The Economic Analysis Of Expectation Formation And The Rational Expectation Hypothesis

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INTRODUCTION

The idea.of "rational expectations" has had a profound impact in shaping the economic theory. More dramatically, it has shaken the foundation of macroeconomic theory and has been associated almost exclusively with the so called New Classical revolution in macroeconomics. This idea is revolutionary because it attempts to focus attention on the underpinnings of economics: individual behaviour. Essentially, it enhances the behavioral assumptions of the "rational economic man" made by the conventional economic theory. This enhancement is done by extending the notion of rationality to the learning process. How do people learn? How do they acquire and process information to make accurate decisions? How do they handle uncertainty? More generally, do they posses the cognitive abilities to undertake complex decisions in an uncertain world? These questions were addressed implicitly by John Muth in explaining expectational behaviour. In his famous pathbreaking article (1961), Muth observed that even though expectations play a very important role in shaping the behaviour of economic agents, no theory of expectation formation was developed that was consistent with empirical evidence and principles of economic theory.

Our goal in this paper is to present a critical review of expectations formation in the context of a theory of informational efficiency.

THE PROCESS OF EXPECTATION FORMATION AND UNCERTAINTY

The goal of economic theory is therefore to model individual behaviour in an uncertain world. This 'endeavor" is undertaken through the standard methodological approach: constrained optimization in a defined institutional framework. In this approach, the most salient characteristic of the decision problem is "[that] the consequences of [the decisions] are uncertain at the time the choice is made" (kreps, 1990, p. 71). Therefore, following Perasan (1987, p. 11), we can say that "a decision-making process is subject to uncertainty if the individual decisionmaker is not perfectly aware (or knowledgeable) of the consequences of his/her actions."

Uncertainty, generally speaking, arises from "imperfect information" or from "unpredictable" events or from a combination of both. These situations are evident when we introduce the time dimension into economic behaviour. Production and consumption take time, imposing restrictions on the decisions of producers and consumers. As Arrow (1989, p. 15) has emphasized, "the future conditions under which production and consumption will take- place must be anticipated, for they are not currently known." These anticipations or expectations consequently play an important role in current decisions since as indicated by Arrow (1989, p. 15) that "the image or expectation of the future ... shapes the present."

In this line of thinking, the implications of expectations for economic theory are evident. G. K. Shaw (1989, p. 22) explains that "the point, however, is a simple one, namely that utility-maximizing agents form expectations in their decision-making process and if economic theory is to be able to explain the behaviour of economic agents it must be capable of taking expectations formation-and more importantly changes in the pattern of expectations formation-fully into account". We must add that expectations in our case emerge from the consideration of dynamic economic models in which the problem for the economic agent is one of finding the optimal path to be followed through time, or as Silberburg (1990, p. 614) indicates, one in which "decisions made in the present affect decisions in the future". It, therefore, becomes necessary to make the concept of expectations more precise, and to indicate in a more sensible way why the concept plays such an important role in economics.

WHAT ARE EXPECTATIONS?

We are interested here in a conceptual approach towards expectations . Perasan (1987, p. 14) notes that expectations are 'attitudes, dispositions or psychological states of mind' that relate to events the outcomes of which are uncertain. In this general sense, expectations are psychologically held subjective beliefs that may or may not be related to the

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individual's past experience or his present perception.
The above interpretation of expectations has a strong psychological content. Carter and Maddock (1984. p. 13) state that expectations are essentially subjective-the personal judgement of a particular individual. They do not have an independent existence apart from the person or decisionmaker who holds them. One important consequence of this interpretation of expectations is that it assumes implicitly the existence of a learning process by which the individual develops or forms those subjective beliefs. Assuming that these subjective beliefs can be represented by probability measures, the learning process is described by Perasan (1984. p. 33) in a general way as a trial-and error elimination process. Trial (formulation) of new theories, and elimination (or rejection) of false theories or models in the basic process according to which learning normally takes place. In practice, this ongoing process can be carried out by means of classical statistical inference or by resort to Bayesian techniques. Whether such a learning process is capable of 'narrowing down' the discrepancy that may exist between subjective beliefs and the true state of the world very much depends on the nature of the data generating process, the available information, and the agents' degree of a-priori understanding of the way the economic system functions. The existence of this learning process is reinforced by the existence of uncertainty. It implies that imperfect information and unpredictability force the individuals to learn in such a way that satisfy the considerations mentioned above. It also implies that since learning takes time and effort, there must exist some motivation that induces the individual to be engaged in such a process. These considerations will become important at the time of considering the ways in which expectations could be modelled.

