in Germany during the hyperinflation. Frenkel infers inflationary expectations from the forward exchange market after testing for the efficiency of that market [22, 1977]. The idea is that the forward rate represents an unbiased estimate of future spot rates and expectations of future spot rates depend on expected relative purchasing power. Therefore implicit in the future rate is an expectation of inflation. This expectation of inflation is applied in a regression estimate of the demand for money.

Barro has also tested the rational expectations hypothesis. Barro's studies attempt to show that it is only the unanticipated component of monetary growth that affects employment, real output, and the price level [7, 1977; 9, 1978]. Barro is undoubtedly asking *the* interesting question from a rational expectations point of view. However, this method of answering the question appears to violate the spirit of rational expectations in the following way.

In Barro's published models anticipated monetary growth is not inferred. Anticipated money growth is rather taken to be the money growth given by a regression equation of actual money changes on variables shown able to predict money supply growth over the entire period under observation (1941–73). The measure of anticipated monetary growth is therefore not made conditional on the information available to economic agents when expectations were formed.

In an earlier version of this study Barro measured anticipated monetary growth for period t based on information available only up to period $t-1$. This is clearly a procedure that meets the objection raised above. Barro showed that bringing up to date the sample led to "little evolution of the coefficient estimates" [5, 1976, pp. 14–15]. When these properly dated measures of anticipated monetary growth were applied in the test of the hypothesis that only unanticipated monetary growth affected unemployment, they gave support to the theory, though not as much support as the alternative specifications. It is however notable that when the period of observation is extended and lower weights attached to World War II observations, the estimated values of the coefficients measuring the impact of monetary growth lagged one and two periods on anticipated monetary growth becomes 0.41 and 0.21 compared to the previous 0.24 and 0.35 [9, Barro, 1978, p. 551]. It is therefore not clear which equation properly represents the equation economic agents are assumed to know when they estimate the money supply. One is in effect being asked to accept a joint hypothesis. The appropriateness of the measure of anticipated monetary growth is judged by its ability to help predict unemployment. Since the theory of anticipated monetary growth is a simple single equation and inevitably somewhat ad hoc, there would seem no way to reject the first part of a joint hypothesis of this kind.

Objections on logical grounds to Barro's theory of the money supply process may also be raised. In this theory the government is assumed to rely on money creation rather than taxation when the federal deficit rises relative to the normal deficit. This clearly implies that the authorities also control interest rates, for otherwise higher interest rates could ration the supply of bank credit without requiring accommodating increases in high powered money. Such controls on interest rates would also make the money supply vary procyclically with employment. However, included in the anticipated money supply equation is a countercyclical effect of unemployment on money supply growth.

Sargent's measures of anticipated monetary growth and other variables as established by best fit autoregressions over the entire period of observation are also vul-

nerable to the criticism that anticipated variables are not conditioned on what could have been known [61, 1973; 62, 1976]. We know that autoregressive methods do not forecast well outside the sample period. One would therefore expect maximizing economic agents to be aware of the necessity for "parameter drift" in their forecasting exercises. To meet this criticism, Sargent could have economic agents revise their "ARIMA" (autoregressive integrated moving average) forecasts as new information became available. Unfortunately econometric exercises of the kind that assume that economic agents know the structure of the model for the entire sampling period may give credence to the view that rational expectations imagines economic agents to be, in Arrow's words, "superior statisticians capable of analyzing the future general equilibrium of the system."

Perhaps the most inventive econometric application of the rational expectations approach is the procedure devised by Robert E. Hall to examine the life-cycle and permanent-income hypotheses. The flaw in many tests of aggregate consumption behavior is the failure to take account of the endogenous character of income when income is assumed to be a determinant of consumption. As Hall points out, even simultaneous estimates of consumption and income often have to make uneasy compromises about the exogeneity of instrument variables. Hall tests a so-called stochastic version of the theory of consumption. As Hall explains the theory [26, 1978, p. 972]:

> When consumers maximize expected future utility, it is shown that the conditional expectations of future marginal utility is a function of today's level of consumption alone—all other information is irrelevant. In other words, apart from a trend, marginal utility obeys a random walk. If marginal utility is a linear function of consumption, then the implied stochastic properties of consumption are also those of random walk, again apart from a trend.

