

61

**THE RATIONAL EXPECTATIONS HYPOTHESIS
AND
ITS MACROECONOMIC IMPLICATIONS**

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M. PHIL. DISSERTATION

1986

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AND
ITS MACROECONOMIC IMPLICATIONS**

**A Dissertation Submitted to the
UNIVERSITY OF POONA
For the Degree of
MASTER OF PHILOSOPHY
(IN ECONOMICS)**

BY

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PUNE 411 004

1986

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ACKNOWLEDGEMENTS

I am extremely grateful to Prof. V.S. Chitre for his valuable guidance during the course of this dissertation.

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CONTENTS

	Page
INTRODUCTION	(iii)
I. EXPECTATIONS AND ECONOMIC THEORY	1
II. THE RATIONAL EXPECTATIONS HYPOTHESIS	36
III. THE NEW CLASSICAL MACROECONOMICS AND ITS POLICY IMPLICATIONS	70
IV. EMPIRICAL EVIDENCE	137
V. CONCLUSIONS	190
ABBREVIATIONS USED IN BIBLIOGRAPHY	208
BIBLIOGRAPHY	209.

(ii)

INTRODUCTION

A salient feature of nearly all economic decision-making is that it is inherently forward looking : most economic decisions and actions are based on anticipations of the future which is only imperfectly known. Furthermore, the actual values of economic variables and their evolution over time are sensitive to expectations of economic agents and the changes therein. Hence, economic theorists investigated the alternative processes of expectations formation and tried to assess and analyse what the expectations are at a given moment of time, how they would change and thence cause changes in the economic processes.

The Rational Expectations Hypothesis is one of the most recent developments in expectations - theory. Building up from the principle of rational behaviour, it postulates that expectations of rational economic agents are based on an information set including a clear outline of the structure of the economic system, the ways in which the variables are inter-related, the policies proposed and adopted by the government, and so on. The hypothesis has been applied in several areas of economic theory - in analysing the production and inventory decisions of firms in response to price and sales expectations, in agricultural markets, forward markets, stock - market speculation, in analysing exchange rate expectations and

and balance of payments problems, and has been applied to the Natural Rate Hypothesis to examine its macroeconomic implications.

One of the most dramatic implications of the Rational Expectations Hypothesis is that all systematic macroeconomic policy rules are futile, that they can have no impact on the real variables in the economy such as employment, output, real wages, real interest rates, etc. Because of the importance of these policy conclusions we have focussed on the macroeconomic implications of the hypothesis. Also, the literature on the other applications of the Rational Expectations Hypothesis is fairly vast and extensive, making a comprehensive study a difficult task.

Accordingly, Ch. I of the dissertation discusses the role of expectations in economics and the alternative approaches to expectations - formation which preceded the Rational Expectations Hypothesis. Ch. II presents and discusses the Rational Expectations Hypothesis and Ch. III, its macroeconomic implications. Ch. IV gives a broad outline of the major empirical tests of the Rational Expectations Hypothesis and its macroeconomic implications. The conclusions drawn from the study are discussed in Ch. V.

I

EXPECTATIONS AND ECONOMIC THEORY

THE ROLE OF EXPECTATIONS IN ECONOMICS

Economic behaviour is invariably in response to an anticipated, yet uncertain future. As Frank Knight remarked, "We live only by knowing something about the future; while the problems of life, or of conduct at least, arise from the fact that we know so little".¹ While much of economic theorising abstracts from uncertainty, or imposes on economic agents the ability to foresee the future accurately, the fact remains that nearly all economic decisions are made in the context of uncertainty. Knowledge of the future is often less than perfect and the practical problem of decision making relates to the partial degree of knowledge or ignorance of the future.

Thus, intertemporal decision making is presumably based on certain expectations, formulated either explicitly or implicitly, of what the future may bring. Again in Knight's words, we live only by our ability to "see things coming".² Consumers, for example, are guided not merely by their current incomes and the current prices of commodities, but also by the expected future incomes and prices which may influence their decisions to prepone or

1. Frank H. Knight, "Risk, Uncertainty and Profit", Ch. VII, 1921.

2. *ibid.*

defer purchases (especially in the case of durables). Producers when planning outputs, attempt to forecast the market prices that will prevail when the goods are ready for sale. Investments in plant and machinery depend on expected future returns which, in turn, depend on the strength of the future demand for the particular products, the availability and costs of factor inputs, the future state of technology (which could affect the obsolescence of the plant in which investment is contemplated), and so on. Stock-market speculators' profits depend largely on their ability to foresee future movements in share prices in advance of the rest of the market. Creditors, presumably, seek to alter nominal interest-rates to account for their inflationary anticipations. Policy makers are faced with the task of selecting a particular policy-rule from a wide array of possible actions, the outcomes of which will materialise only in the future. The selection of a policy-rule is based on the goals which the authorities set themselves to achieve, and on an understanding of the way in which the economy functions. The latter, obviously, should include an understanding of the way in which economic agents formulate expectations.

Furthermore, the concept of an "equilibrium over time"³ necessitates the realisation of all expectations :

3. J.R.Hicks, Value and Capital, 2nd ed.,1946, Page 132.

all ex ante values of relevant economic variables must be realised ex post. This requirement of equilibrium is met in a stationary economy where the same set of values of economic variables gets repeated at all dates. Or, when economic conditions have remained fairly stable over a period of time, the forces of change either absent or balancing each other out, agents' forecasts of economic variables would be equivalent to their equilibrium values observed earlier and which would continue to be realised in the future.

However, no economic system ever does exhibit perfect equilibrium over time, one of the important causes of disequilibrium being the divergence of anticipations from realised values. In fact, "the degree of disequilibrium marks the extent to which anticipations are cheated and plans go astray."⁴ Specifically, in periods of rapid change and movement, acute disequilibrium is likely to occur. Furthermore, any major discrepancy between expected and realised values would be indicative of malinvestment and consequent waste : resources have been used in a way in which they would not have been used had the future been foreseen more accurately; wants which could have been satisfied had they been foreseen will remain unsatisfied or satisfied imperfectly.

4. *ibid.*

Hence, a world in which expectations are liable to be falsified cannot be adequately portrayed through static equilibrium models. Rather, the mechanism of change and the adjustment to disappointed expectations can, according to Joan Robinson, be effectively put forth only in historical models : " A model applicable to actual history has to be capable of getting out of equilibrium; indeed, it must normally not be in it. To construct such a model we specify the technical conditions obtaining in the economy, and the behaviour reactions of its inhabitants, and then, so to say, dump it down in a particular situation at a particular date in historic time and work out what will happen next. The initial position contains, as well as physical data, the state of expectations of the characters concerned (whether based on past experience or traditional belief). The system may be going to work itself out so as to fulfil or so as to disappoint them."⁵

Thus, if dynamic economic processes are to be fathomed, an explanation of expectations-formation becomes vital. The future values of economic variables and the economy's performance over time are extremely sensitive to the expectations of economic agents, the manner in which they are

5. Joan Robinson, *Essays in the Theory of Economic Growth*, 1962, pp. 25-26.

formed and the changes therein. In times of stability one could perhaps neglect expectations. But in conditions of change, neglecting the role of expectations in shaping dynamic economic processes would detract from the relevance of economic theory to the real world.

Thus, the task of finding out what the expectations are at a given moment and how they have been formulated is to improve the diagnosis of the prevailing situation. And good diagnosis helps the economist in making better predictions of the future.

EARLIER VIEWS ON EXPECTATIONS

The neo-classical economists, notably Marshall, Edgeworth and Pigou, dealt with systems in which though change and uncertainty were not completely ruled out, expectations were assumed to be given in a definite and calculable form : "the calculus of probability, though mention of it was kept in the background, was supposed to be capable of reducing uncertainty to the same calculable status as that of certainty itself."⁶ That is, economic agents were assumed to be capable of visualising all the possible mutually exclusive outcomes of any course of action and assigning to each of them a proper fraction measuring its probability of occurrence.

6. J.M.Keynes, "The General Theory of Employment", QJE, 1937.

However, later economists, Keynes (1937) and Shackle (1949) in particular, questioned the validity of this approach; only in a limited number of cases of actual decision-making could the principles of probability be applied. For, as Shackle (1949) notes, probability estimates could be gathered only if sufficiently numerous trials of the proposed experiment had previously been conducted (the probability of an outcome being determined by the frequency of its occurrence in these trials), and these estimates could serve as a valid basis for forming expectations only if an equally large number of future trials of the experiment were being proposed, all trials conducted under an unchanging set of conditions or a stable system. In some instances the first prerequisite, numerous past trials, could be met with, though only partially, as, for example, in the case of minor variations in the quantity of output, input use etc. (which may not, however, be made in the same set of conditions or uniform circumstances), of which the producer may have sufficient past experience. But there are certain decisions of which the individual decision-maker has no past experience of his own to go by, no sufficient number of previous trials of the experiment to estimate the probability of success in the future, as, for example, when a major innovation is being proposed by a firm, and the innovation is the first of its kind in the firm's

history. Of course, in some cases individual decision-makers could refer to the experiences of other economic agents and accordingly formulate a probability distribution of outcomes, and the problem could be overcome.

The more serious objection to the orthodox probability approach arose from the non-fulfilment of the second condition - numerous future trials. Often, as Shackle (1949) argues, economic decisions are, by their very nature unique (as, frequently, in the choice of a career), or contingently crucial, when the possibility of conducting future trials is dependent on the outcome of the first (as in the case of a large-scale investment by an individual wealth-owner, the failure of which could doom chances of future investments of a similar size). And while an expectation derived from a probability distribution could yield an accurate estimate of the average result of an aggregate of several future trials, it is quite irrelevant for predicting the outcome of a single trial; the probability of a single, isolated event is meaningless. As Keynes (1937) remarked, forecasting the price of copper twenty years hence, the prospect of a war, etc., are matters for which there is " no scientific basis on which to form calculable probability whatever. " ⁷

7. *ibid*

Consequently, the orthodox views came to be increasingly replaced by the psychological theories of expectations-formation which recognised that uncertainty regarding the future cannot always be reflected through probability-distributions, and that expectations are essentially subjective in nature. In George Katona's words : "Expectations are assumed to originate in emotional and impulsive factors which are believed to be neither understandable nor predictable."⁸

Frank H. Knight (1921), one of the foremost writers in this field, described decision-makers' expectations of the future as an image of the future state of affairs, an image formed more by flashes of intuition than by rigorous logical deduction. "We perceive the world before we react to it and we react not to what we perceive but always to what we infer."⁹ Hence, the act of forming an expectation involves the perception of the present situation (as well as the past) and, from it, a two-fold inference - first, inferring what the

8. George Katona, "Business Expectations in the Framework of Psychological Economics (Towards a Theory of Expectations)" in Mary Bowman (ed)., Expectations, Uncertainty and Business Behaviour, 1958.

9. Frank H. Knight, "Risk, Uncertainty and Profit", 1921, Ch. VII

future situation would be without the particular individual's interference, and second, what changes would be wrought in it by his own actions. Neither process is infallible, neither accurate nor complete. We do not perceive the present as it is and in its totality, nor is our inference regarding the future very dependable, and nor, too, can we fully comprehend the consequences of our own actions. Thus, while all economic behaviour is forward looking or stimulated by images of the future, an unavoidable element of such image-formation is its liability to err.

In real life the actual process of inference is quite different from that used by logicians - there is no rigorous or exact determination of the future prospects. Ordinarily, decisions are based on crude or rough estimates of future outcomes; for while granting that the future situation depends on the behaviour of a large number of objects and factors, no real effort is made to account for these factors and estimate their separate influences in shaping the future.

Rather, the mental process of estimating the future is very obscure, with very little technique behind it. In Knight's words : "Prophecy seems to be a good deal like memory itself",¹⁰

10. *ibid.*

flashing across our minds often when we are thinking of something else. And hence, there is little resemblance to the formal processes of logic which a scientist uses in an investigation. This does not, of course, deny the relevance of probability distributions in those instances where probabilities can be computed. In fact, as Knight reminds us, insurance companies would take pains to estimate the probabilities of accidents etc. which are insured against. But this is only the measurable portion of uncertainty which Knight calls risk, while the uncertainty which individuals may often face in decision-making is not thus measurable.

Another aspect of such image formation is the recognition of the liability to err - individuals aware of their imperfect faculties of judgement attempt to estimate the accuracy of the original estimate. Or, individual actions are based not only on the images formed, but also account for the reliability of such images, or the subjective feeling of confidence in the prediction.

Keynes (1937), too, rejected the orthodox probability approach to expectations on the ground that individuals, in actual decision-making, rarely possessed sufficient knowledge with which to estimate probabilities of future events : the fact that "our knowledge of the future is fluctuating, vague and uncertain",¹¹ renders the methods of probability-

11. J.M.Keynes, "The General Theory of Employment", QJE, 1937.

distributions and mathematical expectations inappropriate for tackling the task of understanding expectations.

While recognising that entrepreneurs, for example, do not hold single, definite expectations of what sale-proceeds would be, but several hypothetical expectations, Keynes (1936) for the sake of analysis, defines an ~~xx~~ expectation as that which, if held with certainty, would result in the same behaviour as does "the bundle of vague and more various possibilities"¹² of which the state of expectations is comprised. Further, Keynes differentiates between short-term and long-term expectations, the former relating to the immediate future as, for example, in the case of producers' anticipations of market prices of the finished output of goods that are currently being manufactured. Such Short-term expectations are revised continuously in the light of the realised results of the individuals' decisions such that " expected and realised results run into and overlap one another in their influence."¹³

Long-term expectations, on the other hand, refer to the state of psychological expectations of distant events or of matters extending over an appreciable length of time - for example, an investor's forecast of the returns to be earned from an investment in plant and equipment, the output from which will continue to flow over a number of years. It would be foolish, according to Keynes, to base such expectations on

12. J.M. Keynes, "General Theory of Employment, Interest and Money," 1936

13. *ibid.*

matters that are uncertain. As our knowledge of the future is highly precarious, it would be more reasonable to be guided by the facts of ^{the} prevailing situation which, though not always directly relevant to the event to be forecasted, are known beforehand and with certainty. The latter outweighs the greater relevance of other facts regarding the future of which, however, our knowledge is only vague and scanty. Hence, "the facts of the existing situation enter, in a sense disproportionately, into the formation of our long term expectations."¹⁴ The working method in expectation formation is then, according to Keynes, a projection of the existing situation into the future, modifications being ventured only when we have definite reasons for anticipating changes. Thus, the present is accepted as a more or less serviceable guide to the future.

More importantly the state of long-term expectations consists not only of the most likely or most probable forecast, but also of the confidence with which we make it, which is akin to Knight's remarks on the reliability of the estimates of future prospects.

Furthermore, doubting the reliability of his own judgement, each individual will endeavour to fall back on the judgements of the rest of the market or to conform with the majority opinion. Similarly, as the profits of speculators would depend

14. *ibid.*

on their ability to gauge future price movements at least a little in advance of the rest of the market, their attempt would be to ascertain the majority opinion and the majority behaviour on which future prices would depend. And an estimate of the average opinion or of the average expectation of the mass of individuals, each trying to copy the others, yields, in Keynes' terminology, a conventional judgement.

The crux of the matter then is that expectations in Keynes' views, are not formed independently or in isolation, but are the result of the mass psychology of a large number of individuals and consequently, are liable to fluctuate suddenly and violently in response to sudden shifts in the opinions of individual market participants. In abnormal times, therefore, markets could be subject to "waves of optimistic and pessimistic sentiment",¹⁵ and the marginal efficiency of capital and the liquidity preference schedules being sensitive to the state of expectations, would also be subject to such shifts which in turn would lead to fluctuations in the level of economic activity. As Gottfried Haberler (1980, a) remarks, it is the cumulative errors of optimism and pessimism which are partly responsible for the business cycles in Keynes' Scheme.

Much of this inherent instability gets heightened when as Keynes argues, individual actions are guided more by a

15. *ibid*

spontaneous urge to action or by "animal spirits"¹⁶, rather than by a careful calculation of the "weighted average of the quantitative benefits multiplied by quantitative probabilities"¹⁷.

Thus, it would appear that expectations being psychologically determined, one could not treat them endogenously in a dynamic economic model (Begg 1982, a). In fact, much of Keynes' analysis treats expectations as given exogenously, the main thrust of his argument being to highlight the fluctuations in economic activity and employment corresponding to different states of expectations.

G.L.S. Shackle (1949) advanced a rather novel treatment of expectations formation by individual decision makers. The problem of choosing a particular course of action from amongst an array of such alternative courses is complicated by the fact that the outcome of any given venture or enterprise is uncertain. Individuals, in Shackle's scheme, tackle this problem by first listing the various hypothetical outcomes of each such course of action. While the exact basis on which such a list is formulated is not clearly spelt out, Shackle believes that each individual exercises his imagination in visualising the hypothetical outcomes, while the effective set of outcomes which he refers to are those that he deems actually possible: "Imagination constrained to congruity with what seems in some degree

16. ibid.

17. ibid.

possible we shall call expectation"¹⁸.

Furthermore, each individual can judge the varying degrees of possibility of the alternative outcomes and thence, accord to each outcome a degree of belief in its actual occurrence. The precise ground on which such degrees of belief are assigned to outcomes is not discernible even to the individual concerned. "His whole personal history and every detail of his experience and education and even of his heredity may be relevant to the understanding of such a judgement"¹⁹. Hence, expectations are predominantly subjective in nature.

In Shackle's formulation these degrees of belief are converted into degrees of potential surprise: the concrete mental experience corresponding to the degree of belief in a particular hypothesis of the outcome of a venture is the degree of surprise which would be experienced should the hypothesis be proved false. Specifically, there exists a range of possible intensities of potential surprise extending from zero surprise applicable to those hypothetical outcomes believed most likely to occur, to that intensity accorded to those hypotheses believed impossible or whose non-occurrence is held practically certain. Thus, the likelihood of various hypotheses regarding the outcome of a course of action can be described through a potential surprise function, $y = f(x)$, where y denotes the intensity of potential surprise associated with outcome x (x representing

18. G.L.S. Shackle, "Decision, Order and Time in Human Affairs", 2nd edn., 1969, Ch.II

19. *ibid.*

the possible gain or loss from the particular course of action) . That sub-set of hypotheses believed most likely to occur constitutes the inner-range or inner-set, with y equalling zero (nil potential surprise).

Shackle also discusses the change in expectations through time and through the acquisition of additional information regarding the possible outcomes. There could be an addition to the initial set of possible outcomes as the individual gains further insight into the consequences of the action that is contemplated; there could be a rearrangement of hypotheses along the potential surprise function, as the degrees of belief in the occurrence of the different outcomes strengthen or weaken; and there could be a clarification of expectations, when the inner-range becomes more sharply differentiated from the other hypothetical outcomes which are now deemed to be even more unlikely.

However, as Gorgescu - Roegen (1958) pointed out, as the intensity of potential surprise varies inversely with the degree of belief in a hypothesis, one could as well take $1-p$ as an ordinal measure of surprise, p being the subjective probability of the outcome, and thereby rank the probabilities of the alternative outcomes of a course of action. However, the degrees of potential surprise in Shackle's scheme are not additive, and one could not, despite the apparent resemblance

to the subjective probability approach, speak of expectations as the weighted average of the probable outcomes.

J.R.Hicks (1979) accepts subjective probabilities as being relevant in economic decision-making. Using Jeffreys' definition, Hicks explains the notion of subjective probability as " a valid primitive idea expressing the degree of confidence that we may reasonably have in a proposition, even though we may not be able to give either a deductive proof or a disproof of it... It depends both on the proposition considered and on the data in relation to which it is considered."²⁰ Anticipations in economics are thus based on some evidence or data, though the exact relation between the evidence and the expectation formed from it is inherently subjective.

While analysing the movement of prices over time, Hicks (1939) assumes that every individual has a definite expectation of the price that is relevant to his decision-making, cautioning us, however, that this assumption errs in two ways. Firstly, individuals' expectations are not expectations of particular prices," but expectations of market conditions, demand schedules for example".²¹ This would be true of the monopolist, for instance, who tries to forecast the demand-elasticity of his product. Secondly, people rarely have

20. Harold Jeffreys, "Theory of Probability", 1939 quoted by Hicks in " Causality in Economics", 1979, pp 107-108

21. J.R.Hicks, "Value and Capital", 2nd edn. 1946, page 125

precise expectations of the relevant prices. " They do not expect that the price at which they will be able to sell a particular output in a particular future week will be just so-and-so much; there will be a certain figure, or range of figures, which they consider most probable, but deviations from this most probable value on either side are considered to be more or less possible." ²² Thus, even if the most probable price remained unchanged, but the possible deviations from it were to widen, then the individual's expectations would become more uncertain.

One of the important implications of these psychological theories of expectations is that if expectations are essentially subjective, then individual behaviour influenced by expectations cannot be predicted simply from an observation of material evidence or known facts. The psychological process of expectations formation must be explored further. Alternatively, economic modelling should accept expectations as exogenously determined, given from outside the system.

22. *ibid.*

EXPECTATIONS AND ECONOMETRIC APPLICATIONS.

However, later, as empirical economic research gathered momentum and as econometric model-builders undertook the estimation of relationships involving the expected values of variables, the concern with expectations and their endogenous treatment began to grow. One of the primary steps in this regard was to segregate expectations into autonomous and induced components, the latter being accounted for in the particular model. Hicks (1939), for example, classifies the influences on price-expectations into three categories : the first is entirely non-economic (the weather, political news, etc.), the second, though economic in character, is not very closely connected with actual price movements (market superstitions, news regarding future demand and supply movements such as news of crop failures, etc.), and the third consists of actual experience of prices, both past and present. The first two sets of influences are then treated as autonomous and, hence, excluded from consideration in the particular model; expectations are then regarded as generated mainly from the experience of past and present price movements. Similarly, Enthoven and Arrow (1956) define autonomous changes in expectations as those resulting from knowledge of the causal factors of particular prices (e.g., the knowledge that a new invention

will reduce a product's price), assuming that such expectations are exogenous. Part of the expected price change is induced by actual changes, is considered endogenous to the dynamic system and is termed as an induced expectation.²³

Secondly, data on expected or anticipatory magnitudes being scarce, expectations were sought to be proxied by appropriate indicators or observable variables. For, as Jacob Mincer (1961) notes, even when such data are obtainable, as in some surveys, they pose questions of reliability. Reliable anticipatory values are those on which economic agents are actually acting. ~~Ex ante~~ reports of such values are not always dependable. And in the absence of such reliable data, economic analysts sought to ascribe certain methods of expectations formation to economic agents. In practice, most of the expectational models used in econometric analyses are extrapolations of current and/or past values of the variable to be forecasted, such extrapolations being labelled as induced expectations.

23. The autonomous and induced components of expectations are not necessarily equivalent to exogenous and endogenous expectations. Endogenous expectations, for example, are anticipations arrived at on the basis of the present and past values of all economic variables included in the economic system, whereas an induced expectation refers to an expectation derived only from the past history of the specific variable to be forecasted.

One such specification of expectations formation is the static expectations hypothesis used predominantly to explain cobweb cycles in agricultural markets (e.g. the hog and cattle cycles) or, more broadly speaking, in markets with a production lag and where the finished produce cannot be stored (M. Ezekiel, 1938). The argument underlying this hypothesis is that the present is viewed as a serviceable guide to the future. Hence, producers are envisaged as projecting the current values of variables into the future; production for future periods is guided by the current market price which is expected to prevail in the subsequent period as well, as in equation (1) :

$$p_{t+1}^e = p_t \quad (1)$$

where p_t is the price prevailing in the t^{th} period, and p_{t+1}^e the forecast for the following period.

A temporary spell of adverse weather resulting in low outputs and, consequently, high prices would, therefore, set in motion a cobweb cycle of prices and quantities : producers expecting the currently high price to persist in the following period would enlarge output which, with unchanging demand conditions, would depress the market price in the next period, which would, in turn, call forth reduced supplies, and so on . And depending on the elasticities of demand and supply, the cycle would be convergent, divergent or oscillating.

Despite the attractive simplicity of the static-expectations model, it came to be increasingly replaced by other, more sophisticated treatments of expectations-formation. For, in a world where the nominal values of economic variables are incessantly subject to fluctuations, it would only be simplistic to assume that agents anticipate no change from the present set of values. In fact, no farmer could be really as myopic as the cobweb theorem would have us believe; he could separate out the impact of temporary shocks (bad weather etc.) from the effects of more enduring shifts in the demand function, both of which could result in price fluctuations. And surely, even if a cobweb movement were observed for a few periods, producers would learn from their past experience - repeatedly disappointed expectations- and cease to expect that current prices will prevail in the future as well. The overriding weakness of the static-expectations hypothesis is the assumption that it is only the present which conditions expectations of the future; experiences of earlier periods have no influence whatsoever.

An important development in the field of expectations was the formulation of the adaptive expectations hypothesis which, first advanced by Phillip Cagan (1956), attributed to economic agents a more plausible behaviour than the static expectations model. Agents here are visualised as adapting or revising their expectations in the light of their past experience; more specifically, expectations are revised per

period of time in proportion to the most recently observed forecast error. Cagan's formulation of this error-learning model is as follows :-

$$\left(\frac{dp^e}{dt}\right)_t = \beta(p_t - p_t^e) \quad \beta \geq 0 \quad (2)$$

where p^e is the expected price, p its actual value, p_t^e and p_t , therefore, referring to the price expected for and that actually prevailing at time t . β is the coefficient of expectations, the magnitude of which depends on the rapidity with which expected prices adjust to previous expectational errors. Or, in discrete time the expectations-equation would be, as formulated by Nerlove (1958) :

$$p_t^e - p_{t-1}^e = \beta(p_{t-1} - p_{t-1}^e) \quad 0 \leq \beta \leq 1. \quad (3)$$

A zero value of β would imply that forecast errors induce no revisions in expectations or that expectations are rigid. At the other extreme, a β of unity would result in the static expectations formula, expectations revised to the full extent of the forecast error. An intermediate value of β would indicate that previous forecast errors are relevant in expectations formation, that economic agents do learn from past mistakes, but that expectations adjust to the forecast-errors only with a lag. Rearranging terms in (3) :

$$p_t^e = \beta p_{t-1} + (1-\beta)p_{t-1}^e \quad (4)$$

and since $P_{t-1}^e = \beta P_{t-2} + (1 - \beta) P_{t-2}^e$, and so on, the expected price can be written as a geometrically declining weighted average of past prices :

$$P_t^e = \beta P_{t-1} + \beta(1-\beta) P_{t-2} + \beta(1-\beta)^2 P_{t-3} + \dots \quad (5)$$

Or,

$$P_t^e = \beta \sum_{i=1}^{\infty} (1-\beta)^{i-1} \cdot P_{t-i} \quad (6)$$

Nerlove's (1958) justification of the above expectations generating equation is based on Akerman's (1957) view that, instead of altering production plans periodically in the belief that current price changes will persist in the future (as in the traditional cobweb theorem) producers wait till they are convinced of the permanence of the change. Only when the new market price has been maintained at the elevated level for a sufficient length of time will producers commit increased resources and enlarge output to the extent deemed profitable at the high price. This suggests that producers carefully review the past price history, refraining from attaching the entire weight to the price prevailing in any one particular period, instead separating out the temporary from the enduring elements of the previous price changes, and only then forming an expectation of the future. Thus, when current prices increase, a part of this increase is discounted ($\beta < 1$) reflecting the producers' doubts regarding the permanence

of the entire change.