THE ROLE OF EXPECTATIONS IN ECONOMICS

According to Carter and Maddock (1984. p. 12) "expectations are essentially forecasts of the future values of economic variables which are relevant to current decisions".
These forecasts, whether true or false affect, the decisions of economic agents, and these decisions aggregated in the markets influence the development of the economic activity. In fact, as Muth (1961, p. 315) explains, "That expectations of economic variables may be subject to error has, for some time, been recognized as an important part of most explanations of changes in the levels of business activity". This indicates that in their attempt to construct relevant economic theories, economists must develop a modelling strategy that specifies the process by which expectations are formed. As Seffrin (1983. p. 4) notes, "progress in economics. Therefore, seemed to require a working. Quantitative knowledge of how expectations were formed."
To that demand there has not been shortage of supply, since economists have developed different ways to model expectations formation. Among them, the rational expectations hypothesis has been at the center of deep and heated debates. In the next section, we will explore different hypotheses about how expectations are formed. Special attention will be paid to the rational expectations hypothesis and how it differs from the other hypotheses.

HYPOTHESIS OF EXPECTATION FORMATION

In this section we will discuss different hypotheses through which expectations' formation has been modeled. Not surprisingly, the order in which they are presented follows an intrinsic historical pattern. As a result, each hypothesis could be regarded as if it replaces the previous one by improving some aspects of the formulation. This section is divided into three sub-sections: (1) this introduction, (2) Non-rational expectations hypotheses (NREH) , and (3) the rational expectations hypothesis (hereafter REH).
Under the heading of NREH, we will discuss four different hypotheses with respect to expectations formation. They are: static expectations, Keynes' view of expectations, extrapolative expectations, and adaptive expectations. In order to compare all these hypotheses, we adopt some standard approach and consider the following points: (1) since the goal of each hypothesis is to be an element of a dynamic model, it should be expressed as a formula (with the exception of the Keynes' view, this is true of all the hypotheses). (2) Each hypothesis should consider the following elements as noted by Muth *1961, pp. 315-316) : What kind of information is used and how it is put together to frame an estimate of future economic conditions is important to understand because the character of dynamic processes is typically very sensitive to the way expections are influenced by the actual course of events. Furthermore, it is often necessary to make sensible predictions about the way expectations change when either the amount of available information or the structure of the system is changed. (3) How each hypothesis improves the formulation with respect to the previous one.

NON-RATIONAL EXPECTATIONS

STATIC EXPECTATIONS

This hypothesis can be regarded as the simplest way to model expectations formation. It assumes essentially as G. K. Shaw (1984, pp. 19-20) states that conditions prevailing today will be maintained in all subsequent time periods. Expected future values then becomes identified with current values.

The well-known cobweb model of a market typically characterizes this hypothesis. In this type of model, as mentioned by Carter and Maddock (1984, p. 14) there exists" ... some delay between the production plans and their realization", Formally, suppose that for a particular market, demand in period t depends upon the price in period t. This is represented by the following linear demand functions:

$$Qt^d = a - bPt \qquad (3.1)$$

Where a and b are positive constants, Qt^d represents the quantity demanded in period t, and Pt represents the price in period t.

The quantity supplied in period· t depends upon what the firms expected to be the price that would prevail at t when they make their production decision. Therefore,

$$Qt^S = C + dpt^e \qquad (3.2)$$

Where c, d are positive constants, Qt^S represents the quantity supplied in period t, and pt^e represents the price expected for period t.

