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A CHILD'S GUIDE TO RATIONAL EXPECTATIONS

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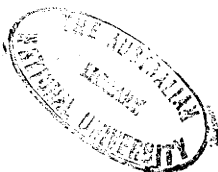
A CHILD'S GUIDE TO RATIONAL EXPECTATIONS

Rodney Maddock and Michael Carter

AUSTRALIAN NATIONAL UNIVERSITY

ABSTRACT

Rational expectations has aroused a great deal of interest, controversy and confusion in the economics profession. This paper is our attempt to illuminate in a simple and lucid way the major issues, results, conclusions and criticisms. It is aimed at a general audience.



DRAMATIS PERSONAE

(In order of speaking)

Ernie
Bert

First Student
Second Student

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A CHILD'S GUIDE TO RATIONAL EXPECTATIONS *

SCENE I: INTRODUCTION

(Two economics students sharing coffee in the union of an unnamed Australian university. They are fairly perspicacious: Bert leans towards monetarist positions while Ernie is more of a Keynesian.)

Ernie: Did you read that ridiculous article in *Challenge* the other day?

Bert: Which?

Ernie: Somebody named McCallum was saying that rational expectations proved that the government could not stabilize the economy. Hang on, I've got it here: "An accurate understanding of how expectations are formed leads to the conclusion that short-run stabilization policies are untenable".¹ I don't know how they could develop theories like that. It's pretty obvious that government policy does affect the economy in the short-run.

Bert: He didn't say they could not *affect* the economy in the short-run or even in the long-run. The key word is *stabilize*.² Just think about what's happened in the last few years - record inflation and record unemployment. You don't call that stabilization, do you?

Ernie: Well, maybe they've been stable at high levels but I take your point. There does seem to have been some breakdown of the ways in which the government can influence the macroeconomy. Do these rational expectations blokes think they have a model to explain stagflation?

Bert: Yes, they do. It's caused by misguided governments

following Keynesian policies that haven't worked, don't work, and won't work in the future.³

Ernie: I suppose they advocate doing nothing and letting the 'free market' do its worst. Great! They sound just like Friedman and all those old-fashioned monetarists. They have always said inflation was just a monetary phenomenon and macro policy couldn't shift the economy to higher levels of employment.

Bert: Yes, that's right. Most economists now agree that the long-run Phillips curve is vertical.⁴ That means that there exists a natural rate of unemployment.⁵ Government policy can bring about a departure from that only in the short-run and then only by fooling people. But you can't fool all the people all the time. Therefore, systematic policy is ineffective.⁶

Ernie: I'm not at all sure that the long-run Phillips curve is vertical.⁷ We used to have about one per cent unemployment; now we seem to be stuck at about eight per cent. How can you explain that with a vertical Phillips curve. "The Phillips curve is vertical but moves around a lot" - hardly seems much of a theory.⁸ Even if it is vertical and we can't get away from it except by fooling people, clearly the government can fool people. Every time it changes policy the people don't know about the new policy for a while so it's a while before they catch up.⁹

Bert: But that's just what rational expectations is all about! It suggests that people anticipate the effects of the new policy. If that's true, then the policies won't cause any increase in employment!

Ernie: How on earth are people supposed to anticipate the effects of policy? I just can't see it. Have they all got

econometric models under the sink?¹⁰

Bert: (*angrily*) Now you're just being silly. Have you read *any* of the basic literature - Lucas, Sargent, Wallace, and so on?

Ernie: I've looked at some but it just seems unreal - too many equations. They never define exactly how they think anybody forms these 'rational expectations'.

Bert: Look, I've got to go to my macro lecture. How about we meet again tomorrow, and I'll introduce you to the magnificent world of rational expectations. Same time?

SCENE II: THE IDEA OF RATIONAL EXPECTATIONS

(Same place. Next day.)

Bert: Well, are you ready to try to understand what rational expectations is about?

Ernie: Yes. Have you got it figured out yet?

Bert: I've been thinking about it. Let's go through it systematically. First, we can talk about just what rational expectations are. Then we can look at the way the policy impotence result is derived. By then we should have a pretty clear idea of what this line of research is on about so we can try to figure out how it relates to the Phillips curve, monetarism, econometric models, and all that. O.K.?

Ernie: Alright. What's the definition of rational expectations? What on earth might irrational expectations be?