Or, as Arrow and Nerlove (1958) suggest, while expectations may be determined by both autonomous and induced factors, making it difficult to forecast a particular period's price level, one could, with reasonable accuracy, estimate the average level about which it would fluctuate. It would also be reasonable to suppose that this average level is dependent on the entire previous behaviour of the relevant price. The market price in a particular period, for example, is the result of the operation of the demand and supply forces which may be peculiar to that period alone and which, therefore, may not persist in the subsequent periods. Citing the example of the impact of the Korean war on the prices of certain affected commodities, Arrow and Nerlove remark that such sharp price increases could not be expected to continue after the war as well - the price rise was largely the result of the peculiarities of that particular period. And it is for this reason that the assumption of the static expectations scheme (that agents ^{expect} current prices to continue unchanged) is not plausible. However, information on a series of past prices will reflect the market forces determining the average level about which market prices in particular periods are likely to fluctuate. Further, prices belonging to the remote past carry less information on the market forces likely to operate in the future, than the more recently observed prices. Hence, the influence of past prices in forming expectations is assumed to decline as one goes back in time.

Equation (6) is a specific version of this view.

The adaptive expectations hypothesis has been applied on numerous occasions; the refinement of econometric techniques for estimating distributed lag functions, perhaps, accounts for its popularity. In fact, in certain models, a specification such as (3) circumvents the necessity of estimating expectations. For example, if inventory demand (D_t) were postulated as a function of expected capital gain :

$$D_t = \alpha (p_{t+1}^e - p_t) \quad (7)$$

and p_{t+1}^e were determined as per equation (3), then inventory demand could be expressed solely in terms of observable variables.

$$D_t = \alpha(\beta-1)p_t + \alpha(1-\beta)p_{t-1} + (1-\beta)D_{t-1} \quad (8)$$

Some of the important applications of the hypothesis are those by Cagan (1956) to estimate the expected rates of inflation in conditions of hyper-inflation (in investigating the inverse relationship between the demand for real balances and the expected rates of price change), Friedman's (1957) estimate of expected income in his Permanent Income Hypothesis, etc.

In a more realistic version of the error-learning model, β , the coefficient of expectations is not assumed to be an arbitrarily determined constant, but is itself a function of

the individual's experience of the past behaviour of the relevant variable. For example, as Cagan suggests, in situations where inflation has persisted for a relatively long period of time and has been on the increase, inflationary anticipations are likely to be strengthened; a fresh spurt of price rise, instead of being deemed as a temporary phase, will be viewed as an indicator of more intense inflation in the future. Accordingly, expectations adapt more swiftly, and the β coefficient is revised upwards.

That economic agents are more cautious in reacting to changes in the values of variables, and that they try to separate the temporary from the more enduring components of such changes by examining the history of the particular variables, appears to be an eminently sensible postulate of individual behaviour. Yet, it is not completely satisfactory. For, one of the obvious deficiencies of this expectations - scheme is that apart from the previous behaviour of the economic variable, no other information is sought or utilised in defining expectations. These anticipation - equations, as Friedman (1970) remarks, are in one sense very general, in another, very special. They are general in so far as they require expectations to be determined by the entire past history of the variable to be forecasted; they are special as they require expectations to be determined not by any other past history or by any currently observed phenomena. These equations deny any autonomous role to expectations. Policy announcements, the

impact of exogenous shocks (e.g. major technological improvements), the behaviour (past and present) of related variables, etc. which may have an important bearing on the future values of variables, are completely ignored. For example, the announcement of a revision in commodity tax rates should promptly induce market participants to alter their expectations of the prices of the affected commodities (which, presumably, would include an expectation of the duration of the new taxes). However, in the error-learning framework no attention would be paid to the announcement, and the adjustment to the revised rates would not commence until expectational errors were observed; and as long as β is less than unity, the adjustment to the new tax rates would be less than complete.

As Cagan (1956) admits, certain observations on the real balances held by individuals during the culminating phases of the hyper-inflations studied by him, are not explained by the expected rates of inflation as estimated by the adaptive expectations formula. Towards the end of the hyper-inflations, when agents expect the authorities to initiate currency reforms and stabilise the rate of price rise, the expected inflation would be much lower than that estimated via adaptive expectations, and real balances would correspondingly be larger than the modeller would expect.

Further, given periods of increasing inflation or a

rising trend in the value of an economic variable, and given an expectations coefficient less than or equalling unity, would result in expectations continually lagging behind actual values - forecast errors occur consistently. Instead of just doggedly reacting to past mistakes that seem to be repeated with embarrassing regularity, individuals would presumably try to project the trend behaviour of the economic variable, when formulating expectations. Friedman's (1957) specification for permanent income, however, does allow for the inclusion of the secular growth in income in the expected permanent income.

Another specific expectations hypothesis based on such trend behaviour of economic variables is the extrapolative scheme in which an increase in the value of a variable leads to an expectation of an even further increase, and vice versa. Such a scheme is related to elastic expectations in terms of Hicks' (1939) concept of expectations-elasticity. Defining the latter as " the ratio of the proportional rise in expected future prices of [commodity] x to the proportional rise in its current price"²⁴, Hicks speaks of the case of elasticity

24. J.R.Hicks, "Value and Capital", 1939. Hicks also marks off the two pivotal cases : where the elasticity is zero, such that expectations are rigid, and the other with unit elasticity, where a given change in prices induces expectations to change in the same direction and by an equal proportion.

exceeding unity, where a change in current prices makes agents feel that they can recognise a trend, so that they try to extrapolate, the current change therefore inducing a greater than proportionate change in expected prices. That is,

$$P_{t+1}^e - P_t^e = \eta (P_t - P_{t-1}) \quad (9)$$

with $\eta > 1$.

A negative elasticity of expectations underlies the regressive expectations hypothesis which, associated with Keynes (1936), postulates expectations to move in the opposite direction to the movement ~~or~~ current changes in the value of the relevant variable. Or, a given increase in actual values is interpreted by agents as "the culminating point of a fluctuation"²⁵ and indicative, therefore, of a regression or return to lower values.

Keynes (1936), when discussing the motives to liquidity, described individuals as preferring to hold money than bonds in anticipation of a fall in bond prices, or a rise in the interest rate, with the consequent capital loss from bond-holding, and vice versa. The expected change in the interest rate was defined in relation to what is considered to be a normal rate; if current rates were considered below normal,

25. J. R. Hicks, Value and Capital, 1939.

the belief that they would regress to their normal level would cause a movement out of bonds and into liquidity.

Modigliani and Sutch (1966) combine the extrapolative and regressive hypotheses in their estimation of long-term interest rates, defining the normal level of the long-term rate (\bar{R}_t) as an average of the long-term rates (R_t) for the past m periods and a constant (c), the latter supposedly measuring a "very-long-run normal level".²⁶ Thus

$$\bar{R}_t = v \sum_{i=1}^m \mu_i R_{t-i} + (1-v)c \quad 0 < v < 1 \quad (10)$$

(The weights μ_i add up to unity, and as the more recent experience is considered more salient, the weights decline as i rises from 1 to m .)

The regressive hypothesis is then formulated as

$$\Delta R_t^e = \alpha_1 (\bar{R}_t - R_t) \quad \alpha_1 > 0 \quad (11)$$

where ΔR_t^e represents the expected change in the long-term rate and α_1 measures the speed with which interest rates return to their normal level. (However, it is not clear why agents believe the weighted sum of past rates to be representative of the normal level). Substituting from equation (10),

26. F. Modigliani and R. Sutch, "Innovations in Interest Rate Policy", AER, May 1966.

(11) can be written as

$$\Delta R_t^e = \alpha_1 \left(v \sum_{i=1}^m \mu_i R_{t-i} + (1-v)c - R_t \right) \quad (12)$$

The extrapolative hypothesis, on the other hand, is expressed as

$$\Delta R_t^e = \alpha_2 \left(R_t - \sum_{i=1}^n \delta_i R_{t-i} \right) \quad \alpha_2 > 0 \quad (13)$$

where expectations account for the recent trend in interest-rates which is approximated by the difference between the current rate and a weighted average of the recent past rates (n is appreciably less than m , the weights δ_i adding upto 1 and declining rather rapidly).

Further, it is thought quite credible that both hypotheses contain elements of truth and that expectations can contain both extrapolative and regressive elements. If so, then combining (12) and (13), the expected change in the long-rates is defined as :

$$\Delta R_t^e = (\alpha_2 - \alpha_1) R_t + \sum_{i=1}^m (\alpha_1 v \mu_i - \alpha_2 \delta_i) R_{t-i} + \alpha_1 (1-v)c \quad (14)$$

($\delta_i = 0$ for $i > n$), which again conveniently proxies expectations via observable variables (and which

is suited to the Almon polynomial lag method of estimation²⁷).

While the above expectations - schemes have been fairly popular in empirical research, and while each, in its special econometric applications, has provided a fairly satisfactory proxy for the unobservable expectations, neither of them seems to be backed by a comprehensive and convincing theory of expectations. There is no reason why an economic agent should limit his forecasting procedure to any one of the equations described above. More importantly, the equations are, after all, very special in character - they completely ignore the autonomous influences on expectations. That expectations can be induced by the past behaviour of the variable to be forecasted is undoubtedly true, but

27. The Almon-method (S. Almon, "The Distributed Lag Between Capital Appropriations and Expenditures", *Econometrica*, 1965) assumes that the coefficients of the lagged variables in the equation can be approximated by a suitable degree polynomial in i , the length of the lag. Thus if the equation is
$$Y_t = a + \sum_{i=1}^k \beta_i X_{t-i} + u_t$$
 then $\beta_i = a_0 + a_1 i + a_2 i^2 + \dots + a_j i^j$. This differs from the Koyck method of estimating distributed lags which assumes geometrically declining coefficients for the lagged variable, i.e. $\beta_i = \beta_0 \lambda^i$ where $0 < \lambda < 1$, λ being the rate of decline or decay of the distributed lag.

that they are not induced by the past history of related variables or forecasts of these variables, is a very restrictive assumption. While certain exogenous shocks to the system (e.g. brief, unpredictable spells of bad weather, unexpected political events, etc.) cannot be included as explanatory variables in the expectations - generating equations, it would be inappropriate to relegate all factors other than the particular variable's own past history to the class of autonomous influences. For example, the expected price of a commodity would depend not merely upon its previous actual values, but also on the forecasted and actual prices of related commodities (substitutes, complements, etc.) Or, more generally, price expectations should be based on expectations of future demands and supplies which, as economic theory tells us, will determine future prices.

As Michael Beenstock (1980) says, until recently the specification of expectations was considered to be the concern of the econometric model-builder, rather than that of the economic theoretician, which, perhaps, is the reason why the development of expectations modelling has proceeded along lines different from those that characterise the bulk of economic theory. None of the above equations invoke fully the rationality postulate, the cornerstone of economic theory. Rationality, in expectations would imply that individuals, appreciating the

importance of accurate forecasts, would strive to collect as much information on all the factors which determine future values - both the autonomous and induced influences will be operational in moulding expectations and must, to the extent possible, be accounted for by the modeller. A producer, for example, would try to anticipate the supplies forthcoming from his competitors, the demand for his product, the market conditions for related goods, the Government's attitude (its policies relating to taxes, subsidies etc.), and so on, before actually forming an expectation of the future price of his own product and committing resources to its production.

Also, as Beenstock remarks, while econometricians resort to sophisticated model-building in order to forecast future values of economic variables, market participants are implicitly assumed to act according to restrictive and naive forecasting schemes. Yet, casual observation suggests that even private agents - speculators in particular - would try to make the best possible forecast, for else, they would stand to lose. Hence, predictions are, more often than not, based on a rational examination of the forces that shape the future.

II

THE RATIONAL EXPECTATIONS HYPOTHESIS.

MUTH'S RATIONAL EXPECTATIONS HYPOTHESIS.

One of the principal drawbacks of the expectations ~~of~~ schemes discussed in the preceding chapter related to the arbitrary restrictions they imposed on the set of information upon which individual's anticipations were modelled. As mentioned earlier, these schemes were very specific in so far as they allowed expectations to be induced solely by the past behaviour of the variable to be predicted, classing all other information (including information on the behaviour of related variables, etc.) as autonomous influences on expectations, the latter then being abstracted away from the forecasting procedure. However, such restrictions on the information set would appear to violate the rationality postulate in economic theory. Rational decision makers, aware of the fact that expectational errors can be costly, would presumably strive for accuracy in their predictions. Hence, they would, as far as possible, analyse and estimate the impact of all the diverse factors causing future changes, instead of confining their forecasting schemes to an examination of the variable's past history alone.

John F. Muth (1961), while commenting on the role of expectations in shaping dynamic economic processes, remarked that it is important for economists to understand

the kind of information that market participants use, and the way in which this information is put together and interpreted in forming estimates of the future. Further, it is important to predict how private expectations would change following a change in the information set conditioning them and/or a change in the "structure of the system"¹ being studied. The latter, he says, is analagous to our curiosity about "demand functions, consumptions functions, and the like, instead of only the reduced form 'predictors' in a simultaneous equation system"².

Explaining how expectations may be formed, Muth advances the hypothesis that "expectations, since they are informed predictions of future events, are essentially the same as the predictions of the relevant economic theory."³ The Rational Expectations Hypothesis, therefore, asserts that as information is scarce, individuals would not waste it, but utilise all that is available in estimating the future. Further, the information set should include an understanding of the structure of the system, the variables upon which the forecasted variable depends, the nature of the inter-relations between these variables, the relative importance of each in determining the future value to be predicted and the nature of the possible shocks or distur-

1. John F. Muth, "Rational Expectations and the Theory of Price Movements", *Econometrica*, 1961.

2. *ibid*

3. *ibid*

bances (i.e. the stochastic properties of the error term to the extent they can be known); hence, expectations would depend specifically on this structure as depicted by the appropriate economic theory. More precisely, Muth argues, expectations of economic agents, or their subjective probability distribution of outcomes, are distributed around the prediction of economic theory. (In fact, as mentioned in Ch.I, Hicks (1939) had argued along similar lines: when anticipating future prices, for example, individuals would first try to estimate future market conditions, the demands and supplies of the particular products, that would determine them.)

The hypothesis can be explained with the help of the market model described by Muth. The model analyses price variations in an isolated market for a commodity which cannot be stored and which is subject to a fixed production lag. The assumptions of the model are that the equations of the system are linear, certainty equivalents exist for the variables to be forecasted, and the random disturbances are normally distributed. The market equations are:

$$C_t = -\beta p_t \quad (1)$$

$$P_t = \gamma p_t^e + u_t \quad (2)$$

$$C_t = P_t \quad (3)$$

where equation (1) represents the demand for the commodity at period t (C_t) as inversely related to the price in that period (p_t); equation (2) describes the market supply (P_t) responding to the price that producers expect to receive in period t (p_t^e), expectations based on information available through the $(t-1)$ st period, and a random term (u_t) representing fluctuations in output due to, for example, changing yields caused by weather variations, etc.; equation (3) is the equilibrium condition equating demand with supply. All variables measure deviations from equilibrium values.

This system of equations can be solved to yield

$$p_t = (-\gamma/\beta) p_t^e - (1/\beta) u_t \quad (4)$$

i.e. the deviation of the market price from its equilibrium value will depend upon the extent of this deviation of the forecasted price and the magnitude of the shock, u_t , in the supply equation. Initially, Muth assumes a purely random, serially uncorrelated error term with an expected value of zero : the fluctuations in output caused by such exogenous shocks as weather changes etc., tend, on an average, to be distributed around a value of zero, and exhibit no detectable pattern of behaviour over time. That is,

$$E u_t = 0 \quad ; \quad E u_{t_1} \cdot u_{t_2} = 0 \quad (t_1 \neq t_2) \quad (5)$$

Where E is the expectations operator. Or, these fluctuations in output are unknown when production decisions are made, but become evident when the commodity is actually produced and brought to the market where they may cause price fluctuations.

Given the above system of equations and the assumptions regarding the error term, the theory would predict

$$E p_t = (-\gamma/\beta) p_t^e \quad (6)$$

i.e, the mean of the probability distribution of the future deviation of the market price from the equilibrium level, equals $-\gamma/\beta$ proportion of the mean of the subjective probability distribution which producers, explicitly or implicitly, arrive at. Further, as per the Rational Expectations Hypothesis, the anticipation of producers must equal the prediction of theory.

$$p_t^e = E p_t \quad (7)$$

From equation (6) it is evident that unless $-\gamma/\beta$ equalled unity, the Rational Expectations Hypothesis requires the expected price to equal its equilibrium level ($E p_t = p_t^e = 0$).

Thus, it is hypothesised that individual producers would collect relevant information regarding the behaviour of the product's price including information on the determinants of this price—the market demand, supply and their responsiveness to price changes, etc. This information would then serve as the basis for their prediction.

However, as Muth specifically states, the Rational Expectations Hypothesis "does not assert that the scratch work of entrepreneurs resembles the system of equations in any way"⁴; producers are not required to estimate rigorously and correctly, the values of the coefficients in equations (1) - (3). Nor does it require that all producers hold identical expectations. Cyert and DeGroot (1974) explain that while all economic agents may have practically the same information set, the interpretation of this information is essentially subjective and will, hence, differ for different agents ; however, what is emphatically asserted is that market participants will try to understand the nature of the interrelationships between the demand and supply forces in the market, instead of trying to gauge future price movements only from their past history. Cross-sectional differences in expectations can be allowed for "as long as the deviation from the rational forecast

4. *ibid.*

for an individual firm is not strongly correlated with those of the others"⁵, but rather tend to cancel each other out over a large number of market participants.

Justifying the hypothesis, Muth argues that "averages of expectations in an industry are more accurate than naive models and as accurate as elaborate equation systems, although there are considerable cross sectional differences of opinion."⁶ And if the prediction of economic theory were consistently more accurate than the forecast of individual firms, then economic theorists would have opportunities of profiting from their additional knowledge by, for example, setting up a price forecasting service, producing the commodity themselves, engaging in inventory speculation, etc. Further, as Maddock and Carter (1982) suggest, individual producers would also try to avail of the superior information possessed by those acquainted with the appropriate economic model, ultimately leading to a situation where the aggregate expectation of the firms is equivalent, to the prediction of economic theory.

Thus, Muth's Rational Expectations Hypothesis states that the anticipations of economic agents in the aggregate are unbiased forecasts of the relevant economic variables and are equivalent to the mathematical expectation of the

5. *ibid.*

6. *ibid.*

variables in question, conditional on the set of information containing the appropriate economic model along with available data on the values of related variables and the stochastic properties of the error term. If X represents the variable to be forecasted for period t , and I_{t-1} denotes the information on which the forecast is based (information available through the $(t-1)$ st period), then the rational expectation is given by $E(X_t | I_{t-1})$. Or, in Tobin's (1980, a) words, rational expectations are those "which will under a stable structure be, on an average, confirmed by events".⁷

This does not imply that the rational forecast will always be accurate; expectational errors are possible, but on an average, given the same underlying structure of the system and over a sufficiently large number of observations, these errors will be distributed around a mean value of zero. That is, denoting the expectational error by η_t

$$X_t - E(X_t | I_{t-1}) = \eta_t \quad (8)$$

$$E(\eta_t) = 0 \quad (9)$$

In terms of the market model described above, expectations will be falsified in so far as there are shifts in the supply curve caused by the random, unpredictable fluctua-

7. James Tobin, "Asset Accumulation and Economic Activity", 1980.

tions in output via u_t ; but in the long run, provided the model continues to describe the particular market, the anticipated prices will, on an average, equal their realised values.

A fundamental implication of the hypothesis is that though economic agents are liable to err in their predictions, these errors will be serially uncorrelated. As expectational errors are costly, rational agents would consciously avoid making them systematically or repeatedly. That is, if individuals observe a regular pattern emerging in the forecast errors made in the past, they will, presumably try to identify the cause of the regularity - a deficiency in the information set, insufficient data on the related variables, mistaken specification of the interrelations between variables, etc. And if the principle of rational behaviour is to be extended to the process of collecting and analysing information, then it follows that optimising agents would try to improve their information base so that such costly systematic errors do not recur.

As Bennet T. McCallum (1980) remarks, this feature, the avoidance of systematic forecast errors, is one of the outstanding strengths of the Rational Expectations Hypothesis, and an important ground on which it scores

over all the other alternative expectations hypotheses. " Each alternative expectational hypothesis, that is, explicitly or implicitly, posits the existence of some particular pattern of systematic expectational errors. This implication is unattractive, however, because expectational errors are costly. Thus purposeful agents have incentives to weed out all systematic components [in forecast errors] .⁸ As discussed in Ch. I, ⁱⁿ periods of rising inflation, for example, under an adaptive expectations scheme, and with the coefficient of expectations (the speed of adjustment of expectations in response to previous forecast errors) less than unity, inflation would be continually and systematically underestimated. And as Barro and Fischer (1976) observe, a fundamental difficulty of these other expectational schemes is that they require a theory to explain continuing systematic mistakes. Such theories, they remark, are more difficult to formulate than those based on rational behaviour, and it would seem reasonable to try to do without them.

Thus, though expectational errors are not ruled out, rationality in information gathering and processing would imply that these errors are uncorrelated with the information set itself $[E(\eta_t | I_{t-1}) = 0]$, and that they

8. Bennet T. McCallum "Rational Expectations and Macroeconomic Stabilisation Policy", JMCB, 1980.

are serially uncorrelated,

$$E(\eta_{t_1} \cdot \eta_{t_2}) = 0 \quad (t_1 \neq t_2) \quad (10)$$

Reverting to Muth's market model, it was assumed that that the disturbance term in the supply function, u_t , was serially uncorrelated with zero expectation. If, however u_t represented systematic changes in technology, a predictable weather cycle, etc. causing fluctuations in the output level, and if agents continued to believe that these shocks were distributed randomly around a mean value of zero, then their forecast errors would over time exhibit a regular pattern according to the pattern of the weather cycle, technological change, etc. Then, the Rational Expectations Hypothesis would imply that producers would try to estimate the pattern of the serial correlation in u_t , incorporate it in their information set and modify their price expectations accordingly. Then, from equation (4) and given the Rational Expectations Hypothesis requirement, equation (7), it follows that the expected price would be

$$p_t^e = \frac{-1}{(\gamma + \beta)} \cdot E u_t \quad (11)$$

Where $E u_t$ measures that part of the future fluctuation in output that can be estimated from the (systematic)

behaviour of the disturbance term (i.e., its pattern of serial correlation and its previous values).

For example, u_t could be expressed as a linear combination of the current and previous values of a random variable ϵ_t , the latter being independently distributed with zero mean and variance σ^2 :

$$u_t = \sum_{i=0}^{\infty} w_i \epsilon_{t-i} \quad (12)$$

$$\text{whereas } E\epsilon_i = 0 ; E\epsilon_i \epsilon_j = \begin{cases} \sigma^2 & \text{if } i=j \\ 0 & \text{if } i \neq j \end{cases} \quad (13)$$

The deviation of the market price from equilibrium being related to the magnitude of the shock, u_t , it follows that this deviation will also be a weighted sum of the ϵ 's. That is,

$$p_t = \sum_{i=0}^{\infty} W_i \epsilon_{t-i} \quad (14)$$

Since by period t , the past history of ϵ_t would have become knowledge, the expectation of p_t conditional on this knowledge would be

$$\begin{aligned} p_t^e &= E W_0 \epsilon_t + E \sum_{i=1}^{\infty} W_i \epsilon_{t-i} \\ &= \sum_{i=1}^{\infty} W_i \epsilon_{t-i} \end{aligned} \quad (15)$$

($E\epsilon_t = 0$ from (13)).

Next, substituting from equations (12), (14) and (15) equation (4) can be written as

$$\sum_{i=0}^{\infty} W_i \epsilon_{t-i} = (-\gamma/\beta) \sum_{i=1}^{\infty} W_i \epsilon_{t-i} - (1/\beta) \sum_{i=0}^{\infty} w_i \epsilon_{t-i} \quad (16)$$

Rearranging terms we obtain

$$\begin{aligned}
 W_0 \epsilon_t + (1 + \gamma/\beta) \sum_{i=1}^{\infty} W_i \epsilon_{t-i} \\
 = (-1/\beta) w_0 \epsilon_t - (1/\beta) \sum_{i=1}^{\infty} w_i \epsilon_{t-i}
 \end{aligned}
 \tag{17}$$

For the above equality to hold, and given that ^{the} ϵ_t 's are independently distributed, the coefficients must be related as below :

$$W_0 = (-1/\beta) w_0 \tag{18a}$$

$$\text{and } W_i = (-1/(\gamma+\beta)) \cdot w_i \quad i = 1, 2, 3, \dots \tag{18b}$$

And, rewriting equations (14) and (15) :

$$P_t = -(1/\beta) w_0 \epsilon_t - (1/(\gamma+\beta)) \sum_{i=1}^{\infty} w_i \epsilon_{t-i} \tag{19}$$

$$P_t^e = -(1/(\gamma+\beta)) \sum_{i=1}^{\infty} w_i \epsilon_{t-i} \tag{20}$$

That is, the serial correlation of the disturbance term being accounted for in expectations, the forecast error would be dependent solely on ϵ_t and, with our assumptions regarding ϵ_t , would be serially uncorrelated, with zero expectation.

Muth also discusses the case in which the rational forecast can be based on the variable's past history. That is, the anticipated price deviation could be formulated as

$$P_t^e = \sum_{j=1}^{\infty} V_j P_{t-j} \tag{21}$$

the object of the exercise being to ascertain the values of the coefficients V_j such that forecasts remain unbiased with serially uncorrelated errors. As before,

$$P_{t-j} = \sum_{i=0}^{\infty} W_i \epsilon_{t-j-i}$$

(from equation (14)).

Substituting for p_t^e from equation (15) and P_{t-j} from above, we obtain

$$\begin{aligned} \sum_{i=1}^{\infty} W_i \epsilon_{t-i} &= \sum_{j=1}^{\infty} V_j \sum_{i=0}^{\infty} W_i \epsilon_{t-j-i} \\ &= \sum_{i=1}^{\infty} \left(\sum_{j=1}^i V_j W_{i-j} \right) \epsilon_{t-i} \end{aligned} \quad (22)$$

And for the equality to hold for all values of ϵ , the coefficients must be related as below :

$$W_i = \sum_{j=1}^i V_j W_{i-j} \quad i = 1, 2, 3, \dots \quad (23)$$

whereby the values of V_j can be solved for, through successive substitutions, in terms of the W_i 's which, in turn, are established as per equations (18). Thus, with the Rational Expectations Hypothesis too, one can formulate expectations as functions of the variable's past history, as is done in some of the alternative expectations schemes discussed in the preceding chapter.

But the important difference arises from the fact that the weights attached to the previous values of the variable would, as per the Rational Expectations Hypothesis, depend specifically on the parameters of the structural equations; the V_j 's in equation (23) are dependent on the values of γ and β (as is evident from equations (18)). And thus, the hypothesis clearly brings out the sensitivity of expectations to the underlying model of the market; once the latter changes, the coefficients γ and β change, the relative importance of the different previous prices changes, and the rational forecast is altered.

Similarly, we could instead of postulating u_t to be a linear combination of the ϵ_t 's imagine the exogenous shock in each period, ϵ_t , as imparting a permanent effect or causing a permanent shift in the supply function. This assumption would be justified in those cases where ϵ_t represents significant improvements in technology, etc. the impact of which endures much beyond the first period, and, hence, the consequent increase in supply in any one period fully includes the increases caused by such technological improvements in the preceding periods. That is, u_t would equal the sum of the current and past values of ϵ_t (each weight equalling unity). And, from equations (18), the values of the coefficients W_t^j would be:

$$W_0 = -1/\beta \quad (24a)$$

$$W_i = -1/(\gamma + \beta) \quad i = 1, 2, 3, \dots \quad (24b)$$

which when substituted in equation (23) would determine the coefficients V_j in terms of the parameters of the structural equations alone.

$$V_j = \left(\frac{\beta}{\gamma}\right) \cdot \left(\frac{\gamma}{\beta + \gamma}\right)^j \quad (25)$$

and, therefore

$$p_t^e = \left(\frac{\beta}{\gamma}\right) \cdot \sum_{j=1}^{\infty} \left(\frac{\gamma}{\beta + \gamma}\right)^j p_{t-j} \quad (26)$$

which resembles the Adaptive Expectations formula used by Nerlove (1958), and described in Ch I, the anticipated price measured by a geometrically declining weighted average of past prices, but the value of the expectations coefficient instead of being estimated from the distributed lag function as in Nerlove, gets automatically determined once the parameter estimates of the structural equations are obtained. That is the coefficient of expectations is specifically dependent on the parameters of the underlying economic model. However, here the geometrically weighted-average forecast is the optimal or rational forecasting procedure for the special pattern of serial correlation assumed for u_t , where all exogenous shocks had permanent effects. Muth (1960) also investigates the more general conditions under which this procedure could yield rational forecasts, where the shock element is comprised of both

permanent and transitory components.