The equilibrium condition is:

$$Qtd = Qt^s = Q_t \qquad (3.3)$$

Using (3.3) and the right-hand sides of (3.1) and (3.2) we solve for Pt in terms of p_t^e**:**

$$Pt = (a-c)/b - (d/b)P_t^e \qquad (3.4)$$

In equation (3.4) the equilibrium price in period t (P_t) is a function of the expected price for this period (P_t^e). However, since pte is not observed, this model is not operational. For that reason, we need to specify how p_t^e is determined.

The simple specification of the cobweb model is that firms' supply decisions in period t depend linearly on the market price that prevailed in period t-1. In other words, the cobweb model has an additional behavioral assumption:

$$p_t^e = P_{t-1} \text{ (Expectations)}$$

In consequence, we can use this equation to obtain an operational expression for P_t^e by substituting it into equation (3.4), the resultant equation is called the "reduced form equation" since it relates the equilibrium price to known constants (a, b, c, and d) and the known past price variables **Pt-1:**

$$P_t = (a-c)/b - (d/b)\, P_{t-1} \qquad (3.5)$$

The stability properties of equation (3.5) depend upon the values of a, b, c and d^1. The typical stable cobweb pattern is illustrated in figure 1.

The main elements implicit in the static expectations hypothesis described in the cobweb model can be summarized as follows: (a) The information used to frame the expectations contains only the facts of the current situation. G. K. Shaw (1984, p. 20) notes that "more distant experiences tend to be more heavily discounted and very distant may be ignored in the formation of one's expectations of the future".

(b) The static expectations hypothesis is very rigid. The economic agents do not learn from their experience. This is reflected in the fact that even though the cobweb market follows a predictable regular pattern, the assumptions of this model do not permit any learning on the part of the economic agents.

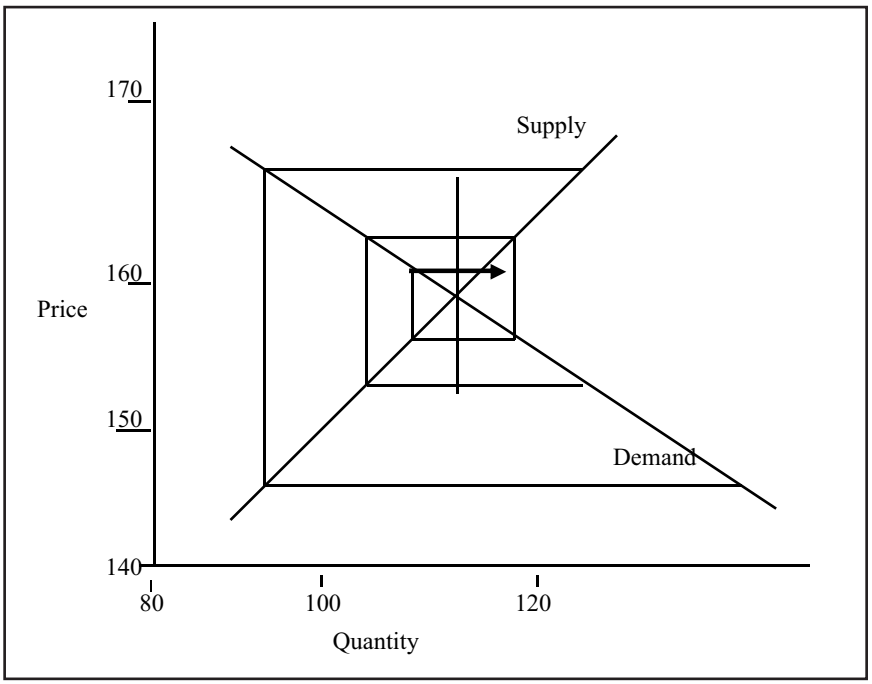
(c) Related with (b), the behaviour of the firms does not take into account the impact of similar actions of other firms.

In conclusion, the static expectations hypothesis is a very naive way of forming expectations. As G. K. Shaw (1984, p. 21) correctly indicates "The static expectations individual not only suffers from myopia, but also from an extreme form of amnesia". The static hypothesis could be relevant only if the economy has achieved steady state equilibrium. In fact, most of the classical economists assumed the existence of static expectations. This creates the connection with the Keynes' view of expectations, which he himself considered a main departure from the classical view.