Bert: First things first. Let's start with familiar ground. What would you say is the basic behavioural assumption of economic behaviour?

Ernie: Utility maximization, I suppose.

Bert: More or less. I would say that the basic assumption of individual behaviour is that economic agents do the best they can with what they have. This principle forms the basis of consumption theory, production theory, human capital theory, and so on.

Ernie: So it's the basis of microeconomics.¹¹ But what's that got to do with expectations?

Bert: Everything. At its most fundamental, rational expectations theorists argue that the same principle should be applied to the formation of expectations. If you want a definition, how about: *rational expectations is the application of the principle of rational behaviour to the acquisition and processing of information and to the formation of expectations.*¹²

Ernie: Am I to infer that my utility function and I sit down together and rationally decide how much information I should acquire in order to form the expectations which will help me maximize my utility? Incredible!

Bert: Yes, you can attack it that way if you like, but that's a more general criticism of utility theory which we can argue about some other time. All I'm saying here is that if one considers economic agents to be rational maximizers, then it's consistent¹³ to consider information gathering and expectation formation as determined by the same procedure.

Ernie: O.K. So you'd insist upon a rational expectations postulate: that private economic agents gather and use information efficiently. That means you believe the marginal costs of gathering and using information are equated to their marginal benefits. McCallum doesn't agree with you. He says: "Individual agents use *all* available and relevant information

and it seems to me that Sargent and Lucas say the same. It almost seems as if they think information is a free good.¹⁵

Bert: That's a good point. Many theorists have ignored the costs of information used in the formation of expectations. That is one of my criticisms of the literature. But I think it is useful to distinguish between rational expectations as a principle of informational efficiency and rational expectations as it appears in some of the macroeconomic literature.¹⁶

Ernie: The term 'rational' is quite confusing in the context and you are right that the distinction between the two things is important. But what difference does rational expectations make to individuals? Can you give examples?

Bert: The example most often used in the literature involves the allocation of time between labour and leisure.¹⁷ In deciding how many hours to work this period, an individual must take account of expected future wages and not just the present wage. For example, if you expect the real wage to be \$10 per hour this week, and \$1 next week, then it makes sense to work as much as possible this week, and have some time off next week. Therefore the number of hours worked in any period, that is the labour supply, will depend not only on the current real wage but on expected future real wages. A rational expectation of real wages will take into account all available information, including the effects of government policy.

Ernie: But my old man works 40 hours every week - he doesn't have much choice.

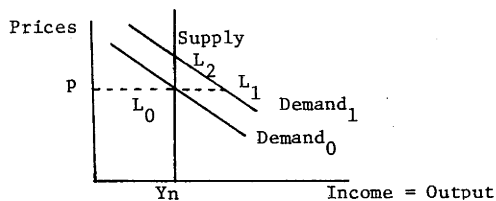
Bert: But your old man's boss does. When he is deciding whether to hire more people or lay them off, he needs to take

into account future prices and wages. His expectations should be based on all the available information. This includes, among other things, the impact of future government policy.

Ernie: O.K. I see how the level of employment might depend upon expectations and how 'good' expectations are better than 'bad' ones. But I can't see why that means that there is no room for government policy.

DERIVING THE IMPOTENCE RESULT

Bert: Most rational expectations models work with the idea that the levels of output and prices are determined by the intersection of an aggregate demand and aggregate supply function. The aggregate supply curve is taken to be vertical,



so that output cannot deviate from Y_n as a direct result of any change in the level of demand. Thus government policies designed to change the level of aggregate demand are not likely to be effective. The level Y_n is the output associated with equilibrium in the labour market at the natural rate of unemployment so we can call Y_n the natural rate of output or income for the economy.¹⁸

Now, the model depends upon the idea that government is able to shift the economy off the aggregate supply curve to a point like L_1 . The government increases the money supply, workers receive higher money wages and, hence, work longer hours (or more people enter the workforce). This shifts the

aggregate supply of goods to the right and hence would increase the level of output. In the process, however, prices go up so that in *real* terms the workers are no better off (compare L_2 with L_0). Thus there is no *real* justification for supply to be to the right of Y_n . It will only be so if people confuse nominal changes in wages (for example with real changes). This means that government policy will only increase the level of income in real terms if it is able to fool people into confusing nominal changes with real ones.¹⁹

Ernie: That's ridiculous! The 'natural' rate of unemployment depends intimately upon all sorts of government policies - for example tax laws, minimum wage laws, immigration policy, school-leaving age, etc., etc. Do you really mean that the government can't change aggregate supply by increasing the investment allowance? Or by going to war, for that matter?