Furthermore, Muth claims that the methods of rational expectations modelling are flexible enough to handle deviations from rationality as well. For example, he demonstrates the case wherein expectations consistently over- or under- discount the influence of current events in future movements. Referring to equation (15), this deviation from rationality can be accommodated by multiplying the weight attached to the most recently observed exogenous disturbance ϵ_{t-1} by factor f_1 . Consequently, the coefficients determining the relationship between the W_t 's and the w_t 's would change, and expectations would be biased resulting in systematic errors. While the latter evidently reflects irrational behaviour, it could be portrayed through the methods described above. Hence, Keynes' view that economic agents are guided mainly by their immediate experience of the variable to be forecasted, the usual practice being to project the present value of the variable into the future, can be accommodated within the above framework: the current information being underdiscounted, $f_1 < 1$, the weight v_1 , attached to the latest observed price, consequently, being very high.

Despite the ability of the hypothesis to accommodate such deviations from rationality, Sargent and Wallace (1975, a) argue that from a purely theoretical standpoint it would be preferable to assume rationality in expectations. While the bulk of economic theory rests on the principle

of rational and optimising behaviour of economic agents, expectations, modelling has hitherto ignored the rationality postulate, instead ascribing to economic agents naive forecasting procedures which place artificial constraints on the kind of information used. The Rational Expectations Hypothesis is appealing because it accords with the economist's usual practice of assuming that agents act in their own best interests. This does not however deny that some individuals can be irrational, but these irrationalities need not cause systematic and substantial deviations from rational behaviour in the aggregate. As they point out, the results of the Rational Expectations Hypothesis still hold good at the market or at the macroeconomic level, when individuals' forecasts are not exactly equal to the conditional mathematical expectation, but to this expectation plus a random term.

In terms of the model above :

$$p_t^e = E p_t + \phi_t \quad (27)$$

ϕ_t being a random term allowing for what may be large deviations from rationality, with $E \phi_t = 0$.

Further, the Rational Expectations Hypothesis is, according to Muth, applicable to all markets and to all kinds of dynamic problems : "Expectations in different markets and systems would not have to be treated in completely different ways".⁹ The hypothesis has on different occasions

9. John F. Muth, "Rational Expectations and the Theory of Price Movements", *Econom&etica*, 1961.

been applied to study speculation in financial markets (Efficient Markets), foreign exchange markets, inventory speculation, the cobweb cycle in agricultural markets, and its implications for the Natural Rate Hypothesis, business cycles, and macroeconomic policy, and so on.

For example, the cobweb cycle which results from the systematic forecasting errors committed by producers under static expectations would, as Pashigan (1970) shows, vanish in a completely deterministic model under rational expectations. The presence of systematic forecasting errors would present "profitable opportunities for sellers of more accurate forecasts and for the transfer of resources from producers who use less accurate forecasting techniques to those who utilise more accurate techniques".¹⁰ In a stochastic model, as in Muth's market model, a shock u_t causing a fluctuation in output would result in an expectational error in period t ; but as the producers' rational forecast equals the equilibrium price itself, there would be no consequent oscillation of prices and quantities, unless the shock happens to be repeated in subsequent periods. Or, if the disturbance term, u_t captures a weather cycle whose pattern can be gauged by producers, then this information being accounted for, producers' expectations of the

10. B. Peter Pashigan, "Rational Expectations and the Cobweb Theory", JPE, 1970.

equilibrium price will differ for each period according to the anticipated shifts in the supply curve caused by the predictable weather cycle. The price oscillation that would then emerge need, however, have nothing to do with forecast errors, but would represent the changing equilibrium values of the market.

THE LIMITATIONS OF THE HYPOTHESIS :

That expectations on an average should be confirmed by actual events, is one of the steady-state equilibrium conditions; turning the point around, people should have expected what actually occurs. As Tobin (1980, a) agrees, it makes no sense to formulate an expectations procedure wherein agents fail to learn from previous mistakes and persistently act on forecasts that prove erroneous. And though in the rational expectations framework forecasts of market participants are postulated to be unbiased in the sense of mathematical expectations, forecast errors are not ruled out ⁱⁿ individual periods. Unexpected shocks and disturbances could cause realised values to diverge from their expected values, and markets could, though temporarily, be thrown out of equilibrium. As J.L. Stein (1982) points out, the disagreement among economists is not regarding the equality between the anticipated and realised values of variables in equilibrium conditions, but regarding the ability of market agents to forecast these equilibrium

values in an unbiased manner, when the conditions for equilibrium themselves are changing.

As outlined in the previous section, Muth's proposition was that expectations of market participants will, on an average, under a stable structure of the underlying market model, and over a large number of observations, be confirmed by observed outcomes. However, realised or observed outcomes do not necessarily provide a sample of observations from a probability distribution generated by a stable market model. Neither the econometrician nor the real World agent is ever sure that the structure is really stable; it is difficult to ascertain which set of observations spanning over which particular period of time has been generated by a stable structure. Furthermore, actual observations are often influenced tremendously by various exogenous shocks which are difficult to identify, in which case, it becomes even more difficult to separate out expectational errors caused by such shocks and those caused by a changing market model, and to rectify the latter.

A more basic question raised against the Rational Expectations Hypothesis is regarding the validity of introducing probability distributions in expectations. H. Simon (1959) doubts whether this is really the way in which humans formulate estimates of the uncertain future. According to him, however satisfying the probability distribution approach may be conceptually, common sense

tells us that people do not really make such estimates, nor does survey data on expectations provide any evidence that they do. Survey data generally yield point predictions which, at best, may be interpreted as the means of the distributions.

While individuals may have formulated their subjective probability distributions, it is doubtful whether the mean can be really viewed as their expectation of the future. Tobin (1980, a) points out that "the priors may be so flat over a wide range that the mean has little significance".¹¹ Hicks (1939) had asserted that it is often incorrect to believe that expectations are represented by the means of their subjective probability distributions; the extent of the deviation of the other possible values of outcomes from the mean will also be a guiding factor in expectations (as mentioned in Ch. I). Further, individuals may be quite unsure of the reliability of their probability estimates, in which case the mean would not be the optimal strategy for expectations; it would be modified to account for this lack of confidence (Shackle, 1949).

Lack of confidence in probability estimates leads one directly to Stein's (1982) postulate of Asymptotically Rational Expectations : given that economic agents are averse to risk, they would not base their demand and supply

11. James Tobin, "Asset Accumulation and Economic Activity", 1980.

decisions on the expected value of the variable per se (i.e. the mean of the distribution), but on this expectation adjusted for risk and risk aversion. To the extent that an element of risk exists and individuals are risk averters, demands and supplies would differ from the levels indicated by Muth's rational expectations. And as this element of risk declines and individuals become increasingly confident about their probability estimates, the expected value adjusted for risk and risk aversion will converge gradually to Muth's rational expectations.

Furthermore, while Muth categorically states that for the Rational Expectations Hypothesis it is not necessary that all individuals have accurate or identical expectations, and while, in fact, expectations are likely to be diffuse, it is still quite unclear as to what combination of these diverse expectations is to be referred to as the market expectation. As Tobin asks, "Whose expectation, or what combination of diverse expectations, is represented by the single symbol in the model ?"¹²

Moreover, since the evolution of the actual values of variables depends on the way in which individuals form expectations guiding their demand and supply decisions, the rational forecaster would need to know how the other market participants form and modify their expectations if

12. *ibid.*

he is to arrive at an unbiased forecast of the market demands and supplies. In a decentralised market with many participants, information regarding others' expectations is inherently unavailable (DeCanio, 1979). On the other hand, with each agent's expectation dependent among other things, on the expectations of the other agents, it is quite possible that the emergence of a determinate result representing the market expectation is obviated.

The unpredictability of the expectations of other agents is, according to Tobin (1980, a) an important and intractable uncertainty. Giving the example of assets - paper of real - of durability longer than the life expectancy of the investor. Tobin shows that since each generation accumulates such assets to provide for old age and as these assets are not themselves consumable, their purchasing power at retirement will depend on the price that the next generation will pay for them. The latter will depend on the prices that this next generation expects its young to pay for them, and so on, ad infinitum. "For certain stores of values - gold, works of art, rare coins, Swiss francs - there is no intrinsic value and only an infinite regress of expectations."¹³ In such instances it would become virtually impossible to form a rational

13. ibid.

expectation. And, as Tobin reminds us, one of Keynes' many insights was "his preception of these essential indeterminacies." ¹⁴ For example, Keynes had specifically noted that a stock market speculator would not formulate a price forecast independently of the opinion of the rest of the market. Aware that future stock price movements are sensitive to the expectations of all market traders, a speculator would try to forecast what average market opinion expects future stock prices to be. And as each speculator adopts this procedure, forecasting could degenerate to indeterminate conjectures.

However, a major criticism against the application of the Rational Expectations Hypothesis to real world economic phenomena is related to the problems of information collection and analysis. According to Benjamin Friedman (1979) while the hypothesis requires economic agents to form their expectations as if they know the process that generates the actual outcomes in question, what is typically missing in the rational expectations models is a clear outline of the way in which economic agents derive this knowledge.

14. ibid.

Firstly, information is often available only at a cost, and hence the rational agent would consider the trade-off between the benefits and costs of added information when forecasting. Feige and Pearce (1976) then show that when such information gathering and processing costs are non-trivial, the economically rational individual may opt for a less expensive forecasting framework, than one which pre-supposes complete knowledge of the underlying model, even though the consequent forecast errors may be larger. While estimating future inflation rates, for example, Feige and Pearce assume that the cost of misestimating inflation (i.e. the cost of the forecast error) could be represented by a quadratic loss function :

$$C = \kappa \cdot [\pi_t - {}_{t-1}\pi_t^e(I)]^2 \quad (28)$$

where C denotes the cost of the error, π_t the actual inflation rate in period t, ${}_{t-1}\pi_t^e$, its expected value, the expectation formed in period t-1 on information I. (However, as Feige and Pearce remark, the loss function could be asymmetrical where for some individuals the cost of underestimating inflation exceeds the cost or overestimating it, or vice versa). The squared forecast error is posited to be a function of the amount and the type of information employed :

$$\left[\pi_t - {}_{t-1}\pi_t^e(I) \right]^2 = f(I_1, I_2, I_3, \dots, I_m) \quad (29)$$

where I_i is the i^{th} type of information available at price c_i .

Then the total cost (TC) involved is the sum of the cost of the forecast error and the cost of collecting information.

$$\begin{aligned} TC &= \kappa \cdot \left[\pi_t - {}_{t-1}\pi_t^e(I) \right]^2 + \sum_{i=1}^m c_i I_i \\ &= \kappa \cdot f(I_1, I_2, \dots, I_m) + \sum_{i=1}^m c_i I_i \end{aligned} \quad (30)$$

Then the optimal cost minimising decision is to buy units of each type of information until the reduction in the cost of the forecast error per rupee spent on each type of information is equated; that is,

$$c_i = -\kappa \cdot f'_i \quad (31)$$

However, the costs of specific types of information may vary across individuals and across time. And if, as Feige and Pearce note, it were assumed that the information cost of past inflation rates is relatively small, then this information would be employed more intensively and one could arrive at an autoregressive procedure where a forecast is based only on the variable's past history. And in some cases, the adaptive expectations method could be the optimal forecasting strategy.

Apart from computing the rational forecast based on knowledge of the market parameters and the time structure

of the disturbance process, Muth did not specify the method by which the individual producer could consciously improve upon his forecasts : the process of learning about the specific market model is missing (DeCanio, 1979). Cyert and DeGroot (1974) introduce an explicit learning process described in Bayesian terms, wherein each firm has a prior distribution for a particular future price and, accordingly, supplies the appropriate quantity (all firms are assumed to have the same prior distribution); this prior distribution is modified when the market results are observed, the new prior now leading to another decision, and so on. If producers, for example, do not know the model of the process determining the price, but base their decisions on an incorrect model, then learning from the feedback of market information could bring them ultimately to an equilibrium, even with the incorrect model. However, since firms are using an incorrect model, the process may converge very slowly to the equilibrium results, or may not converge at all. But they also observe, that if firms believe in models diverging drastically from reality, it would be reasonable to assume that their respective managements would recognise this deviation and search for a model that produced predictions closer to actual observations. And if producers base decisions on a model consistent with reality, but have yet to estimate the parameters of the structural equations, they could, with the Bayesian learning process - forming prior distributions for the parameters,

modifying them in the light of the actual observations, and so on—ultimately come to know the true parameter values. However, the time required for ^{this} learning process could be extremely long.

Benjamin Friedman (1979) also focusses on the learning process which must underlie economic agents' expectations; assuming that economic agents know the correct specification of the true model, their task is to estimate the values of its coefficients. Learning is assumed to occur through Least Squares Estimation (LSE) procedures, similar to the way in which economists typically learn from empirical research. Postulating a linear model relating the value of the variable to be forecasted, y_t , at time period t , to a vector of pre-determined variables, x_t

$$y_t = x_t' \alpha + e_t \quad (32)$$

where α is a vector of fixed coefficients, e_t is the disturbance term with

$$E e_t = 0 \quad ; \quad E e_t e_s = \begin{cases} 0 & \text{if } t \neq s \\ \sigma^2 & \text{if } t = s \end{cases} \quad (33)$$

At time $t-1$ agents forecast the value of y_t by estimating the values of the coefficients in α . The parameter estimates a_{t-1} are assumed to be least squares estimates of α conditional on all the pre-determined values of x and on the observations of y available till $t-1$. The

optimal forecast is

$$E_{t-1}(y_t) = x'_t \cdot a_{t-1} \quad (34)$$

Then the forecast error will depend not only on the disturbance e_t , but also on the extent to which a_{t-1} deviates from the true α ; i.e.

$$y_t - E_{t-1}(y_t) = x'_t (\alpha - a_{t-1}) + e_t \quad (35)$$

And if the forecast errors are to be purely random and unavoidable in the sense that they cannot be predicted with the information that is available - the forecast errors are orthogonal to the information set conditioning forecasts - as per the Rational Expectations Hypothesis, then it follows that a_{t-1} must equal α . However, this equality need not obtain in practice. Incorrect model specification, incorrect functional forms, erroneous exclusion of certain arguments from the function (i.e. incorrectly equating some of the parameters to zero, an a priori restriction on estimation), are some of the reasons that may vitiate the error orthogonality property. And even as time passes, and more and more observations become available, agents may not necessarily discover the true α values.

Secondly, if agents are using a correctly specified model, then over time the coefficient estimates would converge to their true values. But as Friedman reminds us,

"in the world as it exists with limited observations between the initial date of available observations T_0 and the present time t , however, this convergence process is incomplete",¹⁵

and $a_{t-1} \neq \alpha$.

In fact, people do not use all the available observations but often disregard old observations as new ones become available (economists frequently use a rough form of a rolling sample period), the reasons often being that the economic model is believed to have changed - the process generating observations was quite different earlier than what it is believed to be today, such that the old observations are no longer relevant for drawing inferences about future outcomes. Hence, even if t became progressively large, a_{t-1} need not converge to α .

The crux of the above argument is that even when agents are imagined to efficiently utilise all the relevant information, Muth's error orthogonality proposition may remain unsatisfied. Hence, there is an essential difference between the optimum utilisation of available information (e.g. learning through LSE procedures) which is satisfied in Benjamin Friedman's model, and the full information assumption that is required for Muth's results.

15. Benjamin Friedman, "Optimal Expectations and the Extreme Information Assumptions of 'Rational Expectations' Macromodels", JME, 1979.

X:83 : (B28)

In fact, as Friedman demonstrates, the LSE process of forming expectations satisfying the assumption of rational use of information as it arrives could lead to an adaptive expectations formula. Letting τ denote time periods, Benjamin Friedman shows that given the linear model (32) and pre-determined values of x_{τ} for $\tau = t, t+1, t+2$, and so on, the conditional expectation of y_{τ} formed in period t , $E_t(y_{\tau})$ for $\tau = t+1, t+2, \dots$ as in equation (34) based on observations available till period t , would differ from the conditional expectation $E_{t-1}(y_{\tau})$ for $\tau = t+1, t+2, \dots$ also formed optimally, but with observations till $t-1$; and

$$E_t(y_{\tau}) - E_{t-1}(y_{\tau}) = \gamma_{t\tau} (y_t - E_{t-1}(y_t)) \quad (36)$$

$\tau = t+1, t+2, \dots$

The forecast of y_{τ} is revised as additional observations on y become available; i.e. the forecast is adapted in response to the most recent forecast error, the coefficient of expectations, however, dependent on x_t . In certain cases (e.g. a stationary x_t series, etc.) the adaptive - expectations formula with a constant coefficient of expectation, may be a good approximation to the forecasting procedure described above.

However, Muth had specifically stated that the information processing by individual entrepreneurs need not be a strict or rigorous parameter estimation technique, nor should all producers arrive at the equilibrium solution

of the market model. The hypothesis holds true when producers in the aggregate behave as if they are aware of the underlying market model; those in possession of the accurate model would make superior forecasts, other agents would try to avail of their better information, ultimately leading to the situation where the sophisticated forecasters dominate the outcome.

One of the appealing features of the Rational Expectations Hypothesis is, as discussed earlier, that it brings expectations closer to the core of economic theory by building on the rationality principle. But H. Simon (1959) argues that the traditional postulate of an economic, rational human being is in need of drastic revision. Economic man "is assumed to have knowledge of the relevant aspects of his environment which, if not absolutely complete, is at least impressively clear and voluminous."¹⁶ However, there is a marked distinction between man's objective environment, as it exists, and his subjective environment, the one that he perceives and responds to. And since expectations are to be based on this subjective environment, our model of economic man must include some of his properties as a "learning, estimating, searching, information processing organism",¹⁷

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16. Herbert A Simon, "A Behavioural Model of Rational Choice", Ch. 14 in "Models of Man", 1957.
 17. Herbert A Simon, "Theories of Decision Making in Economics and Behavioural Science." AER, 1959.

his model of the world encompasses only a minute fraction of all the relevant aspects of his actual environment, and his inferences extract only a minute fraction of the information that is present even in his model. For human beings are not, according to him, capable of the kind of rationality postulated in economic theory, but only of a limited or bounded rationality : "the capacity of the human mind for formulating and solving complex problems is very small compared with the size of the problems whose solution is required for objectively rational behaviour in the real world - or even for a reasonable approximation to such objective rationality".¹⁸

However, as Tobin (1980,a) remarked, despite our reservations about the Rational Expectations Hypothesis, it does not necessarily mean that the other alternative treatments of expectations are superior to rational expectations methods. The opposite, he suspects, is true. But what is more important is that economists should pay more attention to actual data on expectations and how they are formed, less to their own assumptions about what they are or how they should be formed.

18. Herbert A Simon, "Models of Man", 1959, Page 198.

III

THE NEW CLASSICAL MACROECONOMICS AND
ITS POLICY IMPLICATIONS

The application of the Rational Expectations Hypothesis in the area of macroeconomics and the radical policy conclusions emerging therefrom can be understood against the background of the Phillips Curve and the Natural Rate Hypothesis. In fact, the Rational Expectations Hypothesis may be viewed as supplementing the Natural Rate Hypothesis in the argument that the Phillips Curve does not yield any trade-off between inflation and unemployment that can be consciously exploited by policy makers.

THE PHILLIPS CURVE.

A.W. Phillips (1958) had noticed a striking inverse relationship between British unemployment and inflation rates over a period of 97 years (1861-1957). This empirical observation, which came to be labelled as the Phillips Curve, led to a number of similar studies trying to estimate this relationship for other countries and for different periods. It simultaneously gave rise to the notion of a trade-off between the two variables, which could be exploited by policy makers : an unemployment rate higher than what is considered to be socially desirable or tolerable could be

remedied by moving up the Phillips Curve (with inflation on the vertical and unemployment rate on the horizontal axis) via a policy of inflation and, conversely, inflation rates could be lowered only at the cost of an increase in the unemployment rate. Or, authorities could purchase increases in employment and output by paying in terms of higher inflation rates, and vice versa.

Phillips's theoretical justification for this relationship appeared to be quite straightforward. Just as an excess demand in product markets results in an increase in prices eliminating the disequilibrium, an excess demand in labour markets implies an upward pressure on wage rates. That is, when unemployment is relatively low, firms find it difficult to hire workers at the prevailing wages, and would, therefore, be compelled to bid wages up in an attempt to attract more labour. And the greater the excess demand the greater would be the upward pressure on wages, periods of high employment then being associated with larger increases in wage rates or higher wage inflation. On the other hand, in slack labour markets when unemployment is relatively high, the upward pressure on wages is eased. Further, if wages are a major component of total cost, or if prices are simply a mark-up on wages, the connection between

unemployment and price inflation is established.

One could visualise a map of social indifference curves as functions of unemployment and inflation rates, downward sloping and concave to the origin, more of either variable implying a diminution to social utility (Phelps, 1967). The optimum combination of inflation and the unemployment rate is then determined by the tangency between the Phillips Curve and the lowest attainable curve. If the prevailing rate of unemployment exceeded the optimum rate, determined by this tangency, then the recommendation for policy would be an increase in aggregate spending generated through monetary growth and/or government expenditures, such that, as demand and prices begin to rise, producers are encouraged to employ more resources, resulting therefore in the rate of inflation and the output level consistent with the targeted rate of unemployment on the Phillips Curve. That is, the reduction in unemployment is, in this case, more than worth the additional inflation that it entails.

Consequently there arose a case for activist economic policy; even minor fluctuations in economic activity could apparently be smoothed out by appropriate monetary and fiscal measures. When output and employment are feared to fall, relative to their secular trends, the authorities could adjust their monetary growth rates, tax rates and expenditures to avert the decline in output,

and vice versa - a policy of leaning against the wind to attenuate the business cycle.

However, one of the most crucial propositions implicit in this framework is that relationships between variables, such as the Phillips Curve, or the reduced form equations of econometric models, are invariant with respect to the policies adopted. That is, for example, the terms at which a trade-off between inflation and unemployment can be negotiated are not affected by the particular monetary and fiscal policies adopted for this purpose. It is this proposition which came to be questioned by the Rational Expectations School.

But prior to that the Natural Rate Hypothesis was advanced by Milton Friedman (1968) and E.S. Phelps (1967) which undermined the ability of policy makers to secure any permanent increase in employment through a given increase in the rate of inflation.

THE NATURAL RATE HYPOTHESIS.

Milton Friedman (1968) pointed out the fallacy in Phillips' argument, the failure to distinguish between nominal and real wages, reminding us that demand and supply of labour should be visualised as functions of the real wage rate. An excess demand in the labour market exerts an upward pressure on the real wage, which could as

well be satisfied by a fall in prices, nominal wages remaining unchanged. Periods of high employment need not necessarily imply rapid increases in the price level.

In fact, Friedman argued that labour market decisions should really be viewed as being made with reference to expected real wage rates. Employers would refer to the nominal wage demanded by workers and deflate it by their expectations of the prices of their products. Employees, similarly, would deflate the nominal wages offered by their price anticipations for the basket of goods consumed by them.

The natural rate of unemployment is then defined by Friedman as that rate which corresponds with equilibrium in the structure of real wage rates. It corresponds to that level of unemployment at which real wages are moving along their normal or secular trend, which could be maintained indefinitely as long as capital accumulation, technological progress, etc. continue along their long-run trend. An unemployment rate less than the natural rate is an indicator of excess demand in the labour market exerting an upward pressure on the real wage. On the other hand, if the unemployment rate exceeds the natural rate, it follows that there is an excess supply in the labour market, which will produce a downward pressure on real wage rates. That the natural rate of unemployment is

positive follows from labour market imperfections leading to an equality between the number of jobs vacant and persons unemployed. And as Friedman points out, this natural rate is not unchang^eable or immutable but is liable to alter with improvements in employment exchanges, changing costs of labour mobility, the varying strength of labour unions, minimum wage legislation, etc.

The choice of the term natural rate was apparently made to distinguish between the real or natural and the monetary forces in the economy - the Wicksellian distinction between the market and the natural rates of interest was extended to the labour market. As in Wicksell's argument, the monetary authority can depress and maintain the market rate below the natural rate only by sustained inflation, and the market rate could be made to exceed the natural rate only by deflation. Further, adding price anticipations which adjust in response to the actual course of prices, though with a lag (as in the adaptive expectations scheme), a discrepancy between the market and natural rates could be maintained only by accelerating inflation or deflation, as the case may be, as explained below.

The logic of the hypothesis is as follows : the economy is assumed to be initially in a period of stable prices and wages, abstracting from their secular growth

rates, with unemployment at its natural rate. The monetary authority, however, wishes to peg unemployment below its natural rate, and consequently steps up the rate of monetary growth. This monetary expansion initiates an increase in aggregate spending - at the prevailing prices real balances begin to rise, interest rates begin to fall, consumption and investment expenditures are stimulated. Most of the rise in nominal income will initially occur through increases in output rather than in prices. Producers interpret the rise in demand (increasing sales at the same prices) as limited to their own products and a rise in their relative prices, as cheapening the real cost of labour at the going wage rates, and react by enlarging outputs, and in the process, bid up nominal wage rates to hire additional labour. Workers, evaluating the new wage offer at the initial price level, not having anticipated any price rise, find that, ex ante, their real wages have risen. Employment rises.

But this describes only the initial impact of the monetary expansion. As Friedman says, selling, prices of all products will begin to rise in response to the unanticipated increase in nominal demand, this increase occurring faster than the rise in the prices of factors of production. And as time passes, both employers ^{and} employees

come to recognise that prices in general are rising. Real wages, ~~ex~~post, have declined below their anticipated levels. Price anticipations are then gradually adapted upwards to the observed rise, and hence money wages must rise to restore the real value of wages to the previous level. Producers realise that the rise in the prices of products was a general one and that the real wages to be paid have not diminished. As the ex ante real wages that labourers expect to receive fall with the revised price expectations, and as the real wages that producers expect to pay rise, labour supply and demand begin to contract, and ultimately the economy reverts to an equilibrium position, with unemployment back at its natural rate, but with the rate of inflation higher than the initial rate, corresponding to the higher rate of monetary growth. Hence, the trade-off between inflation and unemployment was purely transitory, lasting only as long as the money-illusion or the erroneous price forecasts lasted.

The conventional Phillips Curve argument is thus static in nature (Phelps, 1967), neglecting the changes in anticipations that are induced by changes in the observed rates of inflation. Or, Phillips' argument implicitly assumes an expectation of an unchanging rate of inflation (or stable prices abstracting from their long-run trend), such that a rise in nominal wages occurring with monetary

expansion, coincides with a rise in the anticipated real wage. However, with expectations adjusting to the rising inflation rate, the Phillips Curve shifts up bodily, with equilibrium at the natural rate of unemployment and the expected inflation rate equal to the actual rate. If the authority is still insistent on achieving a lower rate of unemployment, it will have to step up the monetary growth rate further, which will again raise employment over the period necessary for expectations to catch up with the changed inflation rates. Hence, an accelerating inflation is required to ensure the maintenance of the unemployment rate below the natural rate.