Hall's test of the theory is exactly analogous to the tests of the efficient market hypotheses. The hypothesis is tested by regressing current consumption on lagged consumption, real income, and wealth. Given the time trend in consumption only, the finding that consumption lagged one period can help predict current consumption provides considerable support for the theory. The implication is that anything known to influence future income and consumption is already reflected in current consumption decisions. The strong version of the theory, that consumption is unrelated to *any* economic variable observed in earlier periods, is rejected by the ability of stock market prices to help predict future consumption. Most of the predictive power of stock market prices is derived from the value of stocks in the previous period.

Rational Expectations, the Business Cycle, and the Labor Market

In his interpretation of rational expectations, Lucas addresses Frank Knight's distinction between risk and uncertainty in the following way [42, 1977, p. 15]:

> At a purely formal level, we know that a rational agent must formulate a subjective joint probability distribution over all unknown random variables which impinge on his present and future market opportunities. The link between this subjective view of the future and "reality" is a most complex philosophical question, but the way it is solved has little effect on the structure of the decision problem as seen by an individual agent. In particular, any distinction between *types* of randomness (such as Knight's (1921) distinction between "risk" and "uncertainty") is, at this level, meaningless.
>
> Unfortunately, the general hypothesis that economic agents are Bayesian decision makers has, in many applications, little empirical content: without some way of inferring what an agent's subjective view of the future is, this hypothesis is of no help in understanding his behavior. Even psychotic behavior can be (and today, is) understood as "rational," given a sufficiently abnormal view of relevant probabilities. To practice economics, we need *some* way (short

> of psychoanalysis, one hopes) of understanding *which* decision problem agents are solving.

Lucas suggests that rational expectations, which assumes the coincidence of subjective and true probabilities, is not applicable in situations in which one cannot guess which, if any, observable frequencies are relevant; situations that Knight called uncertainty. Lucas suggests it will most

> likely be useful in situations in which the probabilities of interest concern a fairly well defined recurrent event, situations of "risk" in Knight's terminology. In situations of risk, the hypothesis of rational behavior on the part of agents will have usable content, so that behavior may be explainable in terms of economic theory. In such situations, expectations are rational in Muth's sense. In cases of uncertainty, economic reasoning will be of no value. [42, 1977, p. 15.]

Lucas takes consolation from the apparent regularity of the business cycle as a justification for seeking "an equilibrium theory of the business cycle."

> These considerations explain why business cycle theorists emphasized the *recurrent* character of the cycle, and why we must hope they were right in doing so. Insofar as business cycles can be viewed as repeated instances of essentially similar events, it will be reasonable to treat agents as reacting to cyclical changes as "risk," or to assume their expectations are *rational*, that they have fairly stable arrangements for collecting and processing information, and that they utilize this information in forecasting the future in a stable way, *free of systematic and easily* correctable biases. [42, 1977, p. 15.]

If, however, making economic decisions for the future were complicated only by risk, the problem would be reduced to a zero sum game between firms and insurance companies. It is not plausible to seek an explanation of persistent errors about the allocation of resources that characterize the regular business cycle in these terms. Nevertheless, even if the problem is more than risk, we must accept with Lucas that economic agents have "stable arrangements for collecting and processing information" and that they use the information they have in a stable way "free of systematic and easily correctable bias."

A world dominated by uncertainty in the Knight sense would however seem to offer little profitable scope for the time-consuming nature of production and consumption we observe. It should be conceded that the regular business cycle could be seriously disturbed or "shocked" by an event or series of events for which the past provides very little guidance. Economic agents may not be able to form confident Bayesian priors about what will transpire over the relevant forecast spans. The Great Depression of the thirties in the United States may be explained in these terms. Revolutionary or expected revolutionary political change would also induce a lack of confidence in predictions about profitable investment decisions. The paralysis of investment could explain a prolonged depression, for even if investment were expected to remain at permanently lower levels, it would take some time before resources, especially labor resources, could be reallocated to alternative uses.

Lucas has some profound thoughts on the nature of the business cycle [42, 1977, pp. 19–20]:

> One must go behind price movements to the changes in technology and taste which underlie them. These changes are occurring all the time and, indeed, their importance to individual agents dominates by far the relatively minor movements which constitute the business cycle. Yet these movements should, in general, lead to relative, not general price movements. A new technology, reducing costs of producing an old good or making possible the production of a new one, will draw resources into the good which benefits, and *away from* the production of other goods. Taste shifts in favor of the purchase of one good involve reduced expenditures on others. Moreover, in a complex modern economy, there will be a large number of such shifts in any given period, each small in importance relative to total output. There will be much "averaging out" of such effects across markets.

