CHAPTER III

THEORY OF RATIONAL EXPECTATIONS

3.0 Introduction to Rational Expectations [1]

Muth (1960's) of Indiana University first proposed the theory of rational expectations. He used the term to describe the many economic situations in which the outcome depends partly upon what people expect to happen. The price of an agricultural commodity, for example, depends on how many acres farmers plant, which in turn depends on the price that farmers expect to realize when they harvest and sell their crops. As another example, the value of a currency and its rate of depreciation depend partly on what people expect that rate of depreciation to be. That is because people rush to desert a currency that they expect to lose value, thereby contributing to its loss in value. Similarly, the price of a stock or bond depends partly on what prospective buyers and sellers believe it will be in the future.

The use of expectations in economic theory is not new. Many earlier economists, including Pigou, Keynes, and Hicks, assigned a central role in the determination of the business cycle to people's expectations about the future. Keynes referred to this as "waves of optimism and pessimism" that helped determine the level of economic activity. But proponents of the rational expectations theory are more thorough in their analysis and assign a more important role to expectations.

The influences between expectations and outcomes flow both ways. In forming their expectations, people try to forecast what will actually occur. They have strong incentives to use forecasting rules that work well because higher "profits" accrue to someone who acts on the basis of better forecasts, whether that someone be a trader in the stock market or someone considering the purchase of a new car. And when people have to forecast a particular price over and over again, they tend to adjust their forecasting rules to eliminate avoidable errors. Thus, there is continual feedback from past outcomes to current expectations. Translation: in recurrent situations the way the future unfolds from the past tends to be stable, and people adjust their forecasts to conform to this stable pattern.

The concept of rational expectations asserts that outcomes do not differ systematically (i.e., regularly or predictably) from what people expected them to be. The concept is motivated by the same thinking that led Abraham Lincoln to assert, "You can fool some of the people all of the time, and all of the people some of the time, but you cannot fool all of the people all of the time." From the viewpoint of the rational expectations doctrine, Lincoln's statement gets things right. It does not deny that people often make forecasting errors, but it does suggest that errors will not persistently occur on one side or the other.

Economists who believe in rational expectations base their belief on the standard economic assumption that people behave in ways that maximize their utility (their enjoyment of life) or profits. Economists have used the concept of rational expectations to understand a variety of situations in which speculation about the future is a crucial

factor in determining current action. Rational expectations is a building block for the "random walk" or "efficient markets" theory of securities prices, the theory of the dynamics of hyperinflations, the "permanent income" and "life-cycle" theories of consumption, the theory of "tax smoothing," and the design of economic stabilization policies.

3.1 The Rational Expectations Hypothesis [2]

The premise of the rational expectations hypothesis is that systematic processes generate economic variables. Over time, economic agents learn what the process determining a variable is and they will use this knowledge to form expectations of that variable. Individuals learn about the variable generating process by using all the information available to them that is related to the variable. The end result is that the expectations of firms (or, more generally, the subjective probability distribution of outcomes) tend to be distributed, for some information set, about the prediction of the theory (or the objective probability distribution of outcomes).

To see how the hypothesis works imagine an economic variable, Y, whose value is determined by its own lagged value, by the lagged value of two other variables, X and Z, and by a random variable U. This provides us with the simple linear process:

$$Yt = 0 + 1Yt\text{-}1 + 2Xt\text{-}1 + 3Z\,t\text{-}1 + Ut$$

[2] A:\ rationality.htm.

The expected values of Yt is found by finding the mathematical expectation of Yt . Since Yt-1, Xt-1 and Z t-1 are lagged, their values are known at the end of period t-1 (when the forecast is being made). The values of Ut, however, only becomes known at the end of period t so the rational forecaster must form some expectation of its value at the end of period t-1. This means that:

$$Et\text{-}1(Yt) = 0 + 1Yt\text{-}1 + 2\,Xt\text{-}1 + 3Z\,t\text{-}1 + Et\text{-}1\,(Ut)$$

The random variable is assumed to be distributed with mean zero and variance. The best estimate that can be made of the expected value of Ut is to use its mean value, zero. This leaves us with a formula for the expected value of Y as:

$$Et\text{-}1(Yt) = 0 + 1Yt\text{-}1 + 2\,Xt\text{-}1 + 3Zt\text{-}1$$

Thus, the rational expectation of the variable Y in period t is its mathematical expectation given the available information. Thus, as Muth (1961) explained, rational expectations should be generated by the same (stochastic) process that generates the variable to be forecast.