However, Friedman cautions against such an accelerating inflation policy, for as price rises begin to steepen, the lag in the adjustment of expectations to realised values shortens; the coefficient of expectations in the adaptive expectations formula is successively revised upwards, and the transitory departures from the natural rate become increasingly short-lived. And, secondly, as in the long-run, money illusion is absent, and expectations are fully realised, the long-run Phillips Curve is vertical; that is, any rate of inflation is consistent with the natural rate of unemployment. There is no permanent trade-off

between inflation and unemployment. The trade-off exists only between the unanticipated component of inflation and unemployment.

E.S. Phelps (1970) also demonstrated the transitoriness of the Phillips Curve trade-off, although along different lines. Postulating an atomistic labour market, Phelps argues that the non-homogeneity of workers and jobs, and the lack of complete (i.e. cost-free) information regarding the availability of jobs and labour supplies of different qualities, causes a dispersion of wage rates. Workers then recognise that their own experience with wage offers may differ from what is offered by employers elsewhere. Unemployed workers may then reject the first few sampled wage offers, preferring to remain unemployed in order to search more easily for better wage offers. Employed workers may also quit their jobs in search of more remunerative employment. Hence, the expectation of a dispersion of wage rates causes search unemployment to be normal.

Similarly, firms may also require time to search for new employees with the desired worker attributes, thus leading to job vacancies. The vacancies could be filled by some outlay on help-wanted advertising etc., and if they are especially numerous, by offering a wage

differential—a wage offer higher than the average wage expected to be earned elsewhere - in order to attract the necessary labour supply.

Under stationary conditions, the search activity by firms and workers would ultimately result in an equilibrium - every worker would be employed in his best job, the chances of finding a better employment being so small that further expenditure on collecting information and searching for jobs, is not justified. There would be no unemployment and the wage rate would be uniform for each labour quality. Firms, too, would have no more vacancies as the chances of finding better qualified workers do not justify any further expenses on search and recruitment.

But, in normal times, changing product demands, uneven technological progress and labour — force growth, and so on, would, with imperfect information, justify search activity by firms and workers. Hence, "positivity of vacancies, even for the representative firm in normal times, like the positivity of unemployment in normal times, signalises the cost to both employers and workers of reaching one another under incomplete information."¹

1. E.S. Phelps, " Money Wage Dynamics and Labour Market Equilibrium," in "Microeconomic Foundations of Employment and Inflation theory", 1970.

Phelps then assumes that because of the costs of frequent wage revisions, firms adjust their wage rates only periodically, the wage-setting dates being staggered so that a representative sample of firms sets wage rates each day. At wage setting time, the i^{th} firm considers its desired wage differential, Δ_i^* , defined as

$$\Delta_i^* = (W_i^* - W^e) / W^e \quad (1)$$

where W_i^* is the i^{th} firm's optimal wage rate, W^e , the average wage rate expected to be paid by other firms. It is supposed that workers and firms have the same expectation regarding the future wage rate, and for the first part of the analysis, Phelps postulates static expectations whereby W^e equals the recently observed average wage rate, the expected rate of wage change being zero.

The desired wage differential varies directly with the number of vacancies in the firm - an increase in the number of vacancies will prompt the firm to enlarge the differential in order to facilitate recruitment by encouraging workers to accept the higher wage offer and avoid further search, and at the same time to discourage employed workers from quitting. Further, given the number of vacancies, the magnitude of the wage differential will depend on the unemployment rate in the economy - the higher the unemployment rate,

the larger will be the flow to the firms of unemployed workers in search of jobs, and the greater the probability of attracting the requisite number of workers with a smaller wage differential. Further, a decrease in the unemployment rate may cause increased quits as workers may expect to spend less time in the unemployment pool if they decided to search for better jobs elsewhere. Vacancies may, therefore, increase, requiring a larger wage differential to fill them.

If all firms are roughly equal, then the average desired wage differential, Δ^* is a function of the unemployment rate, u (the ratio of unemployed workers, U , to the total labour force, L) and the over-all vacancy rate, v ($v = V/L$, where V is the number of vacancies). That is,

$$\Delta^* = m(u, v) \quad (2)$$

The actual rate of wage change (\dot{w}/w) in the economy is postulated to be proportional to the desired differential, as each individual firm revises its wage according to its desired wage differential. That is,

$$\begin{aligned} (\dot{w}/w) &= \lambda \Delta^* \\ &= \lambda [m(u, v)] \quad \lambda > 0 \quad \dot{w} \equiv dw/dt \quad (3) \\ (m_1 < 0, m_2 > 0, & \text{ as explained above.}) \end{aligned}$$

Then, continuing with the assumption of static expectations, Phelps goes on to derive the Phillips Curve. The monetary authority is assumed to adopt an expansionary policy with a view to increase aggregate demand and lower the unemployment rate. As firms observe the rising demand for their products and decide to increase output by employing additional workers, recruitment efforts are stepped up. The increased search succeeds in locating some unemployed workers, and the unemployment rate begins to fall, which in turn may encourage quits and create more vacancies. Then, as each firm's wage-setting date arrives, it decides on a higher wage differential and thus raises its wage offer, so that gradually the average wage in the economy rises.² Hence, as the average desired differential, Δ^* , rises the rate of wage inflation also arises, and with it the rate of price inflation. If ~~the~~ unemployment ~~rate~~ is to be maintained at the ^{lower} ~~higher~~ rate, the higher Δ^* value will continue with the associated higher rate of wage inflation.

2. As firms notice the increase in the average wage elsewhere, their expected average wage (W^e) estimates are correspondingly raised - the new higher wage rate is expected to continue in the future. Hence, later on, a part of the increase in the wage rate represents an attempt to catch up with the higher W^e .

Phelps then discards the static-expectations assumption, to enquire into the more general case where firms may forecast wage changes elsewhere. If, for example, a firm's vacancy rate and the labour market conditions were such as to warrant a 1% increase in its wage rate, then if it expects the average wage elsewhere to be increasing at the rate of 2% per annum, it would have to raise its wage offer by 3%. Hence, to determine the actual rate of wage change, one must add the expected rate of wage change, $(\dot{w}/w)^e$, to the rate of wage change as per the desired wage differential under static-expectations :

$$\begin{aligned}(\dot{w}/w) &= \lambda \Delta^* + (\dot{w}/w)^e \\ &= \lambda [m(u, v)] + (\dot{w}/w)^e\end{aligned}\quad (4)$$

Furthermore, the vacancy rate is itself shown to be related to the unemployment rate. The rate of growth of employment depends on the number of persons hired and the number of quits per period of time, which in turn depend on u and v . The higher the unemployment rate, the easier and faster the recruitment (hires) by firms and the more effective the discouragement to quits. On the other hand, the higher the vacancy rate, the more intensive the recruitment effort made by firms and hence,

the greater the recruitment, while this increase in hires may itself induce quits. That is, defining $Z = \dot{N}/L$ where \dot{N} is the growth of employment per unit of time (dN/dt , N being the number of employed persons) and L , the labour force,

$$Z = Z(u, v) \quad (5)$$

which Phelps solves to yield,

$$v = v(u, Z) \quad (6)$$

However, u and Z cannot move independently of each other for long, as a high rate of growth of employment, would imply a falling unemployment rate. Hence, corresponding to any unemployment rate that is to be maintained over a period of time (\bar{u}) there is associated with it a steady \bar{Z} and, hence, a steady \bar{v} . Then, the vacancy rate can be expressed as a function of the unemployment rate alone. Rewriting equation (4) :

$$(\dot{w}/w) = \lambda [f(\bar{u})] + (\dot{w}/w)^e \quad (7)$$

Then in equilibrium, the equality between the expected and realised rates of wage change, will imply.

$$f(\bar{u}) = 0 \quad (8)$$

Phelps shows that there is only one unique \bar{u}^* , the equilibrium rate of unemployment, that satisfies the above equality.

The main point of this result is that \bar{u}^* is independent of the rate of wage inflation, actual or expected. In equilibrium, a large rate of wage inflation will only imply an equally large rate of expected wage inflation, not a smaller rate of unemployment. Or, the steady state equilibrium Phillips Curve is vertical at \bar{u}^* . While Phelps does not explicitly spell out an expectations scheme (in this model) whereby agents forecast wage rate changes, he does mention that any continuing wage inflation will generate expectations of that inflation, so that eventually $(\dot{w}/w)^e$ approaches (\dot{w}/w) : the long-run trade-off between inflation and unemployment is non-existent.

However, the long-run could be interpreted as sometime in the distant future, that anticipations are slow to adjust in reality. Hence, a meaningful trade-off exists in the short-run. And this, as Modigliani(1977) comments, "opened up new vistas of 'enjoy-it-now, pay-

later' policies".³ Hence, activist economic policies, including a feed-back from current economic conditions to policy settings, could still be advocated. Or the Natural Rate Hypothesis could, in the extreme view, be regarded as a mere intellectual curiosity with only remote policy implications.⁴

RATIONAL EXPECTATIONS AND THE POLICY
INEFFECTIVENESS PROPOSITION :

The New Classical Macroeconomics pushes the Natural Rate Hypothesis one fundamental step further by replacing the adaptive expectations mechanism inherent in it by the rational expectations postulate. Expectations of optimising economic agents are hypothesised to be unbiased forecasts of variables, based on information on the relationships between economic variables, the monetary and fiscal policies of the government, and so on. Demand and supply decisions of market participants

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3. F. Modigliani, "The Monetarist Controversy or, Should We Forsake Stabilization Policies ?", AER, March 1977.
 4. The Natural Rate Hypothesis came to be criticised also for its assumption of competitive markets, perfect wage and price flexibility, etc. This criticism which extends to the rational expectations version of the hypothesis will be discussed in conjunction with the latter.

are guided by anticipations of future prices, wages, interest rates, etc. which embody anticipations of government policy measures and their estimated impact on these economic variables. The crux of the argument is that any systematic monetary or fiscal policy rule, which is inherently predictable by economic agents, will be fully accounted for in their market decisions. Because of this any such systematic attempts made by the authorities to affect the real variables, output, employment, etc. will be frustrated.

The argument can be presented with the help of the model formulated by Sargent and Wallace, (1975,a). As discussed earlier, the Natural Rate Hypothesis posits that it is only the unanticipated inflation that is capable of affecting real economic activity, fully anticipated increases in prices leaving output and employment unchanged. Such a short-run Phillips Curve relationship between inflation and unemployment can be written as

$$p_t - p_{t-1} = \phi_0 + \phi_1 U_t + (\phi_1 < 0) \quad (9)$$

where U_t is the rate of unemployment in period t , p_t is the logarithm of the price level, ${}_{t-1}p_t^*$ is the logarithm of the price level anticipated by the public

at period $(t-1)$ to prevail in period t , and ϵ_t is a random term. Hence, an increase in anticipated inflation $({}_{t-1}p_t^* - p_{t-1})$ shifts the Phillips Curve upwards by the full amount of the increase. Or, rearranging terms,

$$(p_t - p_{t-1}) - ({}_{t-1}p_t^* - p_{t-1}) = \phi_0 + \phi_1 U_t + \epsilon_t$$

$$\text{i.e.} \quad (p_t - {}_{t-1}p_t^*) = \phi_0 + \phi_1 U_t + \epsilon_t$$

it is only the difference between the actual and expected rates of inflation, the forecast error, that can influence unemployment. When inflation is fully anticipated it follows that

$$\phi_0 + \phi_1 U_t + \epsilon_t = 0$$

$$\text{or,} \quad U_t = (-\phi_0/\phi_1) - (1/\phi_1)\epsilon_t$$

unemployment varies randomly around its natural level, $(-\phi_0/\phi_1)$.

Sargent and Wallace further postulate a reduced form equation describing the behaviour of the price level :

$$p_t = a.m_t + b.x_t \quad (10)$$

where m_t is the logarithm of the money supply and x_t represents a vector of pre-determined variables including

endogenous variables and random terms; a and b are the parameters associated with m_t and x_t .

The short run trade-off between inflation and unemployment obtains when inflationary anticipations fall short of the realised values. As mentioned in Ch.I, the adaptive expectations scheme, with the expectations coefficient less than unity, results in consistent underestimates of the inflation rate or in consistent forecast errors. This consistent underestimation enables the monetary authority to negotiate a trade-off. To demonstrate the point, Sargent and Wallace posit, first, the following simple expectations scheme.

$${}_{t-1}P_t^* = \lambda P_{t-1} \quad (11)$$

where λ is a parameter. (11)

The three equations (9) - (11) can then be solved to determine unemployment and inflation as functions of the money supply and x_t .

$$U_t = \phi_1^{-1} \left[a(m_t - \lambda m_{t-1}) + b(x_t - \lambda x_{t-1}) - \phi_0 - \epsilon_t \right] \quad (12)$$

$$P_t - P_{t-1} = a(m_t - m_{t-1}) + b(x_t - x_{t-1}) \quad (13)$$

Hence, the unemployment rate is sensitive to monetary growth rates which can be adjusted to secure a reduction

in the former. Or, the monetary growth can be suitably changed to ~~offset~~ fluctuations in employment and output caused, for example, by fluctuations in x_t , if the authority's objective is to stabilize the economy. Or, the authorities can ~~devise~~ an optimal policy rule with reference to the social indifference curves between inflation and unemployment.

Replacing (11) by the geometrically-declining-weighted average scheme of adaptive expectations, with fixed weights, would not cause any substantial change in the above argument. For the benefits of monetary expansion derive from the individuals' inability to make accurate price forecasts : as long as expectations are formed as per either a static or adaptive expectations scheme, the inflation rate will be consistently underestimated, and the rate of unemployment can be maintained below the natural rate, until the bias in expectations is totally removed. With an expectations coefficient less than unity, the expectational errors would continue indefinitely, though diminishing in size as time passes and anticipations adapt gradually to the new higher rate of inflation. Hence, the impact of a given rise in the monetary growth rate gets distributed between output and the rate of inflation, shifting increasingly towards the latter as expectations are revised in the light of the experienced price rises.

As Robert Hall notes, the benefits of the expansionary policy arise from the ability of the authority to "trick economic agents into behaving in socially preferable ways, though this behaviour is not in their own interests... The gap between the actual and expected inflation measures the extent of the trickery."⁵ When expectations adjust rapidly, the entire effect of an expansionary policy gets transmitted swiftly to (anticipated) inflation alone.

Implicit in these Phillips Curve relationships are, therefore, descriptions of the way in which economic agents predict the future on the basis of the past. Economic agents are assumed to behave as if they are ignorant of government policies. Once knowledge of such policies is allowed for, it follows that all rational decision makers will try to estimate their impact on the economic variables of their interest. If, for example, workers came to recognise the pattern of the systematic feed-back rule implemented by the government, they could predict the future monetary growth rates, and with an understanding of their relationship with the rate of inflation, they would correctly anticipate their real wages.

5. Robert Hall, "The Phillips Curve and Macroeconomic Policy" in "The Phillips Curve and Labour Markets", edited by K. Brunner, JME, 1976, Supplement.

They would no longer be deceived into believing that the higher nominal wages offered correspond to a higher real wage. Similarly, if producers were to successfully predict the monetary growth rate, they would foresee that the rise in prices is a general one and not limited to their own respective products. Labour supply and demand remain at their original, pre-expansion levels. The authority can no longer manipulate the economy, for it has been denied the power of systematically tricking the public.

This result can be demonstrated by discarding the expectations scheme (11) in favour of rational expectations :

$${}_{t-1} P_t^* = E_{t-1} (P_t | I_{t-1}) \quad (14)$$

where E_{t-1} is the mathematical expectations operator, conditional on information available through period $t-1$, I_{t-1} , the latter including information on the economic relationships, the previous forecasted and realised values of the variables and the government's policy rule. That is, expectations are postulated to be unbiased forecasts of the relevant variables, with expectational errors serially uncorrelated.

Given information of equation (10) it follows that

$$\begin{aligned} {}_{t-1}P_t^* &= E_{t-1}(P_t | I_{t-1}) \\ &= a E_{t-1} m_t + b E_{t-1} x_t \end{aligned} \quad (15)$$

and substituting from (15) and (10) in equation (9) yields:

$$U_t = \phi_1^{-1} \left[a(m_t - E_{t-1} m_t) + b(x_t - E_{t-1} x_t) - \phi_0 - \epsilon_t \right] \quad (16)$$

The authority is then assumed to follow the feedback rule below :-

$$m_t = G \theta_{t-1} + \eta_t \quad (17)$$

where θ_{t-1} is a set of observations on variables for period $t-1$, and η_t is the random component of money supply which is serially uncorrelated and also uncorrelated with θ_{t-1} .

Then, if expectations are rational, with I_{t-1} incorporating θ_{t-1} and the policy rule (17),

$$E_{t-1} m_t = G \theta_{t-1} \quad (18)$$

as $E_{t-1}(\eta_t | \theta_{t-1}) = 0$.

Therefore, the **expectational** error for money supply is

$$m_t - E_{t-1} m_t = \eta_t \quad (19)$$

Substituting (19) into (16) results in

$$U_t = \phi_1^{-1} [a\eta_t + b(x_t - E_{t-1}x_t) + \phi_0 - \epsilon_t] \quad (20)$$

The parameters of the government's feedback rule, G , do not appear in (20), from which it is evident that the behaviour of unemployment is independent of the systematic and, hence, predictable feedback policy rule adopted by the government. The only component of money supply which alters unemployment is the random element, η_t , and it does so solely because it is unpredictable. On the basis of the information contained in Θ_{t-1} there is no way in which the η 's can be predicted either by the government or the public.

Hence, the authority is no longer able to conduct a countercyclical policy, for there is no feedback rule which it could employ and yet expect to systematically trick the public. And it cannot exploit the Phillips Curve even for one period; the short-run Phillips Curve itself is vertical. Thus combining the natural rate hypothesis with the assumption that expectations are rational, transforms the former from a curiosity with perhaps remote policy implications into an hypothesis with immediate and drastic

implications about the feasibility of pursuing a counter-cyclical policy."⁶ In more precise terms, the probability distribution of output relative to capacity remains the same, irrespective of any systematic response adopted by the monetary authority to economic conditions. The economy is entirely free of money illusion, with economic agents possessing the same information as the monetary authority regarding the structure of the economy, past values of variables and the policy rule in effect. And, just as the government cannot hope to secure any output increases by a monetary expansion, nor need it pay in terms of increased unemployment and output loss if it reduces the monetary growth rate in an attempt to lower inflation rates.

The results of this model then conform with those of classical macroeconomics where the economy was believed to be dichotomised between the real and monetary sectors, independent of each other. Changes in nominal aggregate demand there impinge only on the price level and not on output and employment which are determined in the labour and product markets, with labour demand and supply dependent on the real wage rates, a market clearing condition determining the equilibrium wage rate and

6. Thomas Sargent and Neil Wallace, "Rational Expectations and the Theory of Economic Policy", June, 1975.

and volume of employment, the latter determining the quantity of output via the production function. This neutrality of money results in the New Classical Macroeconomics as well, but applies only to the systematic component of the money supply rule. Random or surprise monetary changes can still catch decision makers unawares, forcing them into expectational errors, and, temporarily, into working and producing more (or less) than they would have, had such changes not occurred.

In fact, the policy neutrality proposition is not entirely novel. The argument behind it had been presented by Wicksell in 1906: "Sometimes ... we hear it said that certain changes in the value of money ... might be preferred under certain circumstances to perfect stability. Rising prices would act as a stimulus to enterprise... This view is, however, evidently naive. It need only be said that if this fall in the value of money is the result of our deliberate policy, or indeed can be anticipated or foreseen, than these supposed beneficial effects will never occur, since the approaching rise in prices will be taken into account in all transactions by reasonably intelligent people."⁷ The New Classical Macroeconomics explicitly incorporates the rational expectations mechanism whereby

7. Knut Wicksell, "Lectures in Political Economy," Vol. II 1935 edn., page 129.

reasonably intelligent people can learn to anticipate such price rises.

More complex macroeconomic models have been built wherein given rational expectations, the policy neutrality proposition is established.: Lucas (1972,a), Sargent (1973), Sargent and Wallace (1975,b), Barro (1976), McCallum (1980), McCallum and Whitaker (1979), etc. These models explore the macroeconomic behaviour underlying the Sargent and Wallace model described above, or investigate those aspects of policy not considered by it, such as pegging interest rates, pegging nominal variables, the impact of fiscal policy and built-in-stabilisers, and so on.

Robert E. Lucas (1972,a), for example, tries to reconcile empirically observed Phillips Curve relationships with the monetary-neutrality and policy-impotence argument within a framework in which all prices are market-clearing, all agents behave optimally in the light of their objectives and expectations, and all expectations are formed rationally. Building up from microeconomic behavioural equations for individual agents, postulating identical economic agent and aggregating, Lucas arrives at an abstract macroeconomic model in which the economy is divided into two physically separated markets, each trading in what is intrinsically the same good, but which

gets differentiated by virtue of the isolated markets. Traders get allocated across the markets in each period in a stochastic way thereby introducing fluctuations in the relative prices between the two markets. Another possible source of price changes arises from the stochastic, and not entirely predictable, changes in the quantity of money. Information on current prices is restricted to the particular market in which the individual is trading—while economic agents know the past values of the general price level, they can only guess its current value as they are assumed to have no information on the current price in the second market.⁸ That is, information on the current real and monetary disturbances is conveyed to agents only through the local price in the market in which each agent happens to be. Thus any change in the local price forces agents to assess whether it results from a relative real demand shift or from a nominal one. This would result in agents reacting to what are really fluctuations in the general price level as if they were, in part at least, changes in relative prices, thus changing real outputs - a non-neutrality of money which could explain empirically observed Phillips

8. This assumption is sought to be justified by arguing that in a multi-commodity world, no one observes all prices; an optimising trader processes only those prices crucial for his decision-making carefully and frequently, less important prices less carefully, and most prices not at all. Hence, information on prices conditioning forecasts is less than complete.

Curves. However, in the next period as the information on the prices in both markets for the previous period becomes available, the change in prices is recognised for what it was, as originating from the aggregate monetary disturbance - the confusion between aggregate and relative values is dispelled, and the change in the money stock no longer affects output, unless, of course, a fresh monetary disturbance occurs.

However, if the monetary authority repeatedly attempts to secure output changes via monetary changes then, with time, individuals will come to recognise the greater and increasing variability of the general price level as compared to that of the relative price, so that subsequent local price changes will come to be increasingly attributed to the monetary fluctuations, inducing therefore, smaller output responses. Or, as the monetary authority deliberately tries to exploit the Phillips Curve, it meets with diminishing success; the Phillips Curve begins to steepen with a worsening of the terms of the trade-off.⁹

Sargent and Wallace (1975,b) formulate a macroeconomic model (not derived from microeconomic behavioural functions, as is Lucas' model) to analyse the effects of alternative monetary policy rules.

9. This result is derived by Robert Barro (1976) as well.

Specifically they consider two strategies available to the government : one to peg the interest-rate period by period, adjusting money supply to accommodate whatever the demand for money at the pegged rate of interest, and two, to set the money supply period by period, accepting whatever interest-rate that equilibrates the system.

The aggregate supply in the economy is postulated as per the Natural Rate Hypothesis, varying in response to productive capacity (a combination of capital accumulated and labour) and, unanticipated inflation. Aggregate demand depends (inversely) on the expected real rate of interest, which is the nominal rate adjusted for anticipated inflation, on productive capacity, which is supposedly a measure of wealth, and a set of exogenous variables such as government expenditures, etc. The portfolio balance condition relates the demand for money to the price level, output and the nominal rate of interest. Productive capacity depends on its previous level, the real rate of interest, and on the exogenous variables, such as government tax rates, expenditures, etc.

The government then has a choice between two deterministic policy rules:

$$r_t = G \theta_{t-1} \quad (21)$$

$$m_t = H \theta_{t-1} \quad (22)$$

where r_t is the nominal rate of interest in period t , m_t , the logarithm of the money supply, and Θ_{t-1} the set of exogenous and endogenous variables, information on which is possessed both by the government and by the public, and which guides the government's choice of interest rate or money supply.

Then, following the argument in the model presented first, it is shown that under either rule the authority finds its attempts to control any of the real variables - the real rate of interest, productive capacity, output, completely foiled. The policy rule actually in effect is known to all agents and is accounted for in their anticipations. If the money supply is pegged at a certain level in response to fluctuations in the variables in Θ_{t-1} then the associated price level is anticipated by market participants, leading therefore to corresponding changes in nominal wages, nominal interest rates, etc. - real wage rates and the real interest rate are unaffected. If the interest rate is pegged, prices adjust, leaving the real rate unaffected. Hence, the real variables in the economy evolve as per exogenous processes - i.e. their distributions are independent of the parameters of the feedback rule. There is, therefore, no optimal policy with respect to the real variables; any one rule is as

good or as ineffective as any other.^{10.}

However, the monetary authority can still, if it so wishes, control the nominal variables in the economy. As Sargent and Wallace (1975,a) remind us, the new classical models are compatible with a policy designed to achieve and maintain any particular rate of inflation. By altering its money-supply, it could bring the public's anticipations in line with the chosen rate. However, a corollary of the neutrality argument is that as alternative rates of inflation have no real consequences, an extremely high rate of inflation which is fully expected is equivalent to a low, expected rate.^{11.}

10. In Robert Barro's (1976) model, which is an extension of Lucas' model with economic agents unable to sift the nominal from the real components of a disturbance, if the monetary authority aims to minimise the variance of output over time, then the optimal money supply rule is one which minimises the monetary variance itself. That is the variations in monetary growth causing the aggregate-relative confusion and the consequent fluctuations in output must be minimised. A policy rule satisfying this criterion of optimality is Friedman's (1968) constant λ , % monetary growth rate rule, which is completely predictable (with Zero-variance of the monetary growth). In the context of any feed-back rule, with random elements (such as equation (17)), the output variance is minimum when the variance of the disturbance term is minimum. That is, the monetary authority must follow a steady path of money growth.
11. However, this implication of the neutrality argument appears unrealistic as discussed later in the chapter.

McCallum and Whitaker (1979) investigate the neutrality proposition with respect to activist fiscal policy and built-in-stabilisers. Their aggregate demand equation,¹² therefore, explicitly includes terms in real government spending on goods and services (g_t) and real tax liabilities net of transfers (Z_t) both in logarithmic terms. To distinguish between automatic or built-in-stabilisers and policy feed-back rules, they assume that the fiscal authority holds tax rates fixed, not changing them in response to economic conditions, so that tax liabilities depend only on current output. On the other hand, government expenditures are determined as per a feedback rule, changing systematically in response to past values of aggregate variables. Specifically, Z_t and g_t are described by :

$$Z_t = \tau_0 + \tau_1 y_t \quad (\tau_1 > 0) \quad (23)$$

$$g_t = \gamma_0 + \gamma_1 g_{t-1} + \gamma_2 y_{t-1} \quad (\gamma_2 < 0 < \gamma_1 < 1) \quad (24)$$

Hence, tax liabilities are positively related to current output measured in logarithms, y_t . Government spending is partly autoregressive, and partly dependent (inversely)

12. These models with explicit aggregate demand and supply equations seem to follow the Keynesian line of modelling, as contrary to the Monetarist practice which accords importance to the money-stock-velocity equation.

or counter-cyclically) on the most recently observed value of output, Y_{t-1} .

Next, the model's IS and LM functions are specified as :

$$Y_t = b_0 + b_1 [r_t - E_{t-1}(P_{t+1} - P_t)] + b_2 g_t + b_3 z_t + v_t \quad (b_1, b_3 < 0 ; b_2 > 0) \quad (25)$$

$$m_t = p_t + c_0 + c_1 Y_t + c_2 r_t + e_t \quad (26)$$

$(c_1 > 0 ; c_2 < 0)$

Output, Y_t , is inversely related with the expected real interest rate (nominal rate r_t , adjusted for the anticipated inflation) and tax payments, z_t , and positively related with the amount of government spending. The demand for real balances ($m_t - p_t$), m_t representing the logarithm of the money stock and p_t the logarithm of the price level in period t , depends on current output and the nominal rate of interest. Expectations are rational, with no difference in the information available to the government and the public, either with respect to economic data, the model describing the economy or the set of government policies. e_t and v_t are the disturbance terms.