KEYNES' VIEW ON EXPECTATIONS

As G. K. Shaw (1989, p. 23) recognizes "There can be no doubt that Keynes laid great emphasis upon the importance of expectations".

Fig 1: The Convergent Cobweb Pattern



However, for Keynes, expectations are determined exogenously". These two conclusions are derived from two important considerations: first, economic agents are involved in decision-making processes with an uncertain future. Secondly, that this uncertainty is such that there is no clear mathematical basis to formulate any expectation; as G. K. Shaw (1989, p. 24) states "there is nothing other than a state of ignorance". All these conclusions, according to Begg (1982, p. 19). " ... rested on the belief that individuals possessed only scanty information about uncertain future events" and it is this type of uncertainty which constitutes the basis for the unstable nature of long term expectations with respect to investment demands. In Keynes' words ... a large proportion of our positive activities depend on spontaneous optimism rather than on a mathematical expectation ... Only little more than an expedition to the South Pole, is it based on an exact calculation of benefits to come. Thus if animal spirits are dimmed and the spontaneous optimism falters, leaving us to depend on nothing but a mathematical expectation, enterprise will fade and die ... (l936,.pp. 161-162).
Under this consideration, Keynes recognizes that expectations formation relies "... upon conventional valuations 'established as the outcome of the mass psychology of a large number of ignorant individuals' and subject to violent change" (Shaw, 1989, p. 25). Then the only way to incorporate expectations logically into formal model analysis is by the assumption of exogeneity. In consequence, as Begg (1982, p. 20) states," The 'General Theory' sets itself the limited task of analyzing the behaviour of current endogenous variables conditional on a particular set of exogenous expectations about the future", G. K. Shaw (1989, pp. 25. 25-26) further notes. The key Keynesian dilemma derives not only from the lack of adequate information on key issues but also from a rather pessimistic view of the way in which individuals behave in forming expectations in the absence of information. It is not easy to model behaviour, which depends upon capricious whim or animal spirits.

EXTRAPOLATIVE EXPECTATIONS

The extrapolative expectations hypothesis was developed by Metzler (1941), in an attempt both to improve the naive approach of the static expectations and to consider expectations as endogenously determined. Metzler considered that future expectations do not only depend upon current levels of the economic variable, but also on its direction of change. Consider the expectations about the future price level of a commodity: if P_{t-l} is the price level in period t- I, and P_{t-2} the price level in period t - 2, the extrapolative expectation for period t is represented by :

$$P_t^e = P_{t-1} + \epsilon (P_{t-1} - P_{t-2}) \qquad (3.6)$$

Where Є is defined as the "coefficient of expectation". Thus, the expectation predicted for the extrapolative formula at

any period is equal to the price level in the previous period plus (or minus) a proportion of the change between two periods. We can then describe the salient characteristics of this hypothesis as follows:
(a) The individuals use a wider range of information than in the static case. They not only look at the current value of the variable to be predicted, but also the evidence that could exist in its trend (contained in the actual values for the two preceding periods). In addition, the individuals look at the structure of the model to determine the value of Є. In fact, the value of Є determines the behaviour of the model. As an example, consider the cobweb model . Given the regular pattern described by this model, a value of Є<0 is clearly appropriate in those circumstances, "This is a simple
(b) demonstration of the notion that the appropriate expectations mechanism depends upon the structure of the model."
(c) The behaviour of the models in which the extrapolative mechanism is used can follow different patterns. This gives higher variety to those models since they can adapt themselves to different situations. This is due to the fact
(d) that the extrapolative expectations mechanism is a second order difference equation, which has a much higher dynamic behaviour.
(e) The main weakness of the mechanism is that "although past trends are considered, past expectations-and in particular past experiences-are not" (G. K. Shaw, 1989, p. 27). In other words, people do not learn from their past experiences.
This last remark leads us to examine the following expectation mechanism: Adaptive Expectations.