Bert: You're right, you're right! I should have been more careful. Clearly government policy can alter the natural rate of unemployment or, if you like, the position of the aggregate curve. What I should have said is that the only way in which government policy can bring about *deviations* from the natural rate of unemployment is by inducing private agents to have mistaken expectations. Let's write down a simple model.

[Bert's scribbling is attached as Appendix B. For those who like mathematical descriptions it should make the discussion clearer but is not a necessary adjunct.]

Ernie: That makes your position clearer. The actual aggregate supply function implies that deviations of actual output from the natural rate are directly proportional to deviations of actual prices from expected prices. Since people with

rational expectations never make mistakes about policy rules, policy will never fool them, and output will never deviate from its natural rate as a result of any policy rule.

Bert: That's the idea but you've put it too strongly. If government policies are random, they will be effective although not necessarily desirable. It's the systematic component of policy that the theory suggests will be ineffective.

Ernie: I'm not too sure about the neutrality²⁰ of money proposition generally but will let it ride for now. You explain the rest of the argument - then I'll put my objections one by one.

Bert: Now the point of rational expectations is that people won't be surprised by any systematic policy. Any government which relies upon a policy rule - one which has a fixed growth of the money supply, or is systematically related to income or unemployment - will never cause prices to differ from expected prices, and so can never cause any deviation from the natural rate.²¹ A random policy will affect real output. But any policy which is systematically related to economic conditions, for example a policy designed with stabilization in mind, will be perfectly anticipated, and therefore have no effect on output or employment. In other words, to have real effects, monetary policy must be completely unpredictable. Any systematic policy will be impotent.

Ernie: Can we put it this way? Rational expectations are based on all available information. The available information set includes the government policy rule. Therefore, a rational expectation of inflation, for example, will include the anticipated effects of government policy so that the policy will

have no effect on output.²²

Bert: Yes, that pretty well sums it up.

CRITICISMS

Ernie: Now that I think I understand what you're on about, can I tell you what I think is wrong with the model?

Bert: O.K.

Ernie: First, I don't like your supply curve. There are lots of criticisms one could make, but the most important in the context of the model is that you assume an extreme form of the neutrality of money.²³ Even perfectly anticipated inflation has no real effects in your model. That's clearly wrong. The usual argument is in terms of portfolio readjustments because of the effect on the real return on money balances which bear a zero nominal return.²⁴ Of far more empirical significance, I think, are the distortions introduced by the progressive tax structure under inflation.

Bert: Yes, but all models are approximations.

Ernie: True, but not all approximations are good approximations! Here's another problem. If expectations are rational, then expectation errors should be randomly distributed over time. A straightforward implication of that for this model is that the level of output (or unemployment) is uncorrelated over time. Yet it is well known that the GNP and unemployment series have a high degree of serial correlation.²⁵ We tend to go through a series of years in which unemployment is below the 'natural rate', and then a series of years in which it is above the 'natural rate'. It doesn't seem to be distributed very randomly. Compare the sixties and seventies in Australia.

Bert: I can't deny the serial correlation in the unemployment or income series. Most rational expectations models include lagged income or lagged unemployment as explanatory variables in the supply function.²⁶ This does make the models fit the data better, but there is no good theoretical justification for it. Lucas is the only one I know who really addresses the issue.²⁷ He relies on the well-known 'fact' that all people live on islands. At the end of each trading period people choose a new island at random. Because they don't know the history of their new island, they can't distinguish between real and nominal effects immediately.²⁸

Ernie: These island models seem appropriate to a society in which the fastest form of communication is a floating coconut. Hasn't Lucas ever heard of radio and the telephone?²⁹

Bert: I have to agree with you. I said that the explanations for persistence weren't very convincing, especially when the government regularly publishes lots of statistics. The newspapers carry stock exchange prices every day. The information seems to be essentially free. We really don't have a good explanation for persistence (serial correlation). I willingly concede that point. What's next?

Ernie: O.K. Even if all that information is freely available, you assume that all the agents know the correct model of the economy. How ...