The equilibrium solution for output is then shown to be independent of the parameters of the rule governing g_t . Any change in government spending is estimated from information on g_{t-1} and y_{t-1} , the consequent impact on aggregate spending (assessed from (25)) and on the price level, estimated in advance. As price anticipations are thus altered, private spending adjusts and accommodates the increased government expenditure, ^a leaving aggregate output unaltered.

However, the tax-rate parameter, τ_1 , does influence the level of output indicating, therefore, the efficiency of built-in-stabilisers as opposed to the impotence of the activist feedback rule. This is so because tax liabilities are determined automatically in the equilibration process. While government spending and expectations thereof require knowledge of economic aggregates, the tax liability of each economic agent is computed only with respect to his own current income or output, requiring no such knowledge of aggregate variables. Thus, for example, an exogenous shock increasing aggregate supply, implies that each individual agent finding his output and income increased, transfers a larger amount as taxes to the government, thereby reducing his disposable income for spending, reducing the upward pressure on prices, and hence counteracting

in part at least, the response of outputs to the increased demand and prices. The impact of the disturbance is reduced. In fact, the higher is τ_1 (the ratio of the marginal to the average tax rates), the higher the progressivity in the tax structure, the greater the built-in-stability, which the authority can fruitfully exploit.¹³

If the authority were capable of setting its expenditures and money supply in the light of immediate information on output (i.e. y_t), the feedback occurring from current aggregate values, then their activist policies could also stabilise the economy, for this information, not being available to individuals, would lead, therefore, to inaccurate predictions of policy instruments. But McCallum and Whitaker argue that there is a lag with which aggregative information becomes available, both to the government and to the public, and feedback rules must therefore be in the context of previous (the most recently observed) values of economic aggregates, which, again, are known both to the authority and to market participants. On the other hand, "the distinctive effectiveness of built-in-stabilisers results because they serve to decentralise the setting of control values

13. The model, however, does not consider the ~~distinctive~~ distinctive effects on labour supply arising from very high marginal tax rates. Realistically, increasing τ_1 could impart greater stability to output, but it could also lead to diminished work effort and output levels.

so that no single decision requiring aggregative information, and hence, delayed reaction, is needed." 14.

However, as McCallum and Whitakar admit, equations (23) and (24) appear to be somewhat implausible as descriptions of fiscal policy. Equation (23) relates tax liabilities to current real output implying either that taxes are indexed to account for price variations, or that the tax schedule is a proportional one. An alternative treatment would be to relate nominal taxes $(z_t + p_t)$ to nominal income $(y_t + p_t)$. Equation (24) on the other hand, assumes that the the government can control real spending for period t , which implies that whatever the price increase in that period, nominal expenditures are revised upwards to ~~keep~~ real government purchases intact. However, larger increases in nominal expenditures could imply larger budget deficits and the government may not wish to raise tax rates or increase its borrowing or money issue to finance the increased expenditures. It would then be preferable to assume that the government aims at a particular level of nominal spending, $g_t + p_t$, ^{in such a way that expected real expenditures} $(g_t + p_t - E_{t-1} p_t)$ are set at the desired level. With these alterations in (23) and (24), McCallum

14. B.T. McCallum and J.K. Whitkar, "The Effectiveness of Fiscal Feedback Rules and Automatic Stabilisers Under Rational Expectations", JME, 1979.

and Whitaker proceed to show that output is still independent of the government's expenditure rule, though dependent on the tax-rate parameter.

POLICY EVALUATION :

The main thrust of the above arguments is then, that empirically observed relationships such as the Phillips Curve, should not be construed as offering policy-makers any substantial control over the economy. Lucas (1976), in fact, believes that empirical estimates of the reduced form relationships of macroeconomic models are quite misleading in forecasting the efficacy of alternative policy regimes. However, successful these models may be in short-term forecasting, they provide no useful information on the actual impact of alternative economic policies.

Lucas describes the economy by a vector of state variables, y_t , exogenous, forcing variables, x_t and a vector of random shocks, ϵ_t . The motion of the economy is determined by

$$y_{t+1} = f(y_t, x_t, \epsilon_t) \quad (27)$$

along with a description of the distribution of ϵ_t , and

the behaviour of x_t over time. The function, f , though fixed is not directly known. The task of the econometrician is then to estimate f , the normal econometric practice being to specify a functional form F in advance, and then estimate a vector ^{of} parameters, α , relating y_{t+1} to y_t and x_t , such that y_{t+1} can be estimated via $F(y_t, x_t, \alpha, \epsilon_t)$; i.e.

$$f(y_t, x_t, \epsilon_t) \equiv F(y_t, x_t, \alpha, \epsilon_t) \quad (20)$$

A policy is then defined as a specification of some of the components of x . Given F and the α estimates, policy evaluation is apparently simple; examine the changes brought about in y by alternative specifications for x .

However, an important assumption in this approach to policy evaluation is that the function F and the values of the parameter vector α are invariant with respect to any proposed policy changes: the estimates of α which are obtained from past sample values when a certain set of policies was in force will, in the future, continue to describe the relationship between the dependent variable (y_{t+1}) and the observed explanatory variables (y_t, x_t) when a different set of policies will be in operation.

But Lucas points out, the components of the F function are really behavioural relationships - demand

and supply functions of economic agents - which incorporate their expectations of the future. As these expectations alter, their optimum demand and supply decisions also change and the relationship between the dependent and the observed explanatory variables is different. To assume that F and α are stable or invariant under alternative policy rules is to assume that economic agents' expectations of policies and their expected impact on the variables that are important to them are invariant in the face of policy changes. And this, Lucas asserts, is an extreme assumption.

To illustrate the point, Lucas refers to the aggregate consumption function formulated by Milton Friedman (1957) wherein permanent consumption is proportional to permanent disposable income, the later being an estimate of a discounted (expected) future disposable income stream. The deviations of current consumption from permanent consumption, and of current income from its permanent level are postulated to be transitory and random. An econometric estimate of the consumption function may, for example, proxy permanent income by a weighted average of current and past observed income, and thereby relate current consumption to observed values of income. Now, if the policy maker wishes to examine the impact of a permanent, constant increase in disposable income of \bar{X} (e.g. via a tax cut) then ^{the} forecasted increase

in consumption from the econometrically estimated consumption function may prove erroneous. If the policy change is understood in advance by economic agents, then their (permanent) consumption is immediately revised upwards by the same proportion as the increase in permanent income (\bar{y}). However, the consumption function formulated for estimation does not permit expectations of future income to change with expectations of a change in policy : the distributed-lag estimate of permanent income does not account for the expected change of \bar{y} in permanent income, and hence actual consumption increases are underestimated. Or, the measured marginal propensity to consume is apparently increased (i.e. the marginal propensity to consume from the econometrician's measured permanent income is higher) Consequently, the policy-maker is misled by the econometric estimates of the consumption function when evaluating the impact of a proposed permanent increase in disposable income.

Reverting to the Phillips Curve, estimates of the output-inflation trade-off obtained when a particular set of policies was in force, will be misleading in forecasting future output and inflation rates when policy changes are proposed. That is, if the authority deliberately sets out to exploit the trade-off and raises the rate of money growth then, as economic agents come to learn of the

policy change, they anticipate the increase in the rate of inflation consequent upon the increased monetary expansion, and accordingly revise their demand and supply decisions. While the parameters of the decision rules describing their responses to expectations remains the same, the parameters relating their expectations to observed variables change. Then, the observed values of the trade-off may be quite different from what was anticipated from the past sample.

For any meaningful evaluation of the alternative policies proposed, the authority must ~~take~~ account for individuals' expectations of policies, how they are altered when policies are modified, and what is the consequent impact of these revised expectations on their economic behaviour.

BUSINESS CYCLES :

If economic agents' expectations are rational, if their information sets include all lagged values of variables, including their forecasts, then their forecast errors must be serially uncorrelated. Therefore, on an average, there will be no systematic relation between the expectational error in any one period with that of any other period. Fluctuations in output and employment, however, are shown to originate from forecast errors and

hence, the new classical models appear incapable of explaining the serially correlated movements observed in output, employment etc.

The new classical theory must apparently depend on serially correlated disturbances to the aggregate supply function to explain business cycles; " the natural rate itself fluctuates,.... variations in unemployment rates are substantially changes in voluntary, frictional or structural unemployment rather than in involuntary joblessness due to generally deficient demand."¹⁵.

Reverting to the labour market specifications, the argument implies that serially correlated movements in output and employment are caused by systematic shifts in demand and supply and the resulting equilibrium, rather than by movements away from and towards their intersection (Tobin, 1980)^a. That is, as labour demand curves shift with changing technology, and as labour supply curves shift with changing preferences between work and leisure, serially correlated movements in employment and output are visualised as resulting from similar movements of technology, tastes, etc. Economic fluctuations are then simply the moving equilibria of the economy's markets.

15. James Tobin, " How Dead if Keynes ? ", Economic Inquiry, October 1977.

However, Lucas and Sargent (1981) consider this criticism fallacious on the grounds that it confuses between "sources of impulses and propagation mechanisms"¹⁶. While an unforeseen monetary expansion, for example, provides the aggregate demand impulse for a movement of unemployment and output away from their natural levels, there could also be a propagation mechanism at work. The latter converts these impulses from the serially uncorrelated forecast errors into serially correlated movements in output, employment and other variables. This point is illustrated below.

Lucas (1975, 1977) describes one such propagation mechanism embodying the accelerator principle of capital stock adjustment to perceived relative price and output (demanded) changes. First, each producer must assess whether a given shift in the relative price of his product is only a transitory one, or one which is likely to endure in the future as well (signal processing). If it is judged to be purely temporary, a rise in the relative price will be met with an increased employment of labour, for investment is more of a long term commitment responding, therefore, to what are viewed as permanent or enduring shifts in relative prices. However, given that producers can only imperfectly discern the transitoriness or

16. R.E. Lucas and Thomas Sargent, "After Keynesian Macroeconomics" in "Rational Expectations and Econometric Practice", edited by Lucas and Sargent, 1981.

permanence of a relative price movement, it seems plausible that their response to the price signal is a mixture of both, an increase in employment of labour and of capital. Secondly, a firm may opt for a staggered adjustment of its capital stock to the optimal equilibrium level; the costs of capital accumulation may vary with its rapidity, there may be gestation lags between the initiation and completion of investment projects, there may be uncertainty regarding future demand and cost shifts, etc.

In such a scenario, if producers further confuse general price movements for relative ones, then an initially unforeseen expansion in aggregate demand can set in motion a movement in employment, capital accumulation and output. That is, if a monetary disturbance were correctly perceived by all, it would result in an increase in absolute prices alone. If, however, producers mistake the price rise to be in favour of their respective products alone (as in Lucas (1972, a)), and possibly permanent, then optimal capital and labour employment decisions are revised, employment and investment increase. However, with time as information on price rises in all other markets begins to filter through, producers recognise their error. In the meanwhile, as capital and employment gradually adjust upwards, the added capacity in firms resulting in increased outputs, retards the price rise, thus postponing the recognition of the magnitude of the initial shock. In such

a way, a monetary (or fiscal) disturbance and the associated forecast error in one period can lead to much longer swings in prices, employment, output etc.

The downturn is built into this enlargement of productive capacity. When producers finally recognise that the price rise was really a case of general inflation, and not restricted to their own products, they will have to cut back their output - investment will have to be at a rate lower than the initial one as capacity readjusts downward. Thus, in principle, serially uncorrelated forecast errors can initiate serially correlated movements in output and employment.

LOOPHOLES IN THE NEW CLASSICAL MACROECONOMICS.

The dramatic conclusion that monetary and fiscal policies cannot systematically affect the time path of real economic variables led economists to search for the possible loopholes in the new classical macroeconomics, such that the policy maker could be rejuvenated.

To begin with, William Fellner (1980) contends that government policies need not always be neatly divisible into systematic and unsystematic components. The systematic policies and the unsystematic shocks usually come in a single package, and it may be difficult, if not impossible, to separately identify the two. G. Haberler (1980,a)

considers it a drastic simplification to divide government measures into two clear-cut categories - one systematic and fully predictable, the other non-systematic and unpredictable. Realistically, government policies are spread out over the whole range between the systematic and unsystematic, such that the question is not one of the systematic versus the random, but one of more and less predictable.

For example, Fellner describes a government policy with no detectable system behind it. The authority may be following a policy of accommodating "a given so-called underlying rate of inflation,"¹⁷ continuing to adjust monetary growth to accommodate the inflation as it accelerates. Later, however, it may shift its stance adopting a restrictive monetary policy, the shifts in monetary growth rates occurring at different levels of acceleration in the inflation rate. Individuals may then be extremely uncertain regarding the timing of the shifts, and their decisions may allow for large risk-allowances in the face of the highly uncertain and unpredictable course of future inflation rates. The government's policy of restricting monetary growth, not being fully anticipated, would produce the real effects on output, interest rates employment, etc.

17. William Fellner, "The Valid Core of Rationality Hypotheses in the Theory of Expectations", JMCB, 1980

Another obvious criticism is that economic agents may not be aware of the policy rule, even if it were completely systematic : the government has superior information about its own future actions, and hence, agents no longer make unbiased predictions of the policy maker's decisions.

John Taylor (1975) considers the case when there is a structural shift in monetary policy; the economy is assumed to be operating under one policy rule for a very long time, and economic agents have been forecasting with reference to that particular rule when, suddenly, the authority adopts a new rule. As individuals cannot instantaneously recognise the changed pattern of policy rules it seems possible that they will, for some time at least, hold a systematically incorrect view of the policy in effect. Later, as time passes and fresh data is acquired, people would gradually learn about the new policy rule. But during the transition period, in the early stages of policy watching, previously held beliefs of policy will affect predictions leading to forecast errors : the government can then influence the real variables. In such a case, Taylor shows that while agents continue to forecast as per the old policy rule, the government can predict their forecast errors. Then, an optimal policy rule can be constructed in which the output and welfare gains from reductions in unemployment (via. the changed policy and the

consequent forecast errors) are set against the possible loss resulting from the public's increasing uncertainty regarding the price level and the resulting distortion in resource allocation. As the unemployment reductions are possible only in the transitional period of learning the new policy, and as unemployment must rise to its original level when the new policy rule is correctly understood, the optimal policy rule will also depend on the policy-makers' rate of time preference.

However, Sargent and Wallace (1975,a) point out that new rules are not adopted in a vacuum; the policy change occurs in response to some event - a change in administration, new appointments, etc. And if policies can be and are changed, rational agents would account for such possibilities as well and try to fathom the process generating such changes. Such complete rationality would then rule out all freedom for the policy maker. "For in a model with completely rational expectations including a rich enough description of policy, it seems impossible to define a sense in which there is any scope for discussing the optimal design of policy rules. That is because equilibrium values of the endogenous variables already reflect, in the proper way, the parameters describing the authorities' prospective subsequent behaviour, including the probability that this or that proposal for reforming policy will be adopted."¹⁸

18. Thomas Sargent and Neil Wallace, "Rational Expectations and the Theory of Economic Policy", June, 1975.

On the other hand, there may be a definite role for monetary and fiscal policies if the authority has superior information on the state of the economy, than the public does, this informational advantage being included in the policy rule. Such an informational discrepancy could result when there are economies of scale in information gathering and processing which could be usefully exploited by the authority rather than by individual economic agents. The government may then for example, be able to recognise shocks to aggregate demand and supply much before they are learnt of by individuals, and accordingly adjust its policy instruments to offset them, stabilising output and employment along their secular trends. Barro (1976) examines the case where an unanticipated disturbance reduces aggregate demand, which, if recognised immediately, would simply cause an equi-proportionate cut in prices, but producers, again falling prey to the aggregate - relative confusion, would begin to reduce outputs. The monetary authority having immediately identified the nature and the magnitude of the shock would adjust monetary growth upwards, to neutralise the impact of the shock — output does not, then, deviate from its "full information" ¹⁹ level, the latter associated with that level of information with which agents are promptly able to separate the absolute from the relative price movements.

19. Robert Barro, "Rational Expectations and the Role of Monetary Policy", JME, 1976.

However, since this stabilisation policy works by preventing a confusion between the relative and absolute price movements, Barro suggests that an alternative to such a policy would be the elimination of the informational discrepancy. The more rapidly received observations on aggregate variables could be conveyed to agents, augmenting their information sets, and avoiding the confusion between real and nominal disturbances. But there may be costs involved in transmitting the necessary information rapidly to the public, in which case the activist stabilisation policy could be the better alternative. Furthermore, as Barro acknowledges, if individuals are aware of the existence of active stabilisation policy, they may find it optimal to reduce their expenditure on gathering information on changes in demand, the nature of price movements, etc.

R. J. Gordon (1976), however, views this differential access to information as "an implausibly weak reed upon which to rest a counterattack against the Application of Rational Expectations to Economic Policy".²⁰ In modern economies, data on prices, interest rates, outputs, etc, are published in newspapers only a few days after they are compiled and economic agents could be as well or as poorly informed about the economy as the government.

However, as Feige and Pearce (1976) claim, if learning about the true structure of the economy is a complicated, long

20. R. J. Gordon, "Recent Developments in the Theory of Inflation and Unemployment", JME, 1976.

drawn out process, not necessarily resulting in accurate knowledge about the relationships between variables, agents may, in fact, discard the rational expectations scheme in favour of the less expensive, adaptive - expectations scheme, as discussed in Ch. II. Then, the consistent errors resulting from this forecasting procedure could grant the authorities a measure of control over the real variables.

A much more forceful line of criticism against the Rational Expectations literature is its complete neglect of institutional rigidities, in particular the rigidity of wages and prices. The Natural Rate Hypothesis and its Rational Expectations version assume that prices and wages are perfectly flexible, adjusting instantaneously to equate demands with supplies, and hence continuously clearing all markets. The entire thrust of the policy ineffectiveness proposition requires all anticipated changes in monetary and fiscal variables to get transmitted directly to prices, the latter flexible enough to adjust to the changed anticipations. And as Tobin (1980,a) argues between the two pillars of the New Classical Macroeconomics, rational expectations and continuous market clearing, it is the second which is crucial for its far reaching implications. That is, systematic policies retain their effectiveness when wages and prices are inflexible, even though expectations may be formed rationally, as discussed below :

Tobin reminds us that while the older classical

theorists did postulate flexible prices, they did not expect markets to be clearing continuously. In fact, it was acknowledged that the system could generally be in disequilibrium, en route from one equilibrium situation to another. The dynamics of the New Classical Macroeconomics, including the business cycle, are, by contrast, those of moving equilibrium, not of disequilibrium adjustment. Such a scenario of continuously cleared markets does not accord with observed facts - orders not filled, stocks unsold, prices set at certain levels and changing only at discrete intervals, with buffers such as inventories and order backlogs to absorb the excess supply and demand at the administered prices. The literal application of the market clearing postulate, therefore, constitutes "a severe draft on credulity"²¹.

Prices and wages are more often than not, fixed for certain lengths of time as, for example, through wage and price contracts. Such sluggish wage and price adjustments to changes in demand could be the outcome of optimising behaviour. A. Okun (1975), for example, explains how long-term contracts or price fixity may be prevalent in product markets. Firms have an incentive in maintaining stable prices, refraining from frequent price adjustments to short-run changes in demand, so as to encourage buyers to avoid searching other firms' prices, instead, returning to their customary suppliers, using the

21. James Tobin, "Asset Accumulation and Economic Activity," 1980.

previous price as a useful guide to its current value. Buyers, in a turn, may be willing to pay their suppliers a premium to avoid frequent price changes, thereby saving themselves the cost involved in search. Thus, price fixity may result from a no-search relationship which tacitly develops between sellers and their customers.

Heterogenous labour and costly search may result in wage-contracts in the labour market (Gordon, 1976). Wages would be perfectly flexible if employers, for example, could be sure that the unemployed job-applicants are perfect substitutes for the incumbent workers. Almost every job, however, is idiosyncratic involving some special skills acquired only with experience. This naturally places incumbent workers in a more favourable position as against equally qualified, but inexperienced bidders, enabling them, therefore, to demand a part of the costs saved to firms through their isiosyncratic experience. Thus a part of their wages are really monopoly rents which would be lost by quitting. Hence, firms may delay raising their wages, being aware that their employees would lose their monopoly earnings by quitting; at the same time employees gain back the increments which could have been earned in periods of expanding demand, but which are not in fact earned because of the fixed contractual arrangements, by avoiding the wage cuts that would have occurred in the absence of contracts, in periods of recessions. Workers may be risk-averse, disliking variability in their incomes, therefore, preferring contracts with their employers

whose payments then consist partly of pecuniary wage payments and partly of insurance services.

Then, as Gordon (1976) notes, if the economy consists of both auction and fix-price markets, then economic agents would not expect prices to change frequently in the latter. Or, a rational expectation of the price level would incorporate the extent of the inflexibility.

But if wages and prices are thus unresponsive to changes in demand and supply, the policy - ineffectiveness proposition loses its validity. Starting from an equilibrium position where prices and wages are fixed at their market clearing values, if there is a fall in money supply, then at the prevailing prices there would be a drop in demand - firms and workers find themselves unable to sell as much as they want to at the ruling prices. Their sales, and, hence outputs, are effectively constrained. Even if the government's policy had been perfectly anticipated, the rigidity of wages and prices renders it non-neutral or effective with respect to real variables. In fact, even if prices and wages were partially flexible, as long as there is some rigidity preventing their readjustment to the levels necessary to restore demand to its original pre-monetary-contraction level, a part of the effect of the monetary action will be seen in terms of changes in employment and output.

Further, as Phillip Cagan (1980) points out, if prices and wages are set and are unresponsive to short-run

changes in demand, then the price-stickiness gets intensified by an additional element - the uncertainty regarding the behaviour of other firms and industries in periods of decreases in nominal demand. All firms in the economy may be aware that a given fall in demand has resulted from a tight monetary policy and that a decrease in wages and prices throughout the economy could restore this demand to its initial level. However, for wages and prices, to be actually lowered requires a degree of coordination between all firms, buyers and sellers. A firm can hope to restore its sales to the original level by reducing its prices, but it will do so only if it were confident that its costs would also decline equiproportionately, which will be the case only if the input suppliers reduced their prices. Not knowing how its suppliers will respond, the firm decides to wait and see what happens to the input price and the general price level. If everyone acts likewise, prices are rendered stickier. The fall in demand turns out to be a fall in real demand, and consequently output diminishes. This reduction in output should be attributed to the lack of coordination between firms, for even if all know that a certain cut in prices would restore demand making them all better off, no one has an incentive to be in the vanguard.

S. Fischer (1979), and Phelps and Taylor (1977), have formulated macroeconomic models to demonstrate that monetary policy can be effective given the existence of long-

term contracts in the economy, even if expectations are formed rationally, Fischer, for example, assumes labour contracts drawn up for two periods; that is, the contract drawn at the end of period t fixes the nominal wage for periods $t+1$ and $t+2$, and so the anticipated real wage is maintained constant over the two periods. The contractual arrangement is specified as:

$${}_{t-i}W_t = {}_{t-i}P_t \quad i=1,2. \quad (29)$$

where W_t denotes the logarithm of the nominal wage rate at period t , ${}_{t-i}W_t$, its contracted value in period t , the contract drawn up in period $t-1$ or in period $t-2$, P_t is the logarithm of the price level in period t , and ${}_{t-i}P_t$, its anticipated value, anticipations formed rationally using information available through period $t-i$.

Aggregate supply is assumed to be a simple decreasing function of the real wage:

$$\gamma_t^s = (P_t - W_t) + u_t \quad (30)$$

where γ_t^s is the output supplied, and u_t is a stochastic term causing real disturbances to output levels.

The demand side is expressed via a velocity equation:

$$\gamma_t = M_t - P_t - v_t \quad (31)$$

where M_t is the logarithm of the money stock in period t , and v_t is a disturbance term.

Each of the disturbances is assumed to follow a first-order autoregressive scheme:

$$u_t = \rho_1 u_{t-1} + \epsilon_t \quad |\rho_1| < 1 \quad (32)$$

$$v_t = \rho_2 v_{t-1} + \eta_t \quad |\rho_2| < 1 \quad (33)$$

In each period t , half the firms in the economy are subject to contracts drawn up in the preceding period, $t-1$, while the other half are operating under contracts drawn up at the end of $t-2$. Hence, the total output supplied is given by:

$$\begin{aligned} Y_t^s &= (1/2) (P_t - {}_{t-1}W_t) + (1/2) (P_t - {}_{t-2}W_t) + u_t \\ &= (1/2) \sum_{i=1}^2 (P_t - {}_{t-i}W_t) + u_t \end{aligned} \quad (34)$$

Substituting from (29)

$$Y_t^s = (1/2) \sum_{i=1}^2 (P_t - {}_{t-i}P_t) + u_t \quad (35)$$

The money supply rule is assumed to be set on the basis of a feedback of information on the demand and supply disturbances (the authority possessing information till the end of $t-1$), presumably with a view to offset the shocks by suitable changes in money supply. That is,

$$M_t = \sum_{i=1}^{\infty} a_i u_{t-i} + \sum_{i=1}^{\infty} b_i v_{t-i} \quad (36)$$

Combining equations (35) and (31), that is equating aggregate demand and supply :-

$$P_t = \frac{1}{4} {}_{t-1}P_t + \frac{1}{4} {}_{t-2}P_t - \frac{1}{2} (u_t + v_t) + \frac{1}{2} M_t \quad (37)$$

Taking expectations, with $E_{t-2}({}_{t-1}P_t) = {}_{t-2}P_t$, the expression for the $(t-2)^{\text{th}}$ the period's anticipation of P_t is

$${}_{t-2}P_t = {}_{t-2}M_t - {}_{t-2}(u_t + v_t) \quad (38)$$

Then, substituting from (38) for ${}_{t-2}P_t$ in (37) and taking expectations again for ${}_{t-1}P_t$ yields

$$\begin{aligned} {}_{t-1}P_t = & (2/3) {}_{t-1}M_t + (1/3) {}_{t-2}M_t - (1/3) {}_{t-2}(u_t + v_t) \\ & - (1/3) {}_{t-1}(u_t + v_t) \end{aligned} \quad (39)$$

Since money supply is set only with respect to information available till $t-1$, the expectation of money supply for period t based on the same information along with information of the money supply rule (36), is

$${}_{t-1}M_t = M_t \quad (40)$$

However, the expectation of M_t formed in $t-2$ would be based on a smaller information set, containing observations only through period $t-2$:

$$\begin{aligned} {}_{t-2}M_t = & E_{t-2} \left(\sum_{i=1}^{\infty} a_i u_{t-i} + \sum_{i=1}^{\infty} b_i v_{t-i} \right) \\ = & E_{t-2} (a_1 u_{t-1} + b_1 v_{t-1}) + \sum_{i=2}^{\infty} a_i u_{t-i} \\ & + \sum_{i=2}^{\infty} b_i v_{t-i} \end{aligned} \quad (41)$$

From equations (32) and (33),

$$E_{t-2}(a_1 u_{t-1} + b_1 v_{t-1}) = a_1 \rho_1 u_{t-2} + b_1 \rho_2 v_{t-2}$$

Hence,

$${}_{t-2}M_t = a_1 \rho_1 u_{t-2} + b_1 \rho_2 v_{t-2} + \sum_{i=2}^{\infty} a_i u_{t-i} + \sum_{i=2}^{\infty} b_i v_{t-i} \quad (41)$$

Therefore,

$$\begin{aligned} M_t - {}_{t-2}M_t &= a_1 (u_{t-1} - \rho_1 u_{t-2}) + b_1 (v_{t-1} - \rho_2 v_{t-2}) \\ &= a_1 \epsilon_{t-1} + b_1 \eta_{t-1} \end{aligned} \quad (42)$$

When wages are set in period $t-2$, a part of the money supply corresponding to the monetary authority's response to the disturbances in $t-1$ (unknown to agents in $t-2$), remains unanticipated. The impact of this component of money supply on prices cannot be estimated in $t-2$ when a part of the contracts was drawn up.