THE ADAPTIVE EXPECTATIONS HYPOTHESIS (AEH)

The adaptive expectations hypothesis was first introduced by Cagan (1956) in the context of a hyperinflationary environment. This expectation mechanism could be viewed within the framework of a model of behaviour: adaptive behaviour. Individuals learn from their past experience and more particularly they learn from their mistakes. The AEH asserts that:

$$P_t^e - P_{t-1}^e = \Phi\,(P_t - P_{t-1}^e) \qquad (3.7)$$

where P_{t-1}^e is the expectation based on information available at the end of the period t-2. At the end of the period t-1, individuals inspect how well their expectation predicted the actual value P_{t-1} and revise their expectation for the level of Pt at period t by some fraction of the error made at t -1.
Rearranging terms in (3.7) yield:

$$P_t^e = P_{t-1}^e + \Phi\,(P_{t-1} - P_{t-1}^e)$$
$$= \Phi P_{t-1} + (1-\Phi)\,P_{t-1}^e \qquad (3.8)$$

Since the same formula must hold for one earlier period,
We have: $P_{t-1}^e = \Phi P_{t-2} + (1-\Phi)\,P_{t-1}^e$.
Through successive substitutions we eventually obtain:

$$P_t^e = P_{t-1} + \Phi(1-\Phi)\,P_{t-2} + \Phi(1-\Phi)^2 P_{t-3} + \ldots + \Phi\,(1-\Phi)^n P_{t-n-1} + (1-\Phi)^{n+1} P_{t-n-2}^e \qquad (3.9)$$

In equation (3.9) all terms are observable except Pt^e-n-2.However, since Φis a positive fraction, as n gets larger, $(1-\Phi)^{n+1}$ gets smaller. This point has a double significance. First, it recognizes that individuals grant greater weight to more recent experiences and second, as Begg (1982, P. 23) notes that AEH allows us to model unobservable expectations purely in terms of past observations on the relevant variable P, without the need to specify the process by which the initial level of expectations is determined.

The following are then the most salient characteristics of the AEH:

(a) The AEH generates an expectation mechanism that is intuitively appealing. In this mechanism, individuals use a wide range of past information about the variable to be forecasted, learn from past mistakes and assign greater weight to the most recent experiences. Furthermore, AEH provides a way to introduce expectations in econometric models, (formally: a distributed lag with geometrically declining weights).

(b) The shortcomings of the AEH emerge first from the fact that it incorporates only past values of the variable to be forecasted. Thus, the AEH does not consider information either about the past values of "other" variables, or about contemporaneous events or facts that can affect sensibly the future value of the variable of interest. Second, as Begg (1982, p. 26) indicates that all mechanistic backward looking extrapolative rules allow the possibility of systematic forecasting errors for many periods in succession. The sub -optimal use of available information hard to reconcile with the idea of optimization, which is the foundation of most microeconomic analysis.

(c) There is no economic justification or a particular value of Φ, and in circumstances of continuous and exogenous changes, the AEH renders an undeniable sub - optimal mode of behaviour.

It is precisely those criticisms of the AEH, and in general the discomfort with ad-hoc non-rational hypothesis, that led economists to search for additional hypothesis of expectations formation. They sought for hypotheses that were: first, more consistent with economic principles, and second empirically relevant. As Muth (1961, p. 315) noted "To make dynamic economic models complete, various expectations formulas have been used. There is, however, little evidence to suggest that the presumed relations bear a resemblance to the way the economy works". The following section deals with the hypothesis that can bear such resemblance: the rational expectations hypothesis.

THE RATIONAL EXPECTATIONS HYPOTHESIS (REH)

The expectations hypotheses discussed above have two elements in common. First, They are arbitrary or ad-hoc hypothesis about how economic agents form 'expectations concerning degree of rationality on the part of the economic agents, but none of them assumes full rationality. The rational expectations hypothesis attempts to correct these two elements by applying the basic assumption of economic behaviour: optimizing behaviour. This attempt was first introduced by John Muth (1961), who believed that through this strategy it is possible to obtain a better understanding of how expectations are formed. In Muth's (1961, p. 316) words "It is sometimes argued that the assumption of rationality in economics leads to theories inconsistent with, or inadequate to explain observed phenomena, especially over time. Our hypothesis is based on exactly the opposite point of view: that dynamic economic models do not assume enough rationality".