Bert: No, I don't. Well, not me really, but that rational expectations people don't necessarily say that *everybody* knows the correct model of the economy. They suggest that some arbitrage process takes place whereby the people who have the correct model dominate the outcome.³⁰ If there are

misapprehensions, then well-informed agents can make profits at the expense of the ill-informed. This will inevitably lead the system to converge to the rational expectations equilibrium. As your old mate, Keynes, said:

... actions based on inaccurate anticipations will not long survive experiences of a contrary character, so that the facts will soon override anticipation except where they agree.³¹

Ernie: Granted there is a role for arbitrage. But how do we know that expectations of the experts will converge the true value? Give me any rational expectations model and I think I can show you a reasonable adjustment process which will not converge to the rational expectations equilibrium.³²

Bert: And I can probably show you one that can. Unless the theorists specify an adjustment mechanism, we can't really argue about this point. Rational expectations theorists haven't addressed this problem.

Ernie: That's a big gap in your theory. But let me read to you what Shiller says:

Even if a model does eventually converge on a rational expectations equilibrium, it may take such a long time to do so that, since the structure of the economy changes occasionally, the economy is never close to a rational expectations equilibrium.³³

To recalculate a quarterly econometric model after a change in policy rule might take 20 quarters. To estimate the effect of policy based on the new estimates might take another 20 quarters. Thus, each stage in the convergence to the new equilibrium could take five years - by which time we may all be dead!

Bert: But if the government's objective is to stabilize the economy, then it wants to make sure that private expectations are

rational, and hence it will inform the public of any new policy rule.³⁴

Ernie: That doesn't get you out of hot water. First, the learning problem doesn't concern the policy rule alone. Agents also have to learn the structure of economy, which is subject to change. Econometric modellers don't have an outstanding record of success, do they?³⁵ Second, why do you assume that the government's objective is to stabilize the economy? It seems to me that the government's real objective is to remain in power - you know, the political business cycle idea. In which case, it seems in their interest to hide information and fool the public.³⁶

Bert: But you must agree that most macroeconomics does assume the objective of stabilization. This literature falls into that tradition which is concerned with government policy rules designed to achieve macroeconomic stabilization.³⁷

Ernie: Let's go and get a beer.

SCENE III: TESTING

(In the union bar)

Bert: Now the testing is a bit tricky. It's a pretty young research move and there are no well-accepted testing procedures as yet. The principal difficulty is that we are really testing a joint hypothesis - the economic model and the expectations mechanism. That makes it difficult to decide just where the responsibility for failures of tests really lie.

Ernie: But why can't you just test the expectations mechanism directly? Ask people what they expect, and see if they are right?

Bert: Some people have done that, but the results have been inconclusive.³⁸ Economists traditionally don't like surveys, anyway.

Ernie: Well, how have rational expectations protagonists tried to test the theory?

Bert: Basically they have taken two different approaches. Have a look at the supply function again. The natural rate hypothesis will only allow non-random deviations if there are expectations errors of some sort. Under the rational expectations hypothesis there are no expectations errors - at least only random ones. Thus deviations from the natural rate must be random.³⁹ In particular, deviations cannot be systematically related to any other explanatory variable, for example the (lagged) money supply or the wage rate. And so the first type of test is essentially to see whether deviations in the natural rate are systematically related to any other variables. This test has been applied in a number of different ways especially by Sargent.⁴⁰ In those papers the joint hypothesis - natural rate and rational expectations - were rejected in a number of cases. With slightly different specifications, they weren't. Sargent concludes that rational expectations is "not obscenely at variance with the data".⁴¹

Ernie: Remarkable resilience, eh!

Bert: Yes, what's more, his next paper was entitled 'The Observational Equivalence of Natural and Unnatural Rate Theories of Macroeconomics'.⁴² This initiated the second approach to testing rational expectations. It was based on the idea that what rational expectations models *add* compared with other models is that price expectations take into account

the policy rule the government is using. If that rule does not change, ordinary models and rational expectations models will fit any data set equally well, though probably with different parameters. What it means is that you can only distinguish between rational expectations macro models and ordinary ones if the policy rule has changed.⁴³ It seems a reasonable idea to me.

Ernie: Maybe.