Then, combining equations (35), (37) - (41), and using equations (32) and (33), the solution for output is :-

$$\begin{aligned} y_t &= (1/2)(\epsilon_t - \eta_t) + (1/3) [\epsilon_{t-1}(a_1 + 2\rho_1) + \eta_{t-1}(b_1 - \rho_2)] \\ &\quad + \rho_1^2 u_{t-2} \end{aligned} \quad (43)$$

The parameters, a_1 and b_1 , of the policy rule now clearly affect the behaviour of output, even when their values are

fully known. For, in the intervening period between the drawing up of the two-period contract and the last period of its operation, the monetary authority receives new information about the recent ($t-1$) economic disturbances to which it can react, thereby affecting the ex post real wage, and hence, outputs.

In fact, given that long-term nominal contracts exist, the authority may try to secure enduring increases in output, over and above its normal secular growth rate, via monetary expansion, after the contracts are drawn up. However, Lucas and Sargent (1981) and Fischer (1979) suggest that one should not regard the structure of contracts in the economy as invariant with respect to alternative monetary and fiscal policy regimes. An attempt made by the authority to exploit the existing contracts, resulting in price and output levels far different from those envisaged when the contracts were initially drawn up, would lead to a reopening of contracts to account for the new price levels in real wage anticipations. And if the government persisted in its attempt to exploit the contract-structure and manipulate prices and employment, a new structure of contracts could evolve, such as one with effective indexation, with nominal wages changing to offset price changes. The structure of contracts in the economy is, therefore, likely to respond to alternative policy regimes.

The new classical explanation for the observed price-output correlation and business cycles relies heavily on restrictions on the information sets conditioning agents' expectations. The misperceptions view which postulates that agents have imperfect information about prices in other markets with the consequent confusion between relative and absolute price movements, is presumably based on the view that there are positive costs associated with gathering information from markets in which agents are not operating. Okun (1980), however, finds it implausible that important information which could dispel the aggregate-relative confusion and the resulting misallocation of resources, should be so costly as to outweigh its value to rational agents. In fact, as noted earlier, market participants obtain a virtually costless flow of information from the reporting on monthly indices of consumer - and producer - prices in newspapers. Similarly, labour suppliers, as in the Natural Rate Hypothesis, are assumed to confuse nominal wage increases, generated by monetary expansion, with increases in real wages, being supposedly unaware of the rise in the prices of final products. But as Okun asks : "How much of an effort is required within the family to ensure communication between workers and shoppers ?"²². Hence, if a piece of information is missing

22. Arthur Okun, "Rational-Expectations-with - Misperceptions as a Theory of the Business Cycle", JMCB, 1980.

it is unlikely that it would remain missing for any prolonged period of time; the aggregate-relative confusion cannot persist for any length of time sufficient to generate a Phillips Curve. On the other hand, by acknowledging the wage-price rigidity one could more easily explain the correlation implied in the Phillips Curve, where increases in aggregate demand get absorbed partly in increased employment and output, and only partly in wage and price adjustments.

Moreover, if as in the equilibrium business cycle, the fluctuations in unemployment are caused only by the optimal responses of workers to changing wage rates, changed preference for leisure at the going wage rate, voluntary quits from jobs in the face of wage cuts to search for better employment elsewhere, then as Tobin (1980a) notes, workers would not really be reporting themselves as unemployed. Further, as Gordon (1976) remarks, the new classical models strain reality by forcing all entry to unemployment through voluntary quit decisions, with no explanations for dismissals and layoffs. Moreover, real world employees are not forced to be unemployed when searching for better jobs: with the advance in modern communication methods, each worker can sample an array of wage offers without any prior need to quit from his current job. For example as Gordon observes, any white-collar worker can search for an alternative job using his company telephone on company time.

Another question raised by Tobin (1965, 1980a) is regarding the neutrality of anticipated monetary changes. An anticipated rise in the monetary growth rate and a rationally expected

increase in the rate of inflation, will cause a real change: the real rate of return on money holdings, which depends inversely on the expected rate of inflation, is reduced, thereby initiating a portfolio adjustment. Individual wealth owners may reduce their money holdings in favour of real assets, for example, leading to a realignment of their real rates of return. Fischer (1979), for example, considers the effect of anticipated inflation on capital accumulation. In particular, his model shows how an anticipation of a monetary expansion in the future period, prompts agents to quickly readjust their asset holdings in expectation of the future price rise; money balances are adjusted to the (expected) future desired levels, the portfolio shift resulting in an investment in real assets (capital), the menu of assets being assumed to be restricted to money and capital stock. The fresh capital accumulation generates output increases, and this process begins even before money supply is actually expanded.

As mentioned earlier, if fully anticipated monetary expansions result only in fully anticipated changes in inflation with no real consequences, then there is no criterion by which the authority could choose between extremely high and moderate monetary growth rates. Any fully anticipated monetary growth rate (with the associated fully anticipated inflation rate) is as good as any other. Realistically, however, extremely high rates of monetary growth could weaken the people's confidence in the currency system and could ultimately lead to the collapse of the monetary payments system.

Hence, the policy ineffectiveness argument of the New Classical Macroeconomics is subject to a number of qualifications. One could even say that it is in essence a long-run result, that during transitional periods when people are still in the process of guessing the exact pattern of the policy rule, when wages and prices show sluggish adjustment in response to shifts in demand, and so on, there is still room for manoeuvre by the authority. The main core of the new classical economists' arguments is then that policy makers should be cautious in using empirically observed macro-relationships as a guide to their future policy decisions. The economic behaviour of individuals reflecting their responses to economic policies will depend upon expectations of economic policies, and empirical observations and econometric estimates of the structure of economic behaviour under one policy regime, could become obsolete when a change in policy is contemplated. If the exact impact of the new proposed policy is to be estimated, then policy-makers must first estimate the public's expectations of policies, and whether they are likely to be revised with a change in policy.

IV

EMPIRICAL EVIDENCE

Empirical tests of the Rational Expectations Hypothesis have, in the main, proceeded along two lines : one, tests of the Rational Expectations Hypothesis as a forecasting procedure, based on survey evidence on the expectations formulated by market participants in practice, and two, econometric tests of macroeconomic models incorporating rational expectations and yielding the policy-neutrality result, the latter thus implying joint tests of the rationality and neutrality postulates.

RATIONAL EXPECTATIONS

Sample surveys which elicit information on expected values of variables and the forecasting procedures used by respondents constitute direct evidence on individuals' formation of expectations. One such exercise by Heady and Kaldor (1954) involves a study of farmers' expectations of the future prices of specific agricultural commodities; a sample of 200 farmers from Iowa, U. S. A., was selected in August, 1947, and questioned about their price expectations at six month intervals between December, 1947 and June, 1949.

While Heady and Kaldor made no specific attempt to test alternative expectations models, one of the impressions

reportedly gained from interviewing farmers was that no single, uniform procedure was employed by all of them; in fact, the same farmer often used more than one procedure over the particular time period and for the different commodities, according to the quantity and reliability of the information available. For example, in December, 1947, some producers simply referred to their experience following World War I to infer that prices would similarly decline in the period following the second war. A more common procedure adopted was to, first, formulate a tentative forecast of future prices from the information contained in the current and previous observed prices, and then make suitable adjustments to account for the expected changes in the demands and supplies of the commodities concerned.¹ Only in those cases where farmers had little information on the demand and supply forces, were expectations based only on the current prices or the recent price trend. More, importantly, producers often visualised a distribution of possible future prices along with a rough idea of the likelihood of the occurrence of each price.

1. In 1947, for example, a major fall in the price of corn was forecast for 1948, because of a large anticipated increase in the production of corn. Adverse weather conditions had reduced corn supplies and raised product prices to unusually high levels. Most farmers expected average growing conditions to prevail in 1948, thus augmenting supply.

However, the forecast errors in the prediction of commodity prices were found to be quite large in 1948: the average of the forecasted prices differed by 10% and more from the realised prices of the various agricultural commodities covered by the survey. Furthermore, only 52% of the price forecasts made by individual farmers fell within the 90% to 110% range of realised values, the remaining 48% farmers under- or overestimating prices by more than 10%. These errors were, however, comparatively small in 1949. And the coefficient of correlation of the individual errors in 1948 to those in 1949 showed that the two were not significantly associated with each other.

The study then suggests that Muth's postulate that individuals exploit all available information in forming forecasts, carefully avoiding systematic errors in prediction, such that any period's forecast error is not correlated with that in the previous period, is not contradicted by Heady and Kaldor's survey data. However, as the authors themselves admit, observations from only two years are insufficient to draw definite conclusions; data for additional years is necessary to adequately test expectations procedures and the pattern of forecast errors.

A series of tests of the rationality of inflation forecasts was conducted by several researchers using Joseph Livingston's survey data on inflationary expectations published in the newspaper, the Philadelphia Bulletin, each June and December. Using the current values of the index, the expected percentage

change in prices in the subsequent 6 and 12 months was computed and published.

James E. Pesando (1975), examining the Livingston series for rationality, first defines, for the purposes of his tests, inflation-expectations as rational if they fully incorporate the information contained in the realised inflation rates in the past. This form of rationality, according to him imposes two requirements : (i) forecasts should be efficient in the sense that the forecasts made for one period ahead and the actual realisations should share a common auto-regressive pattern, and (ii) they should be consistent in that multispan forecasts (forecasts for more than one period ahead) can be obtained recursively, with the one-period-ahead forecasts substituting the as yet unrealised values. That is, if P_{t-i} represents the actual rate of inflation in period $t-i$, ${}^t P^*_{t-i}$ represents the rate forecasted in period $t-i$ for period t , then the efficiency criterion requires $\beta_i = \beta'_i$ in equations (1) and (2) below, and the consistency of forecasts implies the equality $\beta'_i = \beta''_i$ in equations (2) and (3). Rationality, therefore, implies $\beta_i = \beta'_i = \beta''_i$.

$$P_t = \beta_1 P_{t-1} + \beta_2 P_{t-2} + \beta_3 P_{t-3} + \dots + \beta_n P_{t-n} + u_{1t} \quad (1)$$

$${}^t P^*_{t-1} = \beta'_1 P_{t-1} + \beta'_2 P_{t-2} + \beta'_3 P_{t-3} + \dots + \beta'_n P_{t-n} + u_{2t} \quad (2)$$

$$\begin{aligned}
 {}_t P_{t-2}^* &= \beta_1'' ({}_{t-1} P_{t-1}^*) + \beta_2'' P_{t-2} + \beta_3'' P_{t-3} + \dots & (3)^2 \\
 &+ \beta_n'' P_{t-n} + u_{3t} & (3)^2
 \end{aligned}$$

The null hypothesis of rationality and its constituent hypotheses of efficiency and consistency are tested using the Chow test for the equality of the regressions. Tests were conducted by estimating equations (1) - (3) via ordinary least squares (OLS) for the two sample periods, 1959-69 and 1962-69 (with $n = 5$, the lag-length chosen to minimise the standard error of the regressions). The F-statistics obtained reveal that the joint rationality hypothesis ($\beta_i = \beta'_i = \beta''_i$) can be rejected at the 1% significance level: the F-values exceed the critical values for each sample period, therefore implying that the corresponding coefficients in the regressions compared

2. Writing ${}_{t+i} P_{n,t}^*$ to denote the forecast made in month t of the inflation rate that will prevail over the n -month period beginning from period $t+i$, the Livingston data can be represented by ${}_{t+1} P_{6,t}^*$ and ${}_{t+1} P_{12,t}^*$. Pesando assumes that the forecast of the inflation rate for the next 12 months can be expressed as a geometric average of the forecasts of the inflation rates expected to prevail in the two corresponding 6 month periods; i.e.

$$(1 + {}_{t+1} P_{12,t}^*) = [(1 + {}_{t+1} P_{6,t}^*) (1 + {}_{t+7} P_{6,t+6}^*)]^{1/2}$$

(with all variables expressed at annual rates).

Given ${}_{t+1} P_{12,t}^*$ and ${}_{t+1} P_{6,t}^*$, ${}_{t+7} P_{6,t+6}^*$ can be computed thus yielding a series of inflation forecasts for 6 month periods. In the equations (1) - (3) above, however, t denotes a period of 6 months.

are significantly different from each other. This result is largely due to the failure of the Livingston series to meet the consistency requirements, $\beta'_i = \beta''_i$, the associated F-values again exceeding the critical values for the two periods. The hypothesis of efficiency, however, could not be thus rejected.

However, Pesando's tests of rational expectations are not quite satisfactory; his efficiency and consistency hypotheses are not necessarily implied by the Rational Expectations Hypothesis. The efficiency criterion for rationality ($\beta_i = \beta'_i$) will hold only if the autoregressive process (equation (1)) accurately describes the actual process generating observed inflation rates. Only if this condition holds would rational expectations imply an equality between the weights (β_i) in the actual inflation process and those (β'_i) used in the distributed lag forecasting equation. If, in fact, the inflation rate is the outcome of a different process which incorporates other variables such as money growth, etc. then the efficiency criterion is not a valid test of the Rational Expectations Hypothesis.

Secondly, rational expectations do not necessarily imply the consistency hypothesis. Given that economic agents collect and react to whatever additional information that becomes available in each period, a forecast for

period t made in period $t-1$, will differ from (in fact, be in improvement upon) that made in period $t-2$ (for period t). Hence, ${}_t P_{t-1}^*$ and ${}_t P_{t-2}^*$ in equations (2) and (3) need not be equal and $\beta'_i \neq \beta''_i$.

J.A. Carlson (1977) suggested a modification of Livingston's published data to account for the fact that the respondents questioned generally sent in their price forecasts a month before they were actually published, presumably using information available till the preceding month, so that the inflation forecasts were really predictions for the subsequent 8 and 14 month periods rather than 6 and 12 month periods. Hence, instead of referring to the price index at the time of publishing the forecasts, Carlson used the values of the index two months prior to that to compute the expected change in prices. Using the modified data and applying Pesando's procedure for the same sample periods, Carlson rejects the rationality hypothesis, as well as both the efficiency and consistency hypotheses.

D.J. Mullineaux (1978) adopts a different procedure for testing the rationality of the Livingston series.

Subtracting (2) from (1) we get

$$P_t - {}_t P_{t-1}^* = (\beta_1 - \beta'_1) P_{t-1} + (\beta_2 - \beta'_2) P_{t-2} + \dots + (\beta_n - \beta'_n) P_{t-n} + (u_{1t} - u_{2t}) \quad (4)$$

so that the one period forecast error is related to the recent inflation, history, and as efficient forecasting

requires errors to be orthogonal to the information set, the coefficients in (4) must equal zero. The results of the OLS estimates of (4), using alternatively Pesando's and Carlson's data for the period 1959 - 69, yield coefficients which, as per the t- statistics, are individually insignificantly different from zero. The F-values which test the joint significance of the coefficients, imply that the efficiency criterion is satisfied with Carlson's data, but can be rejected at the 5% significance level for Pesando's data. However, Mullineux does not test the second necessary condition of rationality in expectations, the non-autocorrelation of forecast errors.

To test the consistency hypothesis, Mullineux subtracts equation (3) from (2) such that

$$\begin{aligned}
 {}_t P_{t-1}^* - {}_t P_{t-2}^* &= \beta'_1 P_{t-1} - \beta''_1 \cdot {}_{t-1} P_{t-2}^* + (\beta'_2 - \beta''_2) P_{t-2} \\
 &+ (\beta'_3 - \beta''_3) P_{t-3} + \dots + (\beta'_n - \beta''_n) P_{t-n} + (u_{2t} - u_{3t}) \quad (5)
 \end{aligned}$$

Assuming that $\beta'_i = \beta''_i$ for all i , (5) reduces to

$${}_t P_{t-1}^* - {}_t P_{t-2}^* = \beta'_1 (P_{t-1} - {}_{t-1} P_{t-2}^*) \quad (6)$$

The test for consistency ($\beta'_i = \beta''_i$) involves the joint hypothesis $b'_1 = b''_1$ and $b_2 = b_3 = \dots = b_n = 0$ in equation (5), where b_i are the estimated regression coefficients.

Estimates of the unconstrained equation (5) and the constrained equation (6) yield an F-statistic less than the critical value for Pesando's as well as Carlson's data sets, indicating that the regression coefficients b_i are not significantly different from their constrained values ($b'_1 = b''_1$; $b_2 = b_3 = \dots = b_n = 0$): the consistency hypothesis cannot be rejected.

Figlewski and Wachtel (1981) argue that a possible reason for the contradictory results from the earlier studies of Livingston's data, is that they used an average of the individual forecasts from each survey to estimate the distributed lag equations. Selecting a sample comprising of only the more regular respondents in Livingston's surveys, and then examining each respondent's price forecasts over the survey period, Figlewski and Wachtel find that expectations consistently underestimate future inflation rates, the forecasts errors exhibiting a significant positive serial correlation.

Figlewski and Wachtel also test the null hypothesis of unbiasedness of forecasts - the equality of forecasted and realised values, barring purely random errors. Or,

$$p_t = {}_t p^*_{t-1} + u_t \quad (7)$$

where u_t is the random error ($E u_t = 0$, $E u_{t_1} \cdot u_{t_2} = 0$ for $t_1 \neq t_2$). This specification is then tested by running the regression.

$$P_t = a + b \cdot \bar{P}_{t-1}^* + u_t \quad (8)$$

where \bar{P}_{t-1}^* is the average of the forecasts for period t . Thus unbiasedness of forecasts would be satisfied by $a = 0$ and $b = 1$. The OLS estimate of (8) is :

$$P_t = \underset{(0.393)}{1.750} + \underset{(0.239)}{0.957} \bar{P}_{t-1}^* \quad (9)$$

$R^2 = 0.46$

(with standard errors in parantheses).

While the slope coefficient is not significantly different from 1, the intercept term is highly significant indicating a definite forecast bias.

Further, regressing each individual's forecast error on the error in the previous period (i.e. to test autocorrelation of errors), the results were

$$(\bar{P}_{i,t-1}^* - P_t) = \underset{(14.3)}{-0.898} + \underset{(15.4)}{0.297} (\bar{P}_{i,t-2}^* - P_{t-1}) \quad (10)$$

with t-ratios in parantheses).

where $\bar{P}_{i,t-1}^*$ represents the i^{th} individual's forecast in $t-1$ for the t^{th} period. The slope coefficient is significantly different from zero indicating that individuals failed to weed out systematic errors in prediction.

The results of the research on the Livingston data are therefore fairly mixed, supporting or contradicting

rationality in expectations according to the different interpretations of the statement of the hypothesis, the nature of the regression run, the modifications made to the original data, and so on. The one study examining individual responses clearly rejected the rationality hypothesis.

A set of studies investigated the rationality of expectations of manufacturers in U.S.A. Hirsch and Lovell (1969) using survey data from 1959 onwards found that the sales expectations of individual firms are biased, the average of the forecasts made over the entire period by each firm differing substantially from the average of its realised sales. Some firms, they remarked, could be regarded as perennial optimists, generally overestimating future sales, while others were perennial pessimists, generally underestimating sales. However, these over- and underestimates usually cancelled each other out such that the expectations of the aggregate industry appeared to have no bias.

F. deLeeuw and M.J. McKelvey (1980) study sales price expectations at the industry level (for U.S.A.) to test the Rational Expectations Hypothesis. Their test for rationality is analogous to equation (8); regressing the actual rate of increases in sales prices (p_t) on the anticipated rate of change (p_t^e) over the period 1971 - 80, the results were :

$$p_t = \underset{(-0.1)}{-0.112} + \underset{(8.7)}{1.345} p_t^e \quad (11)$$

$$\bar{R}^2 = 0.304$$

(t-values in parantheses)

The unbiasedness of forecasts requires the constant term to be equal to zero, the slope coefficient equal to one; an F-test of the joint hypothesis of these coefficient values yields a highly significant F-statistic of 12.12 implying that forecasts are biased at the industry level. Hence, the Rational Expectations Hypothesis appeared to fare poorly in these two studies.

However, survey evidence need not necessarily represent the actual expectations of market agents. The forecasted values reported in surveys may, after all, differ quite substantially from the expectations upon which individual respondents actually base their market decisions. And as Prescott argues :

"The rational expectations paradigm may be considered in the same spirit as the maximising assumption The rational expectations assumption augmented the maximising assumption by hypothesising that agents use their information sets efficiently when maximising. Like utility, expectations are not observed and surveys cannot be used to test the rational expectations hypothesis. One can only test if some theory, whether it incorporates rational expectations or, for that matter, irrational expectations, is or is not consistent with observations."³

3. E.C. Prescott, 1977, "Should Control Theory Be Used for Economic Stabilisation ?" in *Optimal Policies, Control Theory and Technology Exports*, edited by Brunner and Meltzer.

THE NEW CLASSICAL MACROECONOMICS.

THE NATURAL RATE HYPOTHESIS WITH RATIONAL EXPECTATIONS.

A major part of the empirical work on the New Classical Economics involves testing of the policy neutrality proposition : the behaviour of the real variables in the economy is invariant with respect to systematic and foreseen policy rules which try to set policy instruments with a view to altering aggregate demand and thence real variables such as output and employment. Feedback rules can secure deviations from the natural rates of unemployment and output only by tricking agents into committing forecast errors.

Thomas Sargent (1976) tests the Natural Rate Hypothesis incorporating rational expectations, as described in equation (12) below.

$$UN_t = a_0 (P_t - E_{t-1} P_t) + \sum_{i=1}^n b_i UN_{t-i} + e_t \quad (12)$$

where UN_t is the rate of unemployment in period t , p_t the logarithm of the price level in period t , $E_{t-1} P_t$ the rational expectation in $t-1$ of p_t , and e_t is the disturbance term. Thus, unemployment responds only to the unanticipated part of the price level, and given a lag in the adjustment of outputs and employment (whereby an initial impulse of a forecast error in one period imparts a persistence in the unemployment series), to the previous unemployment rates.

Furthermore, as the Rational Expectations Hypothesis postulates that forecasts are unbiased, equalling realised values except for the random, serially uncorrelated errors with mean zero, $E (P_t - E_{t-1} P_t) = 0$,

$$E_{t-1} UN_t = \sum_{i=1}^n b_i UN_{t-i} \quad (13)$$

That is, the rate of unemployment can be adequately explained only by its own past history; none of the nominal policy variables, money supply, government spending, price inflation, etc. have any explanatory power. This, as Sargent points out, is a rather severe test of the invariance (or neutrality) proposition. That unemployment is caused only by its own lagged values, rules out the impact of all other real variables which could potentially affect the unemployment series. A more general test of the neutrality hypothesis could be conducted along the following lines :

$$\begin{aligned} E_{t-1} [X_t | X_{t-1}, X_{t-2}, \dots, G_{t-1}, G_{t-2}, \dots] \\ = E_{t-1} [X_t | X_{t-1}, X_{t-2}, \dots] \end{aligned} \quad (14)$$

where X_t is the vector of real variables at time t , G_t , the vector of monetary and fiscal policy variables, so that the block of real economic aggregates is invariant with respect to the variables in G . This would, however, allow changes in real interest rates, technology, etc. to affect output and employment.

Using quarterly U.S. data spanning the period 1952 II - 1972 III, Sargent runs the regression:

$$UN_t = d_0 + \sum_{i=1}^4 b_i UN_{t-i} + \sum_{i=1}^6 c_i G_{t-i} + d_1 t \quad (15)$$

where the candidates used as the G variables are, alternately, the logarithm of the money supply (m), the logarithm of the GNP deflator (p), the manufacturing wage index (w), government purchases of goods and services (g), and so on.⁴ Sargent posits that for any of the G variables to cause UN_t, their coefficients must be significantly different from zero. On the Natural Rate - Rational Expectations Hypothesis, however, all such variables are hypothesised to bear zero coefficients.⁵

4. UN represents the unemployment rate for civilians.
5. Sargent here follows Granger's test of causality (C.W.J. Granger, 1969), according to which a variable X is said to cause Y, if we are better able to predict Y using all information on (past) X, than if information apart from (past) X had been used. Regressing Y on lagged X's then the coefficients of the latter must be significantly different from zero, if Y were being caused by X.

When money supply is examined as a causal variable, the regression result is

$$\begin{aligned}
 UN_t = & 1.32 UN_{t-1} - 0.54 UN_{t-2} - 0.03 UN_{t-3} \\
 & (10.25) \quad (-2.64) \quad (-0.14) \\
 & + 0.11 UN_{t-4} - 14.24 m_{t-1} + 7.79 m_{t-2} \\
 & (0.94) \quad (1.89) \quad (0.57) \\
 & + 7.58 m_{t-3} - 24.94 m_{t-4} + 26.85 m_{t-5} \\
 & (0.53) \quad (-1.75) \quad (1.85) \\
 & - 0.862 m_{t-6} - 0.01 - 9.53 t \quad (16) \\
 & (-0.10) \quad (-1.32) \quad (-1.86)
 \end{aligned}$$

$$\bar{R}^2 = 0.918$$

F - statistic on all α_i coefficients $F(6,60) = 2.63$

(t-values reported in parantheses)

None of the coefficients on m_{t-i} are individually significant; the F-statistic which tests the joint significance of the m_{t-i} coefficients is significant at the 95% level of confidence though not at the 99% confidence level.

Similarly when government expenditure, g , is tested as a causal variable, none of the g_{t-i} coefficients are individually significant, and the associated F-value is 0.489 : the hypothesis that government spending does not affect unemployment cannot be rejected. The same holds true for the GNP deflator, where the F-value is 0.936. However, the hypothesis that unemployment is independent of the (money) wage index can be rejected at the 95% confidence level ($F = 2.371$).

Running a similar set of regressions with the long-term interest rate as the dependent variable, the F-statistic for all the coefficients of the lagged money wage index (w) is again the only one that is significant : the hypothesis that the wage index does not cause the long-term interest rate can be rejected at the 99% confidence level. But money-supply, government expenditures and the price level have no significant influence on the interest rate. Hence, as Sargent claims, the empirical research provides evidence that the new classical neutrality proposition "is not obscenely at variance with the data."⁶

The hypothesis that the unemployment rate can be adequately explained only by its own history, as per equation (13), it also tested by J.L. Stein (1982). Using annual U.S. data for the period 1958-1979, Stein's results were :

$$UN_t = 2.24 + 0.71 UN_{t-1} - 0.192 UN_{t-2} + 0.0855 UN_{t-3} \quad (17)$$

(1.87) (3.04) (-0.673) (0.358)

$$\bar{R}^{-2} = 0.308$$

(t - values in parahthes)

The explained variation (\bar{R}^{-2}) is now, however, much lower than in equation (16) and only UN_{t-1} is significant among the lagged unemployment rates. Hence the regression results

6. T.J. Sargent, "A Classical Macroeconometric Model for the United States," JPE, 1976.

using annual observations contradict those of Sargent's exercise with quarterly data.