An explanation of the regular business cycle must surely look to sources of systematic bias in the information available to economic agents that may mislead them about the true state of the economy. It is perhaps worth noting here that pre-Keynesian business cycle theorists, for example, Knut Wicksell and Friedrich Hayek, explained the business cycle as a response to false signals provided by changes in interest rates or the price level. The signals were thought to lead to a misallocation of resources between consumption and investment, which would be revealed by the emerging pattern of demand. This naturally made Hayek very skeptical of plans to increase consumer demand to stimulate employment when the problem was understood to be too many investment goods and too few consumption goods [30, 1933].

Lucas's own theory of the business cycle relies on the assumption of incomplete information and a consequent confusion between relative and absolute price changes [40, 1975]. The persistence of deviations of variables about their trend or permanent values that characterize the business cycle do not obviously accord well with the pure rational expectations property of serially uncorrelated forecast errors. As has been pointed out by Benjamin Friedman, the rational expectations models referred to above do not have any error learning properties [24, 1979]. There is no time lag between the collection of new information and its assimilation and implementation in revised conditional forecasts. As Friedman demonstrates, once such lags are introduced, mathematically optimum forecasts no longer display the property of serially uncorrelated errors. Optimal forecasts may be distributed lags on available information.

If lags in the response to new information are held responsible for the business cycle, an explanation must be sought for the existence and length of such lags that is consistent with maximizing behavior. We shall return to this question after a discussion of labor market characteristics.

Analysis of the Labor Market

The research program of rational expectations has been drawn inevitably to an explanation of labor market behavior. In the other economic markets mistaken plans are undertaken and expectations falsified, but the markets are more or less continuously cleared. Prices are cut or increased, losses are borne, capital is written off and readapted to other purposes. Resources are wasted, but bygones are bygones. Even if market clearing requires the bankruptcy of economic agents, this is not usually considered to be of great consequence. Bankruptcy may be the occasion for government subsidies "to save jobs."

The labor market appears to be different. It is conspicuously a quantity rather than a price adjusting market. Lucas addresses the issue in the following way [42, 1977, p. 12]:

> For nowhere is the "apparent contradiction" between "cyclical phenomena" and "economic equilibrium" theory sharper than in labor market behavior. Why, in the face of moderately fluctuating wages and prices should households *choose* to supply labor at sharply irregular rates through time?

Or to put it another way, why should firms be allowed to employ labor at sharply irregular rates over time [27, Hall, 1979]?

Rational expectations cannot rely on market frictions or search costs as an explanation of unemployment. Rigid wages in the face of persistent unemployment would be recognized sooner or later as inconsistent with maximizing behavior.

It may be assumed that the labor market is not cleared by an auctioneer at the labor exchange because such a system does not best serve the interests of most workers and firms. The absence of these clearing arrangements need not be attributed to

the power of trade unions or to government intervention. The incentive to innovate employment practices is as great as anywhere else in the economy. If there were profitable opportunities to increase the flexibility of wages in the labor market, it can be assumed they would be discovered and utilized. Labor markets are more quantity than price flexible for good reason. The developing theory of contracts may provide better answers to these questions (see Costas Azariadis [3, 1975]; Hall and David Lilien [28, 1978]).

One approach to this issue originated with Lucas and Leonard Rapping. They regard workers as substituting leisure and work over time in the attempt to maximize lifetime incomes. Workers are assumed to be aware of seasonal and cyclical fluctuations in wage incomes and that occupations differ in these respects. Therefore some of the variation in the supply of and demand for labor may be consistent with exceptations and lifetime income and consumption plans. Workers can be regarded as supplying more labor time when demand for labor is considered temporarily high and less when temporarily low. Over a working life, leisure and work may be substituted in response to expected fluctuations in demand for labor. Evidence of such effects has been found [43, Lucas and Rapping, 1969].

However, as Hall has pointed out, by no means all evidence from the labor market supports the view that variations in the supply of labor represent intertemporal substitution. In recessions workers typically are dismissed rather than quit and more particularly spend more time, on average, looking for work [27, Hall, 1979]. This would suggest that unexpected fluctuations in the demand for labor explain part of the observed unemployment.