Bert: Well, anyway, it gave Sargent and Neftci⁴⁴ an idea for a new type of test. First, they estimated the government's policy rule by regressing the money supply on past levels of income. They then analysed the results to see if there had been any significant changes in the relationship, that is, to see if the policy rule had changed. They found changes in 1929 and 1964. They then looked at some ordinary macro-economic models to see whether the parameters had changed at about the same time that the policy rule changed. In each case they found some evidence that it had.⁴⁵

Ernie: Well, that seems like a reasonable sort of approach. Really it depends on the rational expectations idea - that people change their behaviour as policy changes - rather than on the natural rate proposition. I'm inclined to agree that people take into account what the government is trying to do when they plan for the future but the extreme form of the natural rate of unemployment is an over-simplification of a complex world. Of course, the test is a bit tricky. It's not really clear to me that that's the way to estimate the government policy rule⁴⁶ and then, even if it is, there are probably other non-rational expectations mechanisms which would suggest a change in the

econometric structure as a result of a change in policy rule. There's no real alternative hypothesis involved in the test!

Bert: Everyone agrees it's not a very strong test; it's titled 'A Little Bit of Evidence ...', but it is suggestive and does focus upon the relation between expectations and the policy rule and not upon the natural rate. It gets away from the dogmatic form of the natural rate, impotence of policy area, and focuses upon the positive contribution of the rational expectations idea.

SIGNIFICANCE

Ernie: O.K., we've covered the model and the evidence, such as it is. What's all the fuss about?

Bert: Well, it really nails the Phillips curve. Post-war stabilization was based on the idea that there was a trade-off between unemployment and inflation that the government could exploit by influencing aggregate demand - the so-called Phillips curve. Friedman largely undermined that with the natural rate idea. He said that policy only worked by fooling people and that in the long-run they could not be fooled. This still left the way open for effective short-run policy. If people have rational expectations they won't be fooled by systematic policy *even in the short run* so there is no scope for short-run policy either.

Ernie: But that depends really heavily, as you've already agreed, upon the particular macroeconomic model you have set up.⁴⁷ The monetarists have grabbed this idea to support their traditional position that active government policy is not desirable.⁴⁸ It's largely been their baby up to now. The reason is not hard to see. The impotence result strongly

supports their ideological position that the government should keep its nose out of the economy.⁴⁹

Bert: That's rather harsh. Monetarists are no more ideological than other economists. What would be your 'un-ideological' view of rational expectations?

Ernie: I've been wondering how a future historian of thought might assess it. I think rational expectations theory will be seen as a very important development in economics, but *not* because of the impotence result. Rational expectations are important in any situation in which market behaviour is influenced by expectations. Take the case of an aggregate demand deficiency in a Keynesian model. The usual argument is that government stimulation will work through affecting interest rates so that gradually the economy shifts to a higher output level. With rational expectations the shift to the new level would be extremely rapid. If businessmen understand the economic implications of expansionary government policy, they can expand their output in anticipation of those effects rather than waiting for the rise in demand to be obvious in the market. In that case, far from policy being impotent, rational expectations may make policy *more* effective.

What's more, rational expectations can be applied in microeconomic situations.⁵⁰ Cobweb models of dynamic behaviour in commodity markets depend upon 'irrationality of expectations' - the idea that next year's prices will be the same as this year's or even a simple extrapolation of it. Clearly, producers can be better than that, and if they have rational expectations the market is likely to approach its equilibrium quite quickly.

Bert: You're right! The idea can be applied in a wide variety

of models but what about your general conclusions about policy formation?

Ernie: Yes, I agree that there are important implications for policy design. Private economic agents are intelligent decision-makers and can be expected to take the effects of government policy changes into account in deciding their behaviour. This means that the policy-maker must anticipate the effect of policy on private expectations and the consequent changes in behaviour. In practical terms it means that we need to know a lot more about the availability and use of information by private decision-makers.⁵¹ Thus, the focus of the theory of policy should be on expectations and information and on their role in determining behaviour.

CONCLUSION

Ernie: Well, I started off inclined towards Gordon's view that rational expectations is an example of a recent development in economics "in which theory proceeds with impeccable logic from unrealistic assumptions to conclusions that contradict the historical record".⁵² But now I see that that's a bit too harsh.

Most of the research on rational expectations has exhibited great technical competence, 'impeccable logic', and considerable ingenuity. This has contributed in no small measure to its apparent success, and to the confusion and uncertainty which rational expectations has aroused in the rest of the economics profession. The fundamental simplicity of the ideas involved has become obscured by overly rigorous development, and especially by the unconvincing resort to extraneous constructions, such as the 'islands' mentioned above.