The rational expectations hypothesis does not argue that agents are always right in their expectations of future variables. In fact, the forecast error is exactly equal to the random variable that determines Yt. This random variable is uncorrelated with the other variables in the process and with the information set available to the agent. This makes

sense because if such correlation existed, it would logically be included in arriving at the initial expectation. These random variables, and hence any forecast errors, are surprises or news in the system. They are random, they exhibit no definite pattern, they have a mean value of zero and they have a variance less than that associated with any other model of forecasting. This means that, on average, rational expectations will be correct because the mean value of the forecast error is zero and it also means that they are the most efficient (in a statistical sense) means of forming expectations because their forecast errors have the property of minimum variance.

The rational expectations hypothesis thus puts forward a means of forming expectations, which is based on agents taking account of all necessary available information to make their forecasts. The information is used efficiently to determine the process, which generates the variable in question, and the process is then used to formulate an expected value of that variable. The end result is that, Rational expectations, by Muths definition, yield predictions of future events, which differ from the corresponding eventual outcomes only by errors, which are themselves independent of the variables used to generate the predictions.

3.2 The Need for Theory of Expectations[3]

Virtually all economic decisions, other than the trivial, involve time. The most obvious example concerns the decision to invest when outlays are incurred in the current

[3] Shaw, G.K (1984) "Rational Expectations An Elementary Exposition", John Spiers.

period in order to generate future streams to be realized over the life of the asset. In case of a project such as the Channel Tunnel, for example, the asset life may be considerable and even if the most distant returns are virtually entirely discounted the time profile of the pay-off period will run into several years. Clearly, in such an undertaking, any sensible decision must involve making an estimation of future demand patterns, energy prices and the costs of all alternative means of transport. Such estimates may be based upon the extrapolation of past trends or, alternatively, may be based upon different scenarios involving optimistic or pessimistic assumptions and generating a range of possible outcomes with differing probabilities applied to each. In either case, the investment decision is based upon a set of expectations concerning future costs, prices and markets. We will examine the uncertainty surrounding the investment act in more detail below; for the moment we will indicate other choice situations where a sensible or welfare maximizing decision cannot be undertaken without some estimate of the conditions expected to pertain in future.

Consider the theory of consumer behavior, for example. A decision to save implies the decision to postpone consumption until some future time. Thus, in deciding whether or not to save or in deciding upon how much to save in any given period one would need to consider the future rate of inflation in relation to current interest yields. Realistically, one would also be influence by one's expectation of future income as the permanent income hypothesis of consumption behavior and similar statements make abundantly clear. Elementary textbook expositions of inter-temporal choice frequently adopt the simplifying assumption of a two-period analysis in which the incomes

pertaining to each period are known with absolute certainty. It is then a comparatively simple matter, given conventional indifference curve analysis, to determine the optimal combination between consumption and saving. In practice, however, the time horizon with which individual consumers have to concern themselves will extend well beyond the immediate future and expectations of distant income streams will be held a considerable degree of uncertainty. The greater the degree of uncertainty the greater the standard deviation pertaining to the mean value of the anticipated future income stream. Both factors, the mean value of the probability distribution and its dispersion, will logically enter into the consumption decision of the rational individual. This is not to assert that all individuals will respond in the same manner to a given expectation; their response will differ according to their propensity towards risk aversion. What is being asserted is simply that the analysis of consumer behavior will be incomplete unless it incorporates some measure of expectations formation. Equally, expectations enter into decisions to purchase durable consumption goods whose existing prices may reflect heavy initial development cists; likewise expectations of tax rate changes will often influence consumption patterns, as frequently witnessed in last minute attempts to beat the budget.

Economic theory, if it is to be convincing, must contain some means of modeling expectations and taking into account how changes in the prevailing state of expectation may feed back upon the pattern of economic behavior. Unfortunately, to date, expectations have not, generally speaking, been dealt with in a manner commensurate with their importance. Indeed, by far the vast majority of economic models do not deal with expectations at all or, if this is perhaps an overstatement, they deal with them only

implicitly by assuming that they are in some way already incorporated into parameter values. Consider for example, the elementary theory of the supply of labour. It is usual to assert that the supply of labour will be a function of the real wages so that

$$N = N\left(\frac{W}{P}\right)$$

Where N is the amount of labour hours. W the nominal wage and P the general price index. Moreover, it is conventional to assume that the function is positive so that an increase in the real wage will generate an increase in labour supply. This assertation in itself, however, does not specify the quantity of labour, which will be supplied at any given wage rate. In figure 6.1, for example, the information given above would be consistent with any one of the indicated supply curves.