Brunner, Alex Cukierman, and Meltzer, in their attempt to explain persistent unemployment, point to the problem workers and firms may have in inferring promptly the appropriate state of the economy from evidence available to them [11, 1979]. As Brunner and Meltzer explain [14, forth., pp. 4–12]:

> Fluctuations in aggregate economic activity and employment result from changes in the aggregate demand for and supply of output. The timing of the changes is uncertain. The changes may be positive or negative, and may be temporary or persistent. Workers and employers in individual firms do not know whether shocks or changes are temporary or long-lasting, real or nominal.
>
> The uncertainty that affects employment is summarized by the four-way classification of shocks as real and nominal, temporary and persistent. Uncertainty arises because of the inability of workers and employers to distinguish promptly, between the four categories. We assume that there is no way to extract from available data fully reliable information about the type of shock that has occurred.

The distinction between permanent and temporary disturbances is a very important one and adds to a possible confusion between real and nominal changes that characterize the usual rational expectations aggregate supply functions referred to above.

Brunner, Cukierman, and Meltzer have developed a model of stagflation and wage stickiness, which relies on the inability of agents to distinguish between permanent and transitory shocks. The distinction between what are permanent and what are merely transitory shocks is only revealed over time. The difficulty in drawing correct inferences about the state of the economy even after the shocks have occurred makes the mathematically optimum forecast a distributed lag proxy for the expectations of permanent variables. Persistent deviations about permanent values are a property of the model [11, 1979].

Rational Expectations and Stabilization Policy

Critics of rational expectations maintain that because wages and prices are less

than perfectly flexible, a short-run Phillips curve trade-off is still available to the authorities [4, Martin Baily, 1978; 50, Arthur Okun and George Perry, 1978]. This result is thought to hold even if agents are "rational" with respect to stabilization policy but are inhibited by fixed period contracts [21, Fischer, 1977; 56, Phelps and Taylor, 1977]. Bennett T. McCallum has responded in kind to this criticism [44, 1977] (see also Barro [8, 1977]). As is acknowledged by Fischer, the existence of the contracts is taken as given and not explained. How the contractual arrangements would alter if the authorities attempted to make use of these apparent rigidities is also not indicated. It should also be recognized that the periods for which individual firms and workers contract overlap, providing a degree of flexibility to the price level in general that may not be true of an individual price or wage.

The rational expectations critique of conventional stabilization policy would seem to apply *a fortiori* to an economy characterized by long-term contracts for the supply of labor or goods. Economic agents who find it convenient to exercise wage and price setting powers, firms and trade unions for example, will find it imperative to take a position on stabilization policy precisely because reversing positions in these markets is costly over the forecast span. Moreover, given such anticipations, there can be no presumption that the impact of stabilization policy will be under rather than over estimated. If policy turns out to be less inflationary than generally expected, rapid increases in the money supply could precede decreases in real output and employment.

There is however a more subtle possibility that given some inflexibility of prices or wages the authorities could attempt to surprise the market. This could be referred to as unconventional stabilization policy. The authorities would have to know what the market expected of the authorities and act differently. The market in turn would come to expect the authorities to act differently, and so a gaming type problem would emerge. This, of course, is to take discretionary stabilization policy far away from its conventional objective of compensating for the supposedly deflationary bias of a market economy. If rational expectations are taken seriously, it is by no means apparent why a market economy should have any deflationary bias even when wage and price rigidity is assumed. It may be accepted that discretionary stabilization policy will have real effects, given less than instantaneous market clearing, if it is unanticipated. However, the effects of such a policy will only be predictable if the authorities are the superior general equilibrium statisticians and furthermore if they can consistently win the game against maximizing economic agents.

With and without stabilization policy, the economy and economic agents are vulnerable to uncertainty or, to use the terminology of rational expectations, to random shocks. Shocks may be real or nominal, temporary or permanent. Shocks have real effects precisely because they were not and could not be anticipated. To make appropriate plans, economic agents have to identify the nature and duration of shocks. This raises the fundamental issue of the characteristics of the institutions that would enable the system to best cope with unavoidable uncertainty. Discretionary stabilization policy, which imposes nominal shocks on top of real ones, would not seem appropriate.

Conclusion

After a long and regrettable hiatus, macroeconomic analysis is once more wrestling seriously with the role played by expectations. Economic theory without an explanation of expectations will not be able to contribute towards an understanding of macroeconomic phenomena in a future-conscious world. The challenge of rational expectations and the response to it

is busy transforming macroeconomics for the better.

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