Undoubtedly, it is the impotence of policy results which has aroused most attention. Yet these results depend very heavily on a particular type of macroeconomic model usually embodying a strong form of the natural rate hypothesis. If you start with 'classical' models in which policy can have no real effects, it is hardly surprising that you get results in which policy is impotent. In this way, the novelty of rational expectations has become bundled up with tired and worn notions of the way in which the world works. It is vitally important to unbundle these ideas.

The rational expectations hypothesis *per se* should not be provocative to economists. It merely brings expectations within the scope of individual maximizing behaviour. Expectations used to be handled within economic models on an ad hoc basis. Rational expectations provides a way of incorporating expectations which is consistent with the orthodox economic theorizing.

The development of rational expectations theory will make a more significant contribution to economics in the impetus it gives to research on the vital areas of learning and expectations formation. It brings to the fore questions about the availability and use of information. Instead of being the finale of the monetarist's case against policy intervention, it should be seen as the prologue for a revitalised theory of expectations, information and policy.

FOOTNOTES

- * Our thanks to Neville Cain for the inspiration for this paper and our colleagues at ANU, notably Malcolm Gray, Adrian Pagan and Jim Trevithick, for their comments.
1. McCallum (1980), p.37.
 2. Usually defined as minimization of the variance around some fixed macroeconomic objectives. See Chow (1970) for example.
 3. There is a clear ideological component to much rational expectations work and opponents will be tempted to dismiss the theory on ideological grounds. Later, we suggest that there are merits in the theory quite separate from its use to support particular propositions about the role of government.
 4. See Friedman (1968) and R.J. Gordon (1976) for views on this. Appendix A deals with the issue in some more detail.
 5. 'Natural' in the sense that everybody who wants a job at the going wage has one. This view abstracts from the possibility of unemployment arising from a failure of effective demand and hence from the 'Keynesian' problem. See Malinvaud (1977). There is no necessary connection between vertical Phillips curves and a natural rate of employment.
 6. This is Friedman's proposition that in the long run anticipated and actual economic values must be equal so that policies that work through illusions, or systematically wrong anticipations, will be ineffective in that long run.
 7. R.J. Gordon (1976) considers a number of possibilities mainly relying on different forms of sluggish price adjustment.
 8. Hall (1975) makes this criticism. As he interpreted the evidence, most of the variation in output came from changes in the natural rate, provoking questions about the importance of a theory which explained deviations from the natural rate. It would be a useful theory if it explained the movements.
 9. Taylor (1975) explores the possibilities for policy while people learn the new rule. B. Friedman (1979) addresses the same question. See below.
 10. Muth (1961) in outlining what he meant by rational expectations anticipated this criticism, p. 317.
 11. There is clearly some tension in macroeconomics between its empirical behavioural aspects (eg the consumption function) and its derivation of insights from a microeconomic basis (eg permanent income hypothesis. The micro foundations of

macroeconomics literature, for example Harcourt (1977), attempts to resolve this conflict but so far not very successfully.

12. This is *not* the approach usually adopted by rational expectations theorists, see footnote 16. It is, however, closer to the usual economic methodology and seems preferable.
13. That is, consistent with the methodological approach of explaining all behaviour in terms of utility maximization.
14. McCallum (1980), p.38. In fact, Ernie has quoted McCallum out of context. He goes on to admit that information costs are neglected for simplicity.
15. Feige and Pierce (1976) consider the implications of costly information for rational expectations.
16. The distinction seems important for clarifying ideas within macroeconomics. The all-information approach adopted by Sargent *et al* should ideally be given another name, for example Muth expectations, since the objective 'rational' is normally reserved in economics to describe the outcome of a utility maximization process.
Sijben (1980), p.66, writes: "Muth's view implies that economic agents build up their expectations as if they are fully informed of the process which ultimately generates the real outcome of the variable concerned". Pushed further, McCallum follows the line that all models are 'unrealistic', which seems to lead him to the position that theories stand or fall on their predictions.
17. Rational expectations in labour supply decisions have fairly obvious corollaries on capital investment decisions. See Lucas (1975), for example.
18. Appendix A deals with the problems of the vertical aggregate supply curve in more detail. It should be noted that the arguments are usually presented in logs so that the real debate concerns rates of change rather than levels. This problem is abstracted from here.
19. As Sargent and Wallace suggest (1976), pp.177-78, "it must somehow trick the public". The argument is more complex with capital in the model as may be clear from Appendix A.
20. The idea that changes in money supply do not influence people's preferred hours of work, portfolio holdings, etc. Again, this is considered in Appendix A.
21. Sargent and Wallace (1976), pp.177-78, put this argument in almost the same form. Expectations can be wrong but not systematically wrong (ie biased) and hence there is no scope for systematic policy.
22. This follows the usual solution method followed by rational expectations models. See Lucas (1973) for an example.