It would be reasonable to assume that the amount of labour that will be offered at any given wage will be conditioned by what labour had been accustomed to receiving in the past. Suppose that at the wage $\overline{W}/P$ the quantity of labour $\overline{Q}$ had been offered and taken up as indicated by the supply curve N. When labour becomes unemployed it will, initially at least, continue to expect to find employment at the wage $\overline{W}/P$. As the period of unemployment extends and this expectation proves unfounded the reservation wage will be lowered. The supply curve gradually shifts downwards towards N^2 and subsequently N^3. This type of behavior is of course, applicable to search theories of unemployment. When drawing a supply curve to summaries the information contained in

the above equation, the position of the curve implicitly reflects a state of expectation upon the part of labour.

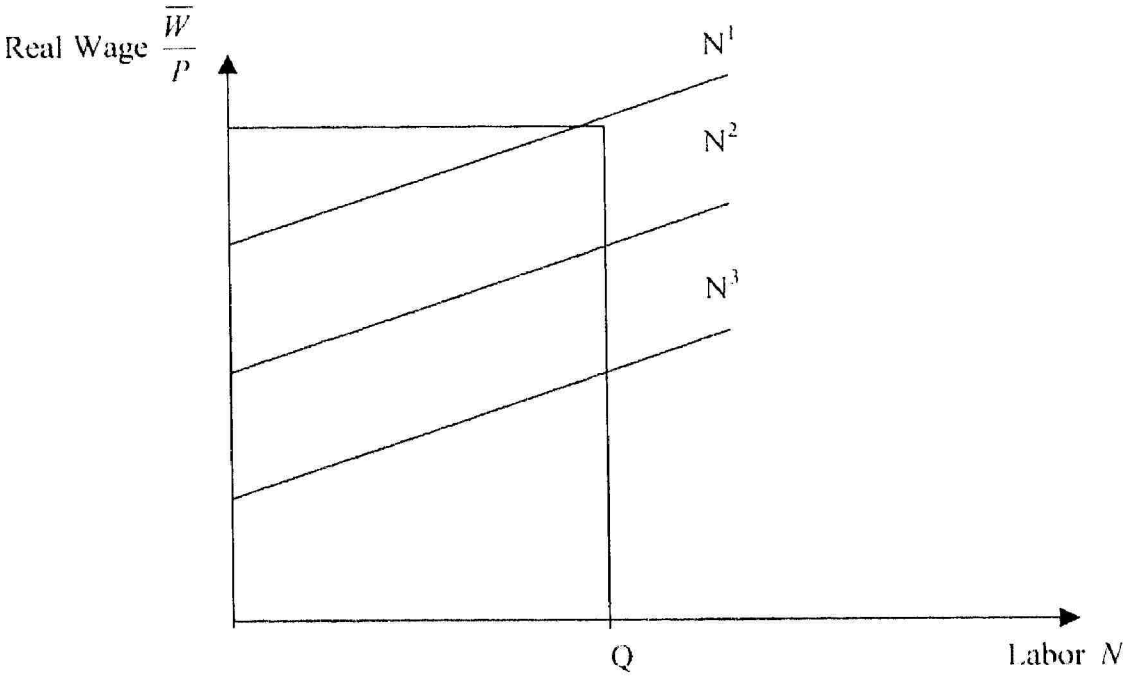

Figure 6.1. Labour Supply Curves Consistent with $N = N\left(\frac{W}{P}\right)$

To reinforce the need for some from of expectations theory in modeling economic decision making let us considers again the act of investment. Over the life of the asset, say n years, the asset will produce an output Q, selling at a price P. It will also involve user costs U, consisting of material cost, labor cost, fuel and so forth. The net proceeds I each year (PQ-U) will in all probability be subject to some form of taxation at rate t. At the end of its useful life the asset in question may possess a scrap value J. Assuming it is possible to determine these magnitudes with some reasonable degree of accuracy it is

then necessary to discount the net income streams by the appropriate interest rate to determine the present value V. Accordingly,

$$V = \frac{(P_1Q_1 - U_1)(1-t_1)}{(1+i)^n} + \frac{(P_2Q_2 - U_2)(1-t_2)}{(1+i)^2} + \ldots + \frac{(P_nQ_n - U_n)(1-t_n)}{(1+i)^n} + \frac{J_n(1-t_n)}{(1+i)^n}$$

Hence, a rational attempt to evaluate the preset value of the asset will require making some judgement about the following unknown factors:

1. The life of the asset n. In all the probability this will be known with a good deal of uncertainty since it will depend upon how quickly it is made obsolescent by the pace of technical change and innovation. In certain industries the pace of technical change may be substantial and the more distant income streams will tend to be discontinued accordingly.
2. The potential scrap value J. For exactly the same reasons as mentioned above the value of J will be decidedly uncertain.
3. The annual output Q. whilst the productive potential of the asset will be known within very small limits the actual output may depend upon the general state of the business cycle and accordingly uncertainty will surround the most distant output estimates.
4. The price of product P. Similar reasoning will imply uncertainty as to the price which may be expected in subsequent years.
5. The user cost U. Again this will be uncertain, being dependent upon wage negotiations, unforeseen factors. Again, the more distant the user

cost the greater the degree of uncertainty, but it is likely that changes in U will mirror changes in P.

6. The rate of taxation t. Again this will be virtually unknowable beyond the immediate income periods essentially subject to political decisions.

7. The interest rate i. Once again the interest may be foreseen with some certainty for the initial periods but beyond that its value may be uncertain.

It follows that the accurate determination of the present value of an asset involves making detailed assessment as to future economic trends and variables. In all probability, risk aversion will dictate that the more distant income streams are discounted entirely. Moreover, it seems reasonable to posit that some of the unknowns will exhibit compensatory changes whilst still others. Nonetheless, there will remain a considerable degree of uncertainty which will require making some estimate concerning future factor and product prices to permit a rational investment decision to be made. It follows that if economic theory is going to attempt to formulate an explanation of how the economy does in fact behave, then it must also attempt to explain how such estimates of future prices are to be formed. In short, economic theory must incorporated, if only implicitly, some statement as to expectations behavior and of the factors that give rise to changes in such expectations.

The advocates of the rational expectations doctrine are simply arguing that it is the most efficient way to formulate one's expectations of the future and that, accordingly,

an individual not using rational expectations will not be pursuing maximizing behavior. If we assume that individual agents do follow maximizing strategy then this statement is tantamount to saying that individuals do indeed formulate their expectations rationality, regardless of how economists choose to model them. It follows that if the models do not incorporate rational expectations formation then the predictions of the models may be found wanting.

Now the simple fact of the matter is that most econometric models which are used for macro-forecasting, including comparatively large-scale models, deal with expectations formation in a manner which can only be describe as naïve and distinctly non-rational. The usual treatment is to make the expected future values of a variable depend solely upon the past behavior of that variable. Moreover, the relationship between expected and past values is usually presented as static and unchanging. The failure of econometric forecasting models top relate expectations formation to current conditions and policy announcement is doubtless one reason why such models provide inaccurate forecasts of future economic conditions. However, the failure to incorporate rational expectations specifications within such models is held by rational expectations theorist to be far more serious and in particular to invalidate much macro-economic policy formulation.

If expectations are indeed formed rationally then such simulation exercise are invalidated from the outset. For the rational expectations thesis argues that utility maximizing individuals will perceive whether macro-economic policy is being

expansionary or contractionary, will form expectations of future inflation rates in the light of this perception and will then modify their behavior pattern in accordance with their revised outlook. Naïve forecasting models which assume that economic agents' expectations are but mere extrapolations of former values ignore completely the influence of policy changes announcements in changing behavior patterns. Not only are the forecasts of the model incorrect but the entire process of policy formulation is invalidated by the adoption of an incorrect unchanging behavioral response to the policy change. The implication of such conclusion are indeed of enormous import for all those engaged in modeling and forecasting activity. This damaging critique of policy simulation exercises stems from Lucas (1976) and suggests that parameters estimated from previous policies will be entirely inappropriate in the simulation of new policies. The implications of the 'Lucas Critique' are of enormous import for all those engaged in economic modeling and forecasting and unless this difficult can be accommodate it implies that a considerable investment in econometric model building will have been wasted.

If expectations are not formed rationally, then existing econometric models may possess greater justification even if their forecasts are not always accurate. Whether expectations are or are not formed rationally is thus of enormous importance not only to macro-economic theory but also to policy formulation and control

3.3 Theoretical Analysis and Critique[2]

One of the main criticisms of the rational expectations hypothesis is that, as Arrow (1978) outlines, Economic agents are required to be superior statisticians, capable of analyzing the future general equilibria of the economy. This criticism stems from the mis-conception that Muth was proposing that economic agents use the exact model used by economists. The fact of the matter, however, is that the rational expectations hypothesis argues that trained economists and economic agents produce the same expectations but it does not argue that they come to that conclusion by using the exact same method. In fact for the hypothesis to hold it is sufficient that in the light of past observation and experience they possess some concept of a reduced-form approach to economic modeling to permit them to make reasonable predictions. This criticism of economic agents needing to be qualified economists for the hypothesis to be viable does not, therefore, withstand closer scrutiny of Muth's thesis.