In an earlier study, Sargent (1973) explicitly tested the hypothesis that anticipated inflation has no impact on the unemployment rate. That is

$$UN_t = \sum b_i UN_{t-i} + a_0 (P_t - E_{t-1} P_t) + a_1 (E_{t-1} P_t - P_{t-1}) \quad (18)$$

where a_1 is hypothesised to be equal to zero. Estimates of $E_{t-1} P_t$ were obtained by regressing the logarithm of the GNP deflator on its past history, previous unemployment rates, past money growth rates, etc., implying that the estimated regression is equivalent to the public's forecasting procedure. The relevant t-statistic, the ratio of the estimated value of a_1 to its standard error, for a hypothesised zero a_1 , is 1.27; a_1 is not significantly different from zero, implying that unemployment is not responsive to anticipated inflation; the Natural Rate - Rational Expectations Hypothesis is not rejected.⁷

However, the regression results of equation (18) will be sensitive to the particular specification of the price-expectation equation (for $E_{t-1} P_t$). To the extent to which the particular specification employed is not

7. The period of fit is 1952: I - 1970: IV, with U.S. data.

truly representative of the forecasting procedure of economic agents, the results of regressing equation (18) cannot be accepted as providing any clear verdict on the Natural Rate-Rational Expectations Hypothesis.

The underlying hypothesis in equation (18) is, as discussed in Ch. III, that since labour market decisions account for all anticipated price movements, anticipated inflation simply leads to an upward revision of nominal wage rates, so that anticipated real wage rates remain unchanged. B.T. McCallum (1975, 1976) postulates a wage-change equation in which the rate of wage inflation depends on the excess demand in the labour market and the anticipated price inflation. With labour supply (L^S) dependent on the real wage rate (w) and population (n) [$(L^S/n) = \alpha_2 w^{\alpha_3}$], and labour demand (L^d) dependent on the wage rate and output (y), [$(L^d/y) = \alpha_0 w^{\alpha_1}$], the logarithm of excess demand is a function of the logarithms of output per capita and the wage rate. Alternative measures of expected inflation are obtained by OLS estimates of inflation regressed on different, alternative sets of explanatory variables including previous observations on the GNP deflator, its rate of change, output levels, monetary growth rates, government expenditure, and so on. The hypothesis tested is, therefore of a one-to-one correspondence between expected inflation and wage adjustments, the relevant coefficient equalling one.

Estimates for U.K. (McCallum, 1975) with quarterly data for the period 1956-71, yield estimated values of the coefficient of expected inflation in the wage change equation ranging from 0.39 to 0.736, according to the alternative estimates of expected inflation, when changes in the weekly wage rates represented wage inflation. When hourly earnings were employed to measure nominal wages, the coefficient's estimates ranged from 0.38 to 0.974. A similar test for U.S.A. (quarterly data, 1952-70) using an index of hourly earnings in the private non-agricultural sector to represent nominal wage, the estimates of the coefficient of anticipated inflation range from 0.38 to 0.809. Thus, while the evidence is not completely in favour of the Natural Rate Hypothesis, some of the estimates of the coefficient of anticipated inflation are not significantly different from 1: the verdict on the hypothesis apparently hinges on the specification of the inflation forecasting equation. Or, as McCallum acknowledges, there remains considerable uncertainty regarding the true responsiveness of wage changes to price expectations.

UNANTICIPATED MONEY GROWTH :

As discussed ⁱⁿ Ch. III, while output, employment, the real interest rate, and other real variables, are hypothesised to be invariant with respect to systematic policy rules, the new classical macroeconomics does allow forecast errors due to the random terms in the policy rule to

cause (temporary) deviations of output and employment from their natural levels. This hypothesis forms the basis of a group of studies which estimate the impact of anticipated and unanticipated monetary growth (and hence, inflation) on the rate of unemployment and output.

In order to implement and test the hypothesis empirically, the notions of anticipated and unanticipated monetary policy must first be quantified. Robert J. Barro (1977) approached the problem by specifying a monetary-growth-equation assumed to represent the authority's feedback rule, the forecasts from which were interpreted as rationally anticipated monetary growth.

In Barro's model money growth is postulated to depend on its own lagged values, government expenditure relative to normal, and on the lagged unemployment rate. Government expenditure provides a revenue motive for money creation. However, given that expenditures can be financed by a combination of money issue and taxation,⁸ with the cost of raising revenue from taxes varying inversely with the capital invested in the tax-raising capacity (the administrative machinery etc.), Barro suggests that any permanent rise in government expenditure is met by raising tax-revenues, while

8. Barro abstracts from government borrowing, stating that extensions of the model to include public debt do not alter its main conclusions.

temporary budget increases are financed by increased money creation. Or, only increases in government expenditure relative to normal induce money creation. Hence, the variable in the money growth specification is $FEDV_t$, government expenditure relative to normal,

$$FEDV_t = \log FED_t - \log FED_t^* \quad (19)$$

where FED_t is the real government expenditure in period t , FED_t^* , its normal level, the latter estimated as per the adaptive formula, $\log FED_t^* = d \log FED_t + (1-d) \log FED_{t-1}^*$ (i.e. $\log FED_t^*$ is a geometrically declining weighted average of past values of real government expenditure).

Money growth is also specified to respond to the previous period's unemployment rate to reflect a possible countercyclical policy response to the level of economic activity. And the lagged money growth values are included in the policy rule to pick up any possible serial dependence or delayed adjustment of money supply that has not been captured by the other independent variables.

Barro's (OLS) estimate of the money-growth equation for U.S.A. using annual data for 1941-73 is

$$DM_t = 0.087 \quad + 0.24 DM_{t-1} \quad + 0.35 DM_{t-2} \\ (0.031) \quad (0.15) \quad (0.13) \\ + 0.082 FEDV_t \quad + 0.027 UN_{t-1} \quad (20) \\ (0.015) \quad (0.010)$$

$$R^2 = 0.90 \quad \text{Standard error of estimate} = 0.02$$

(Standard errors in parantheses)

where DM_t represents the money growth in period t ($DM_t = \log M_t - \log M_{t-1}$, M_1 as the money supply measure), and UN_{t-1} is the lagged unemployment variable ($UN_{t-1} = \log(U/(1-U))_{t-1}$, U being the annual average unemployment rate in the total labour force inclusive of military personnel).

Hence, an increase in government expenditures relative to normal must be financed by increased money creation, and an increase in unemployment rates induces an expansionary policy response.

The estimates values of DM from (20) then form a series of rationally anticipated money growth, \hat{DM} , while the unanticipated money growth, DMR , corresponds to the residuals from (20), $DM - \hat{DM}$ (i.e. $DMR_t = (\log M_t - \log M_{t-1}) - (\log M_t - \log M_{t-1})$). That is, Barro assumes that economic agents acted as if regression (20) were their working-rule in formulating forecasts.

Having thus quantified anticipated and unanticipated monetary growth, Barro proceeds to the specification of the unemployment equation with the hypothesis that a monetary growth greater than expected causes a decline in the rate of unemployment. Apart from the monetary variables, the equation includes two real variables, one a measure of military conscription (MIL), and the other the minimum wage

rate (MINW),⁹ both of which are believed to affect the natural rate of unemployment. In addition to the direct employment effect of conscription, the presence of a military draft could, for example, induce individuals to continue with education rather than enter the labour force, which might lower the measured unemployment rate. Secondly, if the conscription was from unemployed workers, the presence of the (selective) draft may affect the work-unemployment choice for labour market participants and could also work to reduce the unemployment rate.

Regressing UN_t on current and lagged unanticipated monetary growth, MIL and MINW, the estimated equation is

$$\begin{aligned}
 UN_t = & -3.07 & -5.8 & -12.1 & -4.2 & & & & \\
 & (0.15) & (2.1) & (1.9) & (1.9) & & & & \\
 & & & & & -4.7 & + & 0.95 & \\
 & & & & & (0.8) & & (0.46) & (21)
 \end{aligned}$$

$R^2 = 0.78$ standard error of estimate = 0.13
 (standard errors in parantheses)

The DMR coefficients have the hypothesised negative signs, each of them is individually significant, the strongest effect of unanticipated monetary growth appearing after

9. MIL = Military Personnel/Male population, aged 15 - 44
 MINW is the ratio of the applicable minimum wage to private non-farm average hourly earnings, multiplied by the proportion of the non-supervisory employment covered by the minimum wage regulation.

one year.¹⁰ Further, the F-statistic for the 3 DMR coefficients is 21.0 which exceeds the 5% critical value of 3.1, implying that unanticipated monetary growth is a significant explanatory variable. The military conscription variable, MIL, is also highly significant.

Running a regression of unemployment on total monetary growth, DM, (current and 4 lags), along with MIL and MINW, Barro shows that the DM coefficients are insignificantly different from zero:

$$\begin{aligned}
 UN_t = & -2.46 & -1.2 DM_t & -5.7 DM_{t-1} & + 0.7 DM_{t-2} & + 3.5 DM_{t-3} \\
 & (0.34) & (2.9) & (2.7) & (2.5) & (1.8) \\
 & & -3.2 DM_{t-4} & -4.5 MIL_t & -0.3 MINW_t & \\
 & & (1.5) & (1.4) & (1.0) & \\
 & & & & & (22)
 \end{aligned}$$

$R^2 = 0.52$ Standard error of estimate = 0.20
 (Standard errors in parantheses)

The explained variation in unemployment (R^2) drops substantially from 0.78 to 0.52; the DM coefficients are individually insignificant, though the F-statistic testing their joint significance is slightly above the 5% critical value. Hence, a comparison of (21) and (22) indicates that unemployment is sensitive only to that part of total monetary growth that is unexpected.

 10. Additional lagged terms of unanticipated monetary growth were found insignificant.

The hypothesis that it is only the unanticipated monetary growth that affects unemployment is tested by running a regression that simultaneously includes the sets of DM and DMR variables, and then, alternately restricting the DM and DMR coefficients to zero. The F-statistic for the hypothesis that the DM coefficients are insignificant in an equation already including the DMR variable is 1.4, which is less than the critical value at the 5% significance level, 3.1. On the other hand, the F-statistic for the hypothesis that the DMR coefficients are insignificant when the equation includes the DM variable, is 15.7 which exceeds the critical value. Thus, the hypothesis that only unanticipated money matters cannot be rejected, though the reverse hypothesis that unanticipated money does not influence unemployment is easily rejected.

Further, if there were to be no monetary surprises ($DMR = 0$), then, equation (21) could be used to compute the natural rate of unemployment for each year. Thus, from an initial value of 3.4% in 1946, Barro's estimated natural unemployment rate rose to 5.1% in 1947, declined to 3.5% in 1953, and then rose, more or less steadily, to 4.4% in 1969, when it jumped to 6.4% in 1970, fluctuating around that value thereafter, till 1978. The main reason for the jump in 1969-70 was the end of the selective draft system in 1970 and the switch to the lottery draft, which is treated by Barro as

tantamount to a removal of conscription; MIL is set to equal zero from 1970 onwards which, perhaps, is not accurate.

In an analagous exercise, Barro(1978) tests the hypothesis that it is only unanticipated monetary growth that affects output, measured by real GNP(y_t). In addition to the monetary surprises, the output equation includes a time trend variable, t , which reflects the "secular movement of 'normal' output",¹¹ and the military conscription variable, MIL, which is expected to operate positively on output through its induced employment effect. The estimated equation, using annual observations for U.S.A., 1946-76 is

$$\begin{aligned} \log y_t = & 2.95 + 1.04 \text{ DMR}_t + 1.21 \text{ DMR}_{t-1} + 0.44 \text{ DMR}_{t-2} \\ & (0.04) \quad (0.21) \quad (0.22) \quad (0.21) \\ & + 0.26 \text{ DMR}_{t-3} + 0.55 \text{ MIL}_t + 0.0354 t \\ & (0.16) \quad (0.09) \quad (0.0004) \end{aligned} \quad (23)$$

$R^2 = 0.998$ Standard error of estimate = 0.016

(Standard errors in paranthes&s)

11. Robert J. Barro, "Unanticipated Money, Output and the Price Level in the United States", JPE, 1978.

That is, Barro (presumably) describes the natural output level as an exponential function of time.

As expected from the unemployment equation, the unanticipated monetary growth has a strong expansionary effect on output, the major part of the impact coming, again, with a lag.¹²

In the same study, Barro also investigates the impact of monetary changes on the price level, where the key hypothesis tested is that anticipated monetary growth results in an equiproportionate and contemporaneous change in the price level. Starting from an equation describing the demand for real balances, Barro derives a price equation which makes the logarithm of the price level dependent on the logarithm of money supply, nominal interest rate, income, government expenditure, a trend term, t , which captures the impact of the development in financial institutions on the demand for money, and where real income is introduced in the form of the output equation described earlier. Using annual observations from 1948-76 for U.S.A., Barro's regression result explains 99.87% of the variation in the price level. The hypothesis

12. MIL too has a pronounced effect on output, its coefficient being positive and highly significant. However, Barro suspects that it may be proxying for variables other than the draft pressure on employment. One candidate considered was government expenditure which, however, proved to be insignificant when added to the equation, MIL still remaining significant.

of a unit coefficient on the logarithm of the current money supply is not rejected. However, the DMR variable (introduced via the output term) is found significant up to the fifth lag (DMR_t, \dots, DMR_{t-5}), implying that the price response to monetary surprises is much more drawn out than the output response. Discussing this cross-equation discrepancy, Barro contends that it does not necessarily corroborate the wage- and price-rigidity hypothesis. The latter would imply a corresponding pattern of response to monetary movements in both output and price equations; if the drawn-out response of inflation rates to unanticipated money were to be caused by price rigidity, then the output response must have been equally protracted (i.e. DMR must have been significant till $t-5$ in (23), which however, is not so). Further, with wage-price rigidity, anticipated money changes would cause a less than an equiproportionate movement in the inflation rate, implying a less than unit coefficient on the logarithm of money supply in the price equation, which is contradicted by the evidence. Rather, this discrepancy could have arisen from a misspecification

of the price equation.¹³

Re-estimating the equations with quarterly data, Barro and Rush (1980) find a close correspondence between the annual and quarterly results of the money-growth, unemployment, and output equations, but not for the price equation which, when estimated with a correction for the serial correlation of residuals, shortens the DMR lag to 13 quarters, which would approximate to DMR_{t-3} in the annual version. Again, the price equation is suspected to be misspecified.

Several other studies using a similar methodology support Barro's findings. Jacob Grossman (1979) using quarterly U.S.

13. Barro points out that there might be a partial adjustment of money demand to the optimal level, in the demand for real balances equation (from which the price equation was derived). Splitting income changes into temporary and permanent changes, with the temporary component caused by DMR, and the permanent proxied through MIL, t , etc., and postulating that temporary income has a strong effect on current money demand dissipating only gradually in accordance with the adjustment parameter, λ , the demand for real balances ($\log(M/P)$ where M = money stock, P = price level) is

$$\log(M/P)_t = b_0 + f(\gamma_t^p, r_t, t) + b_1 [\log \gamma_t^t + (1-\lambda) \log \gamma_{t-1}^t + (1-\lambda)^2 \log \gamma_{t-2}^t + \dots]$$

y^p represents the permanent part of output and y^t , the transitory, r_t is the nominal rate of interest. Then, because of the lagged adjustment of M/P to y^t , the DMR variable (through y^t) also appears with a long lag in explaining M/P and, hence, P .

data for 1947-75, with nominal GNP proxying for policy instruments¹⁴, regresses unemployment on current and lagged unanticipated nominal income growth and on lagged values of unemployment, and then replaces the unanticipated by anticipated GNP growth in a separate equation. Grossman finds that only unanticipated income growth has a significant (negative) effect on unemployment. Anticipated growth is significant in explaining the rate of inflation. That is, the hypothesis that only unanticipated income growth affects output, and anticipated income changes affect the price level is supported. Similarly, Gillian Wogin's (1980) study using annual Canadian data spanning the period 1926-72 finds unanticipated money affecting unemployment, the anticipated component inducing no unemployment changes. Attfield, Demery and Duck (1981) using quarterly data (1963-78) from U.K. show that output varies in response to unanticipated money alone.

Barro's work is, however, not free from criticism. One of the obvious shortcomings of his methodology is that agents' forecasts of monetary movements are based on information which, in fact, becomes available only after the forecast is made.

14. As the specification of feedback rules setting policy instruments could be arbitrary, Grossman prefers to use nominal income, and changes therein, as reflecting the authority's attempts to influence the economy (via expansions in nominal demand).

The money growth equation (20) uses observations from 1941-73 implying that an estimate of expected monetary growth (for estimating unemployment) in 1950, for example, uses information subsequent to that year. This clearly violates the basic assumption in expectation formation: an expectation for period t is conditioned on information available only till $t-1$. An alternative approach would be to estimate each DM_t using only those observations that are available till $t-1$, but which could also be a little inconvenient, as then there would be as many regression of DM_t as there were predictions.

A more serious objection to Barro's procedure is with respect to his specification of the money-growth equation (20). Barro does not explicitly derive the equation, but merely states that monetary growth should depend on its lagged values, the unemployment rate and government expenditure relative to normal. An important question that arises is how a Barro-type test would stand to alternative specifications of monetary growth (DM and, hence, DMR). For example, the monetary authority may aim to limit interest rate fluctuations and accordingly adjust its money growth rates. Or, if the government is averse to increases in the inflation rate, then it would want to curtail monetary expansion whenever the inflation rate appeared to be on the rise. No such

policy objectives are recognised in equation (20)¹⁵. And if, in fact, these objectives were important then the forecasts from equation (20) would not really represent a rational expectation of monetary movements. These questions can, however, be answered by further empirical work explicitly including the above mentioned variables in the money growth equation. A preferable approach, in fact, would be to construct a money supply and demand model including the range of policy goals, and thence derive the money growth specification.

M.H. Pesaran (1982) points out that the inclusion of the variable $FEDV_t$ in Barro's money growth equation assumes knowledge of real government expenditure in the future period: agents' forecasts for period t are based on information of the nominal government expenditure and the price level that will be realised in period t . Although agents may be able to make fairly precise forecasts of nominal growth in government

15. Further, if the inflation rate were to be included as an explanatory variable in the money-growth equation, and if there were an observed (inverse) correlation between unemployment and inflation, then the coefficient estimates from the regression would be unreliable (on account of the multi-collinearity problem), in which case the estimated regression would be an inefficient forecasting device.

spending in the future period, to assume that they can perfectly anticipate the real expenditure is unrealistic. Further, the level of government spending may be the outcome of a fiscal policy rule, anticipations of which must be explicitly accounted for. Pesaran suggests that it would be preferable to formulate a feedback rule determining real government spending analagous to the money growth equation, and use the residuals therefrom in the latter. Then re-estimating the unemployment equation, the explained variation falls significantly from 0.78 to 0.61.

David Small (1979) notes that Barro's government expenditure variable, $FEDV_t$, depends only on current and past values of expenditure, such that the inducement to money creation is the same whenever government spending deviates from normal, irrespective of whether the deviation is temporary or permanent. But money creation would be greater, as Barro himself had argued, in periods of temporary increases in spending. The coefficient on $FEDV_t$ should be greater whenever the increases in government expenditure measured by $FEDV_t$ are temporary. And Barro's sample period includes the World War II period, the Korean and Vietnam war years, when there were sharp, but temporary escalations in the government budget which, given the war conditions, could have been anticipated by rational agents. As Small points out, the failure of the $FEDV_t$ coefficient to vary

results in a systematic underprediction of the rate of monetary growth: Barro's unanticipated monetary growth rates have a positive bias in the war years, and as the residuals must sum to zero, a negative bias in the non-war years. Correcting for this by inserting a dummy variable to differentiate between the war and non-war years in the money growth equation, the coefficient of the dummy variable was found significant. Using the resulting series on unanticipated money growth in the unemployment equation, R^2 falls to 0.52. Hence, as Small argues the positive bias in Barro's monetary surprises during periods of temporary expenditure increases apparently accounted for his ability to explain the downward movement of unemployment in these intervals of time. The removal of the bias reduces the unemployment equation's ability to track the large decreases in unemployment that occurred during these years.

Small also questions Barro's measurement of the natural rate of unemployment, discussed earlier, which is used to explain the observed rise in unemployment in the 1970's. The increase in the natural rate resulted from the change in the military draft system whereby MIL was set to equal zero from 1970 onwards. This, as per Small's calculations, should imply that 1.68 million persons were unemployed because of the change in the draft system. However, examining the actual data reveals that, at the most, only 1,61,350 persons were added to the ranks of the unemployed, which differs significantly from Barro's 1.68 million. Thus, the

natural rate actually moved much less than estimated by Barro, and accordingly explains a much smaller fraction of the movement in actual unemployment rates.

As mentioned earlier, the tests of the policy invariance proposition involve tests of the joint hypothesis of rationality in expectations and neutrality of real variables to anticipated policy. Frederic Mishkin (1982) suggests a procedure whereby the two hypotheses of rationality and neutrality can be individually tested from the same model:

$$y_t = y_t^* + \sum_{i=0}^N \beta_i (M_{t-i} - M_{t-i}^e) + v_t \quad (24)$$

Where y_t alternately denotes output and unemployment in period t ; y_t^* is its natural level; M_{t-i} money growth in period $t-i$, M_{t-i}^e , its forecast conditioned on information available through period $t-i-1$. Following Barro, an equation can be formulated to generate forecasts of money growth.

$$M_t = Z_t a + u_t \quad (25)$$

where Z_t is a vector of (pre-determined) real variables pertinent to the money growth process, known at time $t-1$; a is the associated coefficient vector. u_t and v_t are the

(serially uncorrelated with zero mean) disturbance terms in the respective equations. Given knowledge of (25) the rationally forecasted M_t is

$$M_t^e = Z_t a \quad (26)$$

Substituting from (26), (24) can be written as

$$y_t = y_t^* + \sum_{i=0}^N \beta_i (M_{t-i} - Z_{t-i} \cdot a) + v_t \quad (27)$$

Writing y_t as a function of both anticipated and unanticipated money, and denoting actual expectations of M_t by $Z_t \cdot a^*$,

$$y_t = y_t^* + \sum_{i=0}^N \beta_i (M_{t-i} - Z_{t-i} \cdot a^*) + \sum_{i=0}^N \delta_i (Z_{t-i} \cdot a^*) + v_t \quad (28)$$

where rationality in expectations requires $a^* = a$, and neutrality, $\delta_i = 0$ for all i .

Mishkin constructs a likelihood ratio test for the joint hypothesis of rationality and neutrality, where the constrained system (25) and (27) ($\delta_i = 0$ and $a = a^*$ ~~not~~ imposed), and the unconstrained system (25) and (28) (constraints $\delta_i = 0$ and $a = a^*$ not imposed) are estimated via. maximum likelihood

methods. The likelihood ratio statistic $-2\log(L^c/L^u)$, where L^c is the maximised likelihood of the constrained system, and L^u , that of the unconstrained system, follows a $\chi^2(q)$ distribution, where q is the number of constraints. The comparison of this statistic with the critical χ^2 value then tests the null hypothesis.

If the joint hypothesis were rejected, with the probability of getting the computed χ^2 value less than a specified level, then it is possible to trace the cause of the rejection to the two constituent hypotheses, by constructing analogous likelihood ratio tests for the rationality and neutrality hypotheses separately. The latter exercise becomes important when despite rational expectations, output and employment are non-neutral to policy rules because of sticky prices, wages, etc. The likelihood ratio test of the neutrality hypothesis would proceed by imposing the rationality constraint ($a = a^*$), but relaxing the neutrality constraint ($\delta_i = 0$) in the unconstrained system. The rationality test imposes the neutrality constraint ($\delta_i = 0$) while relaxing the rationality constraint ($a = a^*$) in the unconstrained system.

With quarterly U.S. data (1954-76) Mishkin first estimates the money-growth equation: monetary growth is regressed on a wide variety of possible causal variables including the inflation rate, the growth rate of GNP, nominal and real, the unemployment rate, the growth rate of government

expenditure, the balance of payments on the current account, and so on. Only those variables which are significant at the 5% level are retained. (Such a specification of the money growth process appears quite ad hoc as also pointed out in the context of Barro's work.) As Mishkin claims, one advantage of this procedure over that used by earlier researchers, is that "it imposes a discipline on the researcher"¹⁶ and prevents him from searching for a specification of equation (25) that leads to results confirming his priors on the validity of the policy neutrality proposition.

Then Mishkin shows that the conclusions on the output and unemployment equations are sensitive to the specification of the lag length of unanticipated money growth. When 7 lags of unanticipated money growth are incorporated in the output and unemployment equations, the joint hypothesis of rationality and neutrality is not rejected. Neither of the two constituent hypotheses is rejected for the output equation; in the unemployment equation, the rationality hypothesis cannot be rejected, but the neutrality hypothesis is rejected at the 5% significance level. However, when the dependent variable is regressed on 20 lags of anticipated money growth, the

16. F.S. Mishkin, "Does Anticipated Monetary Policy Matter? An Econometric Investigation", JPE, 1982.

joint hypothesis is rejected at the 99% confidence level for both output and employment. Rationality and neutrality are separately rejected at the 95% confidence level in the unemployment equation and at the 99% confidence level in the output equation.

Estimates of equation (28) for output and unemployment with 7 lags of the monetary variables, yield significant β_i coefficients while δ_i are insignificant for the first 5 lags, and significant for the last 2. This creates the suspicion that increasing the lag length could lead to a strong rejection of the neutrality hypothesis. And working with 20 lags, Mishkin shows that many of the anticipated money growth coefficients are significant and often exceed the corresponding unanticipated money coefficients. That is, anticipated money growth does produce real effects, though very slowly.

In fact, Mishkin's evidence contradicts even the basic Monetarist position as per which any monetary expansion, which causes unanticipated inflation, may, in the initial phase, induce temporary output responses which are, however, dissipated with time as anticipations adjust. That is, the short-run impact of monetary movements may be concentrated on output and employment but in the long-run the effect shifts fully to the rate of inflation, which adjusts completely to the new monetary growth rate, output and employment reverting to their natural levels. That is, the longer lag values of monetary movements should not

produce any output, employment effects.

Robert J. Gordon (1982) tests the new classical neutrality hypothesis against a specific alternative, the Natural Rate Hypothesis with sluggish or gradual adjustment of prices, NRH-GAP. Prices adjust only gradually in the short-run to anticipated changes in nominal aggregate demand, fully in the long-run. An anticipated rapid increase in nominal aggregate demand leads, partly, to a faster inflation and partly, to increase in output. Eventually, the price adjustment is completed and the inflation rate increases equiproportionately to the increase in nominal aggregate demand, and output returns to its natural level. The sluggish price adjustment is caused by the existence of contracts, etc.

Expressing output deviations from the natural level as a function of unanticipated price movements, defining the price level as the ratio of nominal to real GNP, output deviations in the new classical framework are caused by unexpected nominal income movements, and by the lagged output deviation from the natural level. That is,

$$\hat{Q}_t = (\alpha/(1+\alpha)) U y_t + \lambda \hat{Q}_{t-1} \quad (29)$$

where \hat{Q}_t is the (logarithm of the) output deviation from the natural rate, in period t $U y_t$, the unanticipated growth in nominal income.

The rate of inflation (P_t) is defined as the difference between the rates of growth of nominal and real income which, in turn, equals the difference between these growth rates net of their trend or natural growth rates.

$$p_t = \hat{y}_t - \hat{q}_t \quad (30)$$

where \hat{y}_t is the growth rate of nominal income net of trend, and \hat{q}_t , that of real income, net of trend. \hat{q}_t equals $(\hat{Q}_t - \hat{Q}_{t-1})$ the change in the output deviations; \hat{y}_t can be split into its expected and unexpected component. Then, substituting for \hat{Q}_t from (29), equation (30) is written as

$$p_t = E \hat{y}_t + (1/(1+\alpha)) U \hat{y}_t + (1-\lambda) \hat{Q}_{t-1} \quad (31)$$

where $E \hat{y}_t$ and $U \hat{y}_t$ are respectively the expected and unexpected nominal income changes (net of trend). That is, anticipated nominal income growth causes an equi-proportionate price response in the same period, the coefficient of $E \hat{y}_t$ equalling 1 in (31). The impact of unanticipated nominal income changes gets distributed between output and inflation, the sum of the relevant coefficients equalling 1.