23. As suggested above some criticisms are discussed in Appendix A.
24. Buiter (1980).
25. This was Hall's criticism (1975), and is also put by R.J. Gordon to Sargent (1973), p.478.
26. Lucas (1973) introduced the lagged term with footnote explaining that not all deviation from the natural rate of unemployment could be accounted for by the error in expectations terms.
27. Lucas (1975) attempts a systematic explanation for the serial correlation in terms of information lags.
28. "The idea behind this island abstraction is not, of course, to gain insight into maritime affairs, or to comment on the aimlessness of life. It is intended simply to capture in a tractable way the fact that economic activity offers agents a succession of ambiguous, unanticipated opportunities which cannot be expected to stay fixed while more information is collected. It seems safe and, for my purposes, sensible to abstract here from the fact that in reality this situation can be slightly mitigated by the purchase of additional information." Lucas (1975), p.1120.
29. Lucas does actually mention the problem in the quotation in the previous footnote, but makes nothing of it.
30. Muth (1961) argued that economists could, for example, sell the information profitably if expectations were not rational. Since he wrote in 1960, many have done so. This suggests that market forces would tend to drive decisions to those rationally based.
31. Keynes (1930), p.160.
32. Shiller (1978), p.38, focuses upon the issue of convergence. Ernie's statement seems to capture his viewpoint.
33. Shiller (1978), p.39.
34. Sargent and Wallace (1976), pp.181-83, argue this point.
35. This harks back to Shiller's point above.
36. The nature of the problem when the government's objectives vary over time does not seem to have been well explored. Clearly, rational expectations forces economists to think more about the precise nature of learning.
37. Following the tradition of Tinbergen (1952) and Thiel (1958).
38. Turnovsky (1970) and Pesando (1975), for example.
39. Actually some allowance in the tests is made for persistence by the inclusion of lagged values of the dependent variable.
40. Sargent (1973; 1976a).

41. The theory suggests that no extra information would significantly contribute to the prediction. The evidence would thus appear to falsify the theory. Sargent (1976a) instead went on to an alternative type of test, see especially p.233.
42. Sargent (1976b) and Sargent and Wallace (1975) start to develop this idea.
43. Despite Sargent's earlier insistence that policy rules do not change. See Sargent (1976b).
44. Sargent and Nefcti (1978).
45. The tests were non-parametric.
46. Using M1 there was a policy change, but with M2 none appeared to have taken place.
47. Pagan (1980) explores the way in which the impotence result depends on particular specifications of the macroeconomic model being considered. He develops a more general model which includes the usual rational expectations models as particular cases.
48. Lucas and Rapping used adaptive expectations (1969a), then rational distributed lag expectations (1969b) before Lucas settled on rational expectations (1970).
49. McCallum's (1980) popularisation of their position carries the inference that the results are quite robust, but that does not appear to be the case, see Pagan (1980).
50. The seminal article by Muth (1961) deals with microeconomic market situations.
51. Sargent and Wallace (1975), p.251, provide a start in this direction by modelling a case where government has an information advantage over private actors.
52. R.A. Gordon (1976), p.5.

APPENDIX A

AGGREGATE SUPPLY

The underlying inspiration for rational expectations macro models is derived from the notion of general equilibrium. With price flexibility, for given endowments and skills, a condition of general equilibrium requires equilibrium in the labour markets. In such a world all unemployment is voluntary, everybody who wants a job has one. Every individual has his labour hours and assets allocated according to some personal optimum. The remaining unemployment can be termed the 'natural' rate of unemployment and the level of output termed the 'natural' level of output.