A closely related criticism is the one that argues that the idea of rationality is implausible in itself. Can we really assume that all decision-makers are intelligent enough to use and fully understand all the available information? Once again, this criticism is based on a misconception of what the hypothesis is saying. The hypothesis does not apply to every individual in the economy. Rather, it claims that on the average expectations are rational. Thus, some agents may irrationally overpredict and some may underpredict but this does not mean that on average the expectations in the market cant be rational.

We must also remember that the hypothesis doesn't require that every single agent in the market gathers and formulates the information themselves and makes the expectations for themselves. In many cases individuals let other people form their expectations for them. For example, people's expectations of inflation are often based on the expectations that have been carefully constructed by economists. These expectations are based on full information and are rational. Thus, the market as a whole has rational expectations even though these expectations have been formed by only a subset of society. Another situation where individuals allow others to form their expectations for them is in the labour market: Here, many such agents are perfectly willing to delegate the model-analyzing role of their elected or appointed trade union representatives who do indeed invoke former models and often employ expert financial specialists and consultants to assist them. Thus, the expectations of the market as a whole can be rational without making the highly unlikely assumption that every single individual forms rational expectations.

Finally, the criticism of the hypothesis on the grounds of rationality undermines the basis of economics: The idea that the typical individual is capable of making the best of the opportunities open to him is a common one in economics. Thus, to claim that agents are not rational when making forecasts is equivalent to claiming that the core of economic argument, that economic agents are rational decision-makers, is incorrect.

A third criticism of the rational expectations hypothesis is that the information necessary to form expectations is not always available and when it is it may be very costly to use it. It is true that individuals can not automatically know which variables are important in the variable generating process or know what the size of the coefficients in that process are but it is also true that the rational expectations hypothesis doesn't claim that they do. What the hypothesis argues is that on average and after a period of time, economic agents will learn from past experience what the process is. They will combine this developed knowledge with current available information to form their expectations. This is why the rational expectations hypothesis is best seen as a long-run argument. It is based on a learning process, which takes time, but once the necessary knowledge is acquired the process determining a variable will be known. It must be noted, however, that Friedman (1979) is right to point out that what is typically missing in Rational Expectations models, however, is a clear outline of the way in which economic agents derive the knowledge which they then use to formulate expectations meeting the requirement. This is something, which needs to be developed in models that are based on rational expectations, but we must remember that the models are based on the hypothesis, and are not the same as it. Thus, although knowledge of the learning process of economic agents would make economic models more concise, the absence of it does not take away from the hypothesis itself.

The other side of this information criticism is that even when information is available it is costly to use. This criticism, however, does not take away from the rational expectations hypothesis. The crux of the hypothesis is not that a rational agent should

simply use all the available information but that he should use all the available information in an efficient manner. That is, an efficient and rational individual will carry out a form of cost benefit analysis on the information, using only that which is of net benefit to him. Thus, in fact, the limitation imposed by costly information coincides with the efficiency standpoint of the hypothesis. There is also the argument that when information, that is absolutely necessary, gets too costly, agents can pool together to obtain that information or the government can obtain it and provide it to the public. Both of these methods ensure that agents still get the information and thus they can still form rational expectations.

A fourth criticism of the hypothesis is that it has limited applicability. As it is not always easy to determine the process by which a variable is generated it may not always be possible to form rational expectations. However, as Attfield, Demery and Duck (1985) outline a rational expectation can still be formed without knowing the exact process. In fact, we can still form expectations from an intelligent appraisal of circumstances, though the process behind such circumstances may be a bit harder to discern. Thus, rational expectations can be made even when variables are generated by unique and unusual processes because the economic agent will have enough information to make an intelligent estimate of the process.

The final criticism of the rational expectations hypothesis is the argument that the hypothesis is not testable. The obvious retort to this criticism is that although expectations are inherently immeasurable, there have been numerous attempts made to

incorporate them into econometric models and to test their validity in these models. This fact holds for all proposed means of expectations formation (including adaptive and rational). Although the attempts made to test these hypotheses are not perfect, they are no worse for the rational expectations hypothesis than they are for any other expectations hypothesis. To see how the hypothesis holds up under these tests we must look at some of the empirical work that has been carried out on it.

3.4 Conclusion

This chapter has outline the theoretical view of rational expectations that uses for further discussion in the following chapters.