In the alternative NRH - GAP, inflation depends on its past history, which reflects the "price inertia",¹⁷

17. R.J. Gordon, "Price Intetia and Policy Ineffectiveness in the United States," JPE, 1982.

on the anticipated and unanticipated nominal income growth, each inducing the same inflation response (unlike the new classical version in which the anticipated income changes cause a larger change in the inflation rate, than the unanticipated income changes), and on lagged output deviations. And, as opposed to the new classical postulate, output deviations in NRH - GAP are caused by both anticipated and unanticipated nominal income growth, the impact from the former caused by the sluggish price adjustment whereby a given movement in nominal income (or nominal demand) gets distributed between output and prices. The inflation and output equations in NRH - GAP are then

$$p_t = \sum c_i p_{t-i} + d_0 E \hat{y}_t + d_1 U y_t + d_2 \hat{Q}_{t-1} + d_3 z_t \quad (32)$$

$$\hat{Q}_t = -\sum c_i p_{t-i} + (1-d_0) E \hat{y}_t + (1-d_1) U y_t + (1-d_2) \hat{Q}_{t-1} - d_3 z_t \quad (d_0 = d_1) \quad (33)$$

where z_t denotes the supply shock in period t , which Gordon includes to incorporate the impact of government intervention through price controls in war periods, etc. (captured by a dummy variable).

Using quarterly data from U.S.A. spanning the entire period 1890 - 1980, Gordon splits the nominal income growth into its anticipated and unanticipated components, using the same methodology as above, but running separate regressions for sub-sample periods. The natural output levels

are obtained by regressing the logarithm of real GNP against
time
^ for separate decades.

Then estimating the output and inflation equations, Gordon rejects the new classical hypothesis, and confirms the NRP - GAP hypothesis. There is no one-to-one correspondence between expected nominal income growth and inflation, the price inertia is fairly strong, and output deviations are sensitive to anticipated nominal income changes, the coefficients on the latter significant at the 1% level in all the sub-sample periods, as well as for the total sample period.

LUCAS' HYPOTHESIS ON THE PHILLIPS CURVE

As discussed in the preceding chapter, one of the implications of the policy neutrality proposition is that the Phillips Curve is vertical in the short run itself. This,, however, appears to be contradicted by the observed inverse correlation between unemployment and inflation. But, as Lucas hypothesised, in an economy composed of distinct markets, information flowing between them, and hence, on economic aggregates, only with a lag, with agents forming expectations rationally and optimising their demand and supply decisions, the observed Phillips Curve relation arises because of temporary confusions between relative and aggregate price changes when unanticipated changes occur in money growth (as discussed in Ch. III). Further, Production

(and employment) decisions are believed to be more sensitive to unanticipated inflation when, in the past, the average price level has been relatively stable. Producers are then inclined to attribute a given price change in their respective markets to a movement in relative prices. If the price level has been more volatile in the past, producers discount some of the observed price movements in their respective markets, attributing them to a general inflation, and refrain from altering production decisions. Or, simply, the greater the variance of the inflation rate, the smaller is the responsiveness of output; as the monetary authority repeatedly tries to exploit the Phillips Curve, the terms of the trade-off worsen.

Lucas (1973) tests the above hypothesis by examining the relationship between the variance of the inflation rate and movements in output across countries. In this model, the aggregate demand curve is unit elastic :

$$x_t = y_t + p_t \quad (34)$$

where x_t is the logarithm of the nominal GNP, y_t , the logarithm of output, p_t , the logarithm of the price level. The level of nominal income is determined on the demand side, its division into output and the price level assumed to occur on the supply side : suppliers' production decisions are made solely in response to observed and anticipated relative

prices, whereby any expansion in nominal aggregate demand leaving relative prices unchanged, would result in an increase in the absolute price level, leaving the (equilibrium) volume of output unchanged.

Further, Y_t is composed of its natural level, Y_{nt} , and a cyclical component, Y_{ct} , which is the deviation of actual output from its natural level, the deviation caused by forecast errors, as explained earlier. ($Y_t = Y_{nt} + Y_{ct}$). For empirical purposes, Y_{nt} is approximated by the trend

$$Y_{nt} = \alpha + \beta t \quad (35)$$

In Lucas' scheme, demand fluctuations, Δx_t (caused by monetary expansions, for example), are the major source of variation in the rate of inflation, Δp_t . And as information on current economic aggregates (including the price level) is not available, economic agents confuse the purely absolute price changes occurring in their respective markets for relative ones, and hence alter production decisions. Output deviates from the natural level. That is, fluctuations in x_t cause Y_{ct} .

$$Y_{ct} = a + b \Delta x_t + c Y_{c,t-1} \quad (36)$$

where b measures the responsiveness of output to a nominal demand shock; $Y_{c,t-1}$ is introduced to capture lags in output adjustments. The value of b is hypothesised to depend on the ratio of the variance of the general price

level to the variance of relative prices ; the higher the value of this ratio, the lower is b . Hence, the variance of ΔX_t (the demand fluctuation) is hypothesised to be positively related with the variance of ΔP_t (the inflation rate), and given the variance of relative prices, inversely related with b .

For the cross- country study of these relationships Lucas selected a sample of 18 countries exhibiting a variety of nominal income behaviour over the estimation period, 1952-67. In two countries, Argentina and Paraguay, the estimated variance of ΔX_t was 0.01555 and 0.0345 respectively, at least 10 times that of the remaining 16 countries (including U.S.A., U.K., Canada, West Germany, Austria, Italy, etc.) Hence, Argentina and Paraguay represent two points in the sample, presumably characterised by highly volatile policies, the remaining 16 countries by relatively smooth and moderately expansive policies. Comparing between the two sets of countries, Lucas finds that the estimated b values conform to the relationships postulated above. For the 16 moderately-fluctuating-demand or stable-price countries, b ranges from 0.287 to 0.910, whereas for the two volatile-price countries, this estimate is 10 times smaller. For example, the regression results of (36) for U.S.A. and Argentina are :

$$Y_{ct} = -0.049 + 0.910 \Delta x_t + 0.887 Y_{c,t-1} \quad (37)$$

(U.S.A.)

$$Y_{ct} = -0.006 + 0.011 \Delta x_t - 0.126 Y_{c,t-1} \quad (38)$$

(Argentina)

In stable-price countries like U.S.A., then, an increase in nominal income has a larger initial effect on output, whereas in Argentina the expansions in nominal income have practically no discernible effect on output. Hence, Lucas concludes that the apparent short-term trade-off is favourable as long as it remains unused.

However, within the group of 16 countries characterised by lower demand variance, the evidence is somewhat mixed. Countries with lower aggregate demand variance do not necessarily have a higher responsiveness coefficient b .

Froyen and Waud (1980) examine the above model using a larger set of time-series data with annual observations for 1956-76 for 10 industrialised countries. ¹⁷ In the cross-country comparison

17. The countries are U.K., France, West Germany, Switzerland, Netherlands, Belgium, Italy, U.S.A., Canada and Japan.

they find the expected inverse correlation between b and the variance of Δp_t supported by the evidence. However, the variance of the demand fluctuation (Δx_t) is not significantly correlated either with the variance of the inflation rate (Δp_t) or with the responsiveness coefficient (b). The results, therefore, are not consistent with Lucas' hypothesised sequence of nominal income variations stimulating variations in the inflation rate and, hence, output responses.

In addition, Froyen and Waud examine the intertemporal evidence in each country. A striking feature of the inflation series is a significant increase in the price variability over time: splitting the total period into two sub-periods, 1957 - 66 and 1967 - 76, the variance of the inflation rate is, in all countries except West Germany, higher in the second sub-period. However, the variance of nominal income changes shows no such pattern, but is, in fact, lower in the latter period in five countries, including countries with substantial increases in inflation variability. Further, while in some countries the b estimate is lower for the second period with the increased inflation variability, it is higher in the others. Where the variance of the inflation rate and nominal demand changes increased together, the b value declined as hypothesised.

Froyen and Waud advance three possible for this mixed evidence. Firstly, Lucas' model postulates cyclical fluctuations in output to be caused solely by aggregate demand fluctuations, with no role whatsoever for supply shocks. If supply shocks were important in the second period causing major output fluctuations of their own, then they would explain the divergent movements in inflation and output; an increase in price inflation, if accompanied by an exogenous disturbance which reduces outputs, may not be associated with a nominal income increase. Secondly, in the estimate of b , the relative price variance is implicitly assumed to be stable across countries, which need not be true. And thirdly, if the aggregate demand curve were not unit elastic the nominal income x_t would no longer be exogenous, or determined independently of y_t ; a shift in the aggregate supply schedule (y_t) would cause a change in nominal income, whereupon Δx_t is contemporaneously correlated with the supply disturbance. That is, reverting to equation (36), if we were to specifically incorporate the disturbance term, u_t , then Δx_t and u_t are correlated, which would imply that OLS estimates of b are biased, in which case though the true responsiveness coefficient and the variance of nominal income changes are inversely correlated, the estimated b may show no such relation.

Thus, while the evidence is fairly persuasive in the comparison across the two different sets of countries as shown by Lucas, it yields no definite conclusions on the sensitivity of inflation-output trade-offs to variations in demand policies in countries with only moderately dissimilar inflation experiences.

The empirical evidence is then not entirely unfavourable to the New Classical Economics. As regards rationality in expectations formation, Heady and Kaldor's survey study does indicate that market agents try to analyse and predict demand and supply changes and the consequent price changes, instead of merely reviewing the past price values in predicting future prices. The evidence from the Livingston inflation series however is not conclusive; as pointed out, the efficiency and consistency hypotheses which are tested are not necessarily implied by the Rational Expectations Hypothesis. More importantly, one may hesitate in accepting the evidence from survey data, for the expectations reported in surveys may not be those on which agents

actually base their market decisions.

As regards the macroeconomic implications, Lucas' hypothesised inverse correlation between the variability of the inflation rate and the terms of the output-inflation trade-off appears to be supported by the cross-country evidence. However, the hypothesised correlation between nominal income changes and the inflation rate is rejected.

In the context of the policy ineffectiveness proposition, one empirical exercise that stands out prominently is Sargent's test of the neutrality of unemployment and the long-term interest rate to nominal variables (money-supply, the rate of inflation, government spending, etc), which provides evidence strongly in favour of the neutrality proposition. As regards Barro's tests of the responsiveness of unemployment and output to anticipated and unanticipated money growth, while the neutrality of real variables to anticipated monetary policy appears to be established, the specification of the money growth process is quite arbitrary. As noted earlier, one must check whether the neutrality proposition holds with alternative money-growth specifications.

As against the successful performance of these tests yielding evidence strongly in favour of the neutrality proposition, some of the empirical exercises appear to reject this proposition. Mishkin's test, for example, indicates that anticipated monetary movements do stimulate output and employment responses, though very slowly. On the other hand Gordon's work suggests the definite presence of price inertia: prices adjust sluggishly so that in the short-run output and employment respond to anticipated nominal demand expansions.

These contradictory results stem from the specifications of the equations estimated, the methodology employed in defining the money growth process, and so on. Sorting out these problems could perhaps yield a clearer verdict on the neutrality or non-neutrality of anticipated policy with respect to real variables.

V

CONCLUSIONS

As intertemporal decision-making involves anticipations of what the uncertain future holds, and as dynamic economic processes are sensitive to these anticipations, economic theory must enquire into how expectations are formed. As discussed in Ch. I, an early important trend in economic thinking was to regard expectations as purely psychological in character : forecasts are either flashes of intuition, or subjective inferences from the present state of affairs, or the result of the mass-psychology of market participants each of whom attempts to predict and conform to average opinion. One implication of these theories for economic modelling was that expectations could only be treated as exogenously given.

However, these theories gave way to econometric formulations of expectations : expectations were hypothesised to be induced solely by the past history of the variable to be predicted, and hence could be treated endogenously as extrapolations from the current and / or past values of the relevant variables. But, while these expectations schemes were fairly widely used in econometric research (especially, the error-learning model), one of their major drawbacks was that they arbitrarily restricted the information sets upon which economic agents based their forecasts. They completely ignored the influence of related economic variables, the

impact of policy announcements, major technological improvements, etc., on the forecasts of market participants. Furthermore, they resulted in a systematic pattern of forecast errors. These errors, with their consequent misallocation of resources by economic agents, are costly, and rational individuals would have an incentive to weed out such regular errors. In fact, these expectations schemes appear to be divorced from the rationality postulate that underlies the bulk of economic theory. Optimising agents would not confine their attention to the past history of the variable to be predicted, but would presumably try to ascertain and estimate all the possible factors causing change in it.

The Rational Expectations Hypothesis is built on this very assumption of economic behaviour. The main thrust of the hypothesis is that as expectations are informed predictions of the future, and as information is scarce, rational individuals exploit all the available information in formulating forecasts. This means that agents try to fathom the process generating the actual observations of economic variables - the structure of the underlying economic model, the interrelationships among variables, the nature of the exogenous shocks, etc. - and accordingly estimate future values. Specifically, as explained in Ch. II, the forecasts of economic agents are postulated

to be unbiased predictions of the relevant economic variables and are equivalent to the mathematical expectation of these variables, conditional on a set of information containing the underlying economic model, the data on variables etc. That is, if the particular model continues to describe the market or the economy in question, the forecasts of rational agents will, on an average, be confirmed by actual realisations. In individual instances or in particular periods, the forecasts may deviate from the actual values, but these forecast errors are serially uncorrelated. Agents consciously avoid committing systematic forecast errors, and if errors do display a regularity, then its cause is ascertained and forecasts accordingly improved. Hence, expectational errors fluctuate randomly around an (mathematically) expected value of zero.

As has been argued in Ch.II, the Rational Expectations Hypothesis is a distinct improvement on the earlier expectations hypotheses in so far as it brings expectations in line with the rest of economic theory by invoking the principle of rational economic behaviour, and by requiring economic agents to carefully analyse the available information on all the forces that determine the future before forming a forecast. But whether forecasts will, in fact, be unbiased, and forecast errors serially uncorrelated, is a moot point. The major pitfall in rational expectations

modelling is that it lacks a discussion of how agents actually acquire and process information. Ascertaining the true structure of the economic model, estimating its parameters, and so on, could be a fairly time consuming process during which economic agents may actually be making biased forecasts. And all economic agents may not have the capacity to undertake a detailed and elaborate estimation of the underlying model. An optimising agent would assess the costs and benefits of gathering additional information and may settle for a less expensive forecasting framework that employs less than complete information even though the consequent forecasts may be biased, and the errors serially correlated. As has been shown in Ch.II, in such cases, an autoregressive forecasting procedure may be the optimal one.

But if a particular autoregressive forecasting scheme has been the optimal strategy in a given set of circumstances it does not necessarily follow that it would be optimal in all conditions. As the nature of the economic process, including the policy regime, determining the future values changes, as costs of collecting information change, as forecast errors increase or begin to show a bias that can be (profitably) removed at little expense, forecasting schemes alter. The Rational Expectations Hypothesis serves to highlight this aspect of economic behaviour. The choice of a particular forecas-

ting scheme should be viewed roughly as an optimisation problem, the selection of a particular scheme being sensitive to the particular sets of (information) constraints. As Muth has argued, it is important to understand the kind of information that market participants use and how forecasts change with changing information, instead of arbitrarily assuming that they adhere to a specific autoregressive forecasting procedure.

Consequently, economic theory must enquire into the particular sets of information that are gathered by agents for expectations-formation, and their associated costs. It would presumably be easier and relatively less expensive for an economic agent to acquire information that is directly connected with his particular economic activity. Information related to other activities and occupations may be of secondary interest to him, may require more effort and expense in its collection, and hence, may be partially ignored. A steel manufacturer, for example, would find it imperative to be accurately informed about the prices of iron, coal, and other inputs, and their supplies, the state of technological progress in the steel industry, the prices of all related metals, the availability of labour of the required skills, future steel demand prospects, and so on. This information may be available to him in the ordinary course of his work and at little

expense. However, he may not consider it necessary to be as accurately and exhaustively informed about various agricultural outputs, for example, and their prices, for they are not directly related to his activity, and hence, this information could require more time and effort in its collection. Information costs are, therefore, likely to vary across individuals. Furthermore, with any technological progress that improves the process of collecting and providing information, economic agents are likely to use broader and more detailed information sets. Hence, an expectations theory must adequately explain why (and predict) a particular information set is used by an individual, what is the forecast obtained from it, whether such forecasts deviate from the rational, full information forecast, and what are the implications of these deviations. Further, if information sets differ among economic agents, it is necessary to assess the consequent differences in their expectations, and the implications thereof for market prices, outputs etc.

In fact, though Muth admits that expectations of individual producers, for example, may not be uniform, the expectation of producers in the aggregate (or the market expectation) would be a rational forecast. But when expectations are diffuse it is quite unclear as to what combination of these separate expectations

represents the market expectation. One approach is to compute the average of individual forecasts, but again there is no explanation as to why this average should represent the market forecast.

The Rational Expectations Hypothesis has been applied in various areas of economic theory- the output decisions of firms in response to their price and sales anticipations, agricultural markets and the cobweb cycle theory, stock markets, forward markets, the term structure of interest rates, foreign exchange and balance of payments problems, unemployment, business cycles, and so on. Here, however, attention has been focussed on the macroeconomic implications of the hypothesis partly because of the importance of its implications for economic policy, and partly because the vastness of the literature makes a comprehensive study a difficult task.

The New Classical Macroeconomics discusses the implications of a rational expectation of monetary and fiscal policies. The policy neutrality proposition, which emerges to be the main conclusion of this discussion, denies the authority any powers of consciously and systematically controlling the real variables in the economy. Any systematic feed-back policy rule which sets policy instruments in response to observed values with a view to influencing them will be anticipated and accoun-

ted for by decision makers in advance. And any attempt to secure reductions in the rate of unemployment (below the natural rate) via a monetary expansion and the consequent increases in aggregate demand and inflation (as per the Phillips Curve trade off) will be frustrated. The increase in money-growth would only result in an immediate, equi-proportionate ^{rise} in the inflation rate, leaving output and unemployment unaffected. Of course, the neutrality proposition applies only to systematic and inherently predictable policy rules; any random or surprise component of policy rules will, by virtue of its being unanticipated, produce real effects.

However, as discussed in Ch. III, one of the crucial assumptions of the policy ineffectiveness proposition is that wages and prices are perfectly flexible, nothing hinders the adjustment of nominal wages, for example, to offset anticipated price increases, thereby maintaining real wages at original levels. But contracts are known to be drawn in labour markets, and prices are known to be set for appreciable lengths of time in product markets. This wage- and price-rigidity may, in fact, reflect optimising behaviour, for frequent revisions of wages and prices may be costly (as explained in Ch. III). But if wages and prices are unresponsive to changes in nominal demand, then the authority's control over the real variables is restored. Then a perfectly (rationally)

anticipated monetary policy can produce real effects given the existence of long-term contracts. Or, if prices are known to be administered and rigid in some sectors, then a rational expectation would incorporate this price inflexibility: prices would not be expected to change in areas where they are set for some time. In such conditions, an expansion in nominal demand would, at the fixed prices, imply a real expansion: at the original prices, producers find demands rising and accordingly raise their product outputs. Hence, during the period over which prices are fixed, an increase in monetary growth rates could secure output increases.

A corollary of the policy ineffectiveness proposition is that as perfectly anticipated monetary expansions result in perfectly anticipated changes in the rate of inflation, with output, unemployment etc. unchanged, there is no real difference between alternative anticipated rates of inflation. But one could question whether a very high and accelerating rate of inflation, though perfectly anticipated, is really equivalent to an anticipated moderate rate. Very high rates of inflation may, after all, weaken the confidence in the currency system and could lead ultimately to the breakdown of the system of monetary payments.

Secondly, a perfectly anticipated increase in the rate of inflation would occasion a portfolio readjustment by economic agents. With an expected increase in the rate of inflation, the rate of return to money holdings declines causing a shift to investment in real assets with the associated real effects, as discussed in Ch.III.

A valid and important point made by the new classical economists is that policy makers should be cautious in using empirically estimated macro-relationships as a guide to their future policy decisions. Estimates of macro-relationships obtained when a particular set of policies was in force, could become obsolete when policy changes are proposed. Economic behaviour of individuals which reflects their responses to expectations including expectations of policies, would undergo a change when new policies are adopted and expectations correspondingly altered. A policy maker then must first ascertain how economic agents' expectations and their responses thereto are revised with policy modifications for a better evaluation of the impact of the alternative policies proposed.

As discussed earlier, in the New Classical Macroeconomics, individuals are hypothesised to anticipate the systematic economic policies adopted by the government, as also any proposed changes in these policies.

This implicitly assumes that individuals fully understand the government's decision-making process and its responses to changes in the economy (which may, after all, be motivated by political considerations among other factors). That is, there must then exist a tested theory explaining the government's objectives and behaviour, which could then be used to forecast the policies that will be adopted in different circumstances. However, the existence of such a theory yielding a reasonably accurate description of government behaviour is perhaps doubtful.

Empirical tests of rational expectations as a forecasting procedure yield evidence that is somewhat favourable to the hypothesis. Heady and Kaldor's (1954) survey study does indicate that individuals try to predict future prices by first estimating future prices by first estimating future market demands and supplies, instead of merely reviewing the past behaviour of the relevant prices. The tests conducted by Pesando (1975) to examine the rationality of the Livingston inflation forecasts, however, may be subject to the following criticisms. As argued in Ch.IV, the efficiency and consistency hypotheses as defined by Pesando are not necessarily implied by Muth's rational expectations. If the inflation rate can really be described as a

distributed-lag-function of its past values alone, then rationality in expectations would require equality between the weights attached to previous inflation rates in the forecasting equation and those in the actual autoregressive process, as in Pesando's efficiency criterion. However, the inflation rate may not, in fact, be determined by an autoregressive process. Secondly, the consistency hypothesis which requires equality between the forecasts made at two different periods for the same period in the future, is not implied by rationality of expectations. The forecast made at the later date may be an improvement on the earlier one, for it would be based on additional information that was not available at the earlier period. However, some of the tests do support the efficiency and consistency hypotheses (e.g. Pesando (1975), Mullineaux (1978)). Tests by Figlewski and Wachtel (1981) to check whether forecasters make systematic errors rejected the Rational Expectations Hypothesis: inflation forecast errors were found to be serially correlated.

The empirical tests of the New Classical Macroeconomics have been more successful. Thomas Sargent's (1976) test of the neutrality of real variables (unemployment and interest-rate) to nominal variables such as money supply, the price level, government spending, etc. provide evidence strongly in favour of the policy

ineffectiveness proposition. McCallum's (1975,1976) estimates of the responsiveness of nominal wage rates to rationally anticipated changes in inflation (whereby real wage rates and, hence, employment are unaffected by expansionary policies), seem to vary with the specification of the equation generating price forecasts. Some of the estimates, however, imply that wages adjust fully to offset any anticipated changes in inflation.

An important set of studies investigates the sensitivity of output and employment to anticipated vis-a-vis unanticipated money growth. Robert Barro's (1977, 1978) work in this context yields impressive support for the New Classical Economics. The hypothesis that output and employment vary in response to anticipated monetary growth is rejected, whereas their responsiveness to unanticipated monetary growth is established. But Barro's money-growth specification, the estimates of which are meant to proxy rational expectations, appears quite ad hoc, as discussed in Ch. IV. One suspects that including variables such as the inflation rate, the interest rate, etc. (excluded by Barro) in the feedback equation may possibly water down the evidence favouring the neutrality proposition. However, a preferable approach would be to build up a model of money supply and demand which would explicitly allow for policy makers' reactions to changes in economic

variables that they wish to govern, their policy objectives, as also their estimate of the impact of changing money growth rates on the goal variables. This model would then lead to the specification of the policy feedback rule.

On the other hand, some empirical exercises have yielded evidence rejecting the neutrality proposition. The tests conducted by Mishkin (1982) indicate that the responsiveness of output and unemployment to unanticipated and anticipated monetary expansions depends specifically on the lag length of the latter. Including additional lagged values of anticipated and unanticipated money growth (explanatory variables in the output, unemployment equations), Mishkin finds that anticipated money movements are significant in explaining output and unemployment. This result goes against the neutrality proposition. In fact, it also contradicts the monetarist position wherein a monetary expansion may stimulate output increases in the initial phase, but in the long-run would affect only the rate of inflation, real variables reverting to their pre-expansion values.

The policy ineffectiveness argument has been presented mainly in the context of demand management policies. One could argue that policy efforts on the supply side would still be effective despite rational expectations. For example, alterations in the tax rate

structure may change the actual post-tax incomes of workers, thereby inducing work effort and augmenting labour supplies. And while, in the New Classical framework, the government is incapable of securing systematic deviations of employment and output from their natural levels, it is still in a position to affect the natural rates themselves by improving the information on the availability of jobs and labour supplies in the labour market, by altering the minimum wage legislation, by facilitating labour mobility, etc.

One question that remains to be answered is regarding the relevance of the new classical propositions to the Indian economy. Whether expectations of economic agents in India are formed rationally or not is an issue that can be empirically tested. However, one could visualise decision-makers trying to predict future values of variables important to them by first analysing their determinants, in the Indian context as well. One must then ascertain the information conditioning their forecasts: whether individuals consciously try to understand the economic processes generating observations, the costs involved in obtaining this information, whether the benefits from the improved forecasts make it worthwhile to incur these costs. Furthermore, the ability of

economic agents to forecast government policies will depend on whether a systematic policy rule is, in fact, being followed, whether there is an adequate explanation of the government's decision-making whereby policy changes can be anticipated. The announcement of a long term fiscal policy, for example, would lead individuals to first assess whether the authority would in fact adhere to (indeed whether it will be able to adhere to) its declared policy, and then forecast the consequent impact on economic variables.

However, one obvious qualification to applying the policy ineffectiveness proposition in the Indian context is the observed presence of administered prices. All major fuel and fertilizer prices, for example, are fixed by the government or its administrative authorities. The larger steel producers are obliged to follow the prices set by the governmental authority, the smaller manufacturers allowed to vary their prices in response to market demand. Similarly, the amount of sugar to be allocated through the public distribution system at the administered prices, is also determined by the government, the rest of the sugar output then supplied in the free market. Hence, prices of major inputs and products may change only after long intervals, and during the interim period an excess demand or supply may persist. A rational expectation of the

price level must then account for those sectors in which prices are fixed and those in which they are free to vary, and the relative importance of each.

A more basic question, however, relates to applying the Natural Rate Hypothesis for explaining Indian unemployment and output data. One approach to explaining Indian unemployment is the lack of complementary capital assets to absorb the labour force. One must then determine the amount of unemployment that can be described as structural unemployment and then examine whether the remainder is really caused by expectational errors as per the Natural Rate Hypothesis.

On the other hand, one could maintain the relevance of policies that consciously attempt to improve output levels, growth rates, employment, etc. by working on the supply side. Entrepreneurs are observed to respond favourably to incentives such as tax cuts, subsidies etc.; industrial output is known to increase with government investment in infrastructure.

In conclusion, the New Classical Economics provides a hypothesis of expectations formation, which is attractive in so far as it brings expectations theory closer to the mainstream economic theory based on the assumption of rational economic behaviour. And while its policy

ineffectiveness proposition is subject to a number of important qualifications, it does highlight the need, while appraising the effectiveness of the alternative policies that may be proposed, to explore how economic agents' expectations and market decisions change with changing policies.

ABBREVIATIONS USED IN BIBLIOGRAPHY

AER	American Economic Review.
BREA	Brookings Papers on Economic Activity.
EJ	Economic Journal.
JEL	Journal of Economic Literature.
JET	Journal of Economic Theory.
JMCB	Journal of Money, Credit and Banking.
JME	Journal of Monetary Economics.
JPE	Journal of Political Economy.
OEP	Oxford Economic Papers.
QJE	Quarterly Journal of Economics.

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