Abstracting from inter-industry shifts in production, the only way output can change is through a change in employment. To increase or decrease the level of output government policy must alter the equilibrium in the labour markets. But if the natural rate of unemployment represents an optimal position for private actors, how can government policy affect it?

The models rational expectations theorists usually work with suggestions that it is possible only if the government is able to fool people. If people confuse nominal wage changes for real ones, they might reallocate their portfolios and their hours of work, and thus increase output. While allowing for this possibility the models suggest that such a change would not be desirable for the worker, representing a sub-optimal decision which would be avoided if workers had rational expectations. They suggest that the labour supply decision is made in *real* terms so that labour market equilibrium is independent of prices which, in turn, is taken to imply that output is independent of prices. This result is presented as vertical aggregate supply curve.

Alternative macro-economic theories suggest that the optimal

allocation decisions of private actors *will* be affected by changes in prices, but *not* just because people are fooled. If this were true, increases in aggregate demand could increase output and employment even with rational expectations. One argument for the proposition suggests people hold some money in their asset portfolios not simply for transaction purposes. If prices go up the desirability of holding such money goes down, changing people's private allocation decisions and perhaps the rate of capital formation or number of hours worked. Thus it might be said that the rational expectations models assume that the only motive for holding money is the transactions motive.

APPENDIX B

ALGEBRA OF THE MODEL

$$\text{Supply:} \quad y_t - \bar{y} = a(p_t - p_t^*) - u_t \quad (1)$$

$$\text{Demand:} \quad y_t = -bp_t + cx_t \quad (2)$$

$$\text{Expectations:} \quad p_t^* = E[p_t/I_{t-1}] \quad (3)$$

where y_t = income

\bar{y} = income level corresponding to the natural rate of unemployment

p_t = prices

p_t^* = price expectations

x_t = government policy instrument, eg money supply

I_{t-1} = all available information at time t-1

u_t = random error term, $E u_t = 0$

E = expectations operator.

Equating demand and supply, we obtain the following reduced form equation:

$$p_t = \frac{1}{a+b} (ap_t^* + cx_t - \bar{y} - u_t) \quad (4)$$

Now, by the rational expectations assumption (equation (3)),

$$p_t^* = E[p_t/I_{t-1}]$$

$$\begin{aligned} \text{using (4)} \quad &= E\left[\frac{1}{a+b} (ap_t^* + cx_t - \bar{y} - u_t)\right] \\ &= \frac{1}{a+b} (aE p_t^* + cE x_t - E \bar{y} - E u_t) \end{aligned}$$

$$\text{But} \quad E p_t^* = p_t^*, \quad E \bar{y} = \bar{y}, \quad E u_t = 0$$

$$\therefore \quad p_t^* = \frac{1}{a+b} (ap_t^* + cE x_t - \bar{y}) \quad (5)$$

Subtracting (5) from (4)

$$P_t - P_t^* = \frac{1}{a+b} (c(x_t - Ex_t) - u_t) \quad (6)$$

Substituting (6) in equation (1)

$$\begin{aligned} y_t - \bar{y} &= \frac{a}{a+b} (c(x_t - Ex_t) - u_t) + u_t \\ &= \frac{ac}{a+b} (x_t - Ex_t) + \frac{b}{a+b} u_t \end{aligned} \quad (7)$$

That is, the deviation of output from the 'natural' level \bar{y} depends only on the unsystematic component of government policy ($x - Ex_t$). To see this, assume that the government uses the following policy rule:

$$x_t = kx_{t-1} + ly_{t-1} + my_{t-1} - np_{t-2} + v_t \quad (8)$$

where v_t is a random variable, $Ev_t = 0$.

$$\text{Then, } Ex_t = kx_{t-1} + ly_{t-1} + mp_{t-1} - np_{t-2} \quad (9)$$

Subtracting (9) from (8)

$$x_t - Ex_t = v_t$$

Putting this in (7)

$$\begin{aligned} y_t - \bar{y} &= \frac{ac}{a+b} v_t + \frac{b}{a+b} u_t \\ &= \frac{1}{a+b} (acv_t + bu_t) \end{aligned}$$

Deviations of y_t , from \bar{y} ($y_t - \bar{y}$), are entirely random. This implies that systematic government policy is impotent (*in this model*), since the systematic component of any policy will be incorporated in Ex_t , and therefore be cancelled out in forming $x_t - Ex_t$.

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