The Application of the rationality principle used in economics leaded Muth to formulate the REH in the following terms "Expectations". Since they are informed predictions of future events, are essentially the same as the predictions of the relevant economic theory, the hypothesis asserts three things :

(i) Information is scarce, and the economic system generally does not waste it,

(ii) The way expectations are formed 'depends specifically on the structure of the relevant system describing the economy;

(iii) A 'public prediction' ... will have no substantial effect on the operation of the economic system (unless it is based on inside information)" (Muth, 1961, p. 136).

In other words, to assume 'enough rationality', it is necessary that the expectations of economic agents must be consistent with the models used to explain their behaviour. Sheffrin (1983, p. 5) argues that Muth's insight was that it was possible to require economic agents to form expectations of economic variables by using the very model that actually determined these variables. This ensured that the behaviour of the model was consistent with individual actors' beliefs about the behaviour of the economic system.

The use of the 'relevant model' and the information to be processed with that model imply that Muth reasoned that the economic agents 'economize' in the use and processing of information. In this sense, information is considered as just another resource which will be acquired and processed up to the point where "the perceived marginal benefits from doing so (in terms of an improved expectation of the future or an expectation held with greater certainty) exceed the marginal cost of acquiring and processing the relevant information" (G. K.Shaw, 1984, p. 48). Furthermore, it is also implied that individuals will adapt their behaviour to changes in the information available, if these changes affect the costs and benefits of their expectations. As Begg (1982, p. 28) states "[The REH] is concerned with incentives to acquire information and exploit profitable opportunities for revising behaviour".

To make these ideas operational, the hypothesis can be rephrased a little more precisely as follows: that expectations of firms (or, more generally, the subjective probability distribution of outcomes) tend to be distributed, for the same information set about the prediction of the theory (or the 'objective' probability distribution of outcomes). (Muth, 1961, p.316).

This means that subjective expectations of people are, on average, equal to the true values of the variable. The above statements can be formalized in the following way: if P is the variable to be predicted, $_{t-1}P_t^e$ (or P_t^e) is the subjective, psychological expectation for Pt (made at the end of t-l) and I_{t-1} is the set of information available at the end of t-l, then subjective expectation is equal to objective expectation i.e.

$$_{t-1}P_t^e = E[P_t/I_{t-1}]$$

Thus, as Sheffrin (1983, p. 8) concludes " ... there is a connection between the beliefs of individual economic actors and

the actual stochastic behavior of the system".
According to the ideas discussed above, the properties of rational expectations (RE) are the following:
(1) The RE are unbiased. This means that the exceptional terror is defined as the difference between the actual outcome (Pt) and the forecasted outcome (Є(Pt)), then

$$\text{Єt} = \text{Pt} - \text{E[Pt/It-1]h}$$

Where Єt is a random variable
Since economic agents do not use all the information and since any information has some degree of uncertainty, RE do not imply perfect foresight. Sheffrin (1983. p. 9) notes "The REH differs from perfect foresight because it allows for uncertainty in economic systems". What this implies is that E [Єt] = O which means that "Expectations are not systematically and hence predictably. Wrong in any particular direction" (Peel, 1990. p. 74).
(2) The expectational error is uncorrelated with any relevant information that is available to economic actors at the time expectations are formed. This property is called the "orthogonality principle" and can be expressed as

$$E\ [\text{Єt} * I_{t-1}/\text{It-1}] = 0$$

This means that economic agents do not make systematic mistakes. For if there would exist any connection of this type, economic agents could take advantage of this knowledge and improve their expectations of the future outcome. Statistically speaking, consider the regression (see Peel, 1990. p.75)".

$$\text{Єt} = \text{Pt}\ E[P_t] = a + bZ_t + u_t\ \text{Є}$$

where Zt is a random variable known at the time expectations are formed, a and b are constants, and u_t is an error term. Then, if expectations are rational, a and b are not statistically different from zero and u_t is the error term.

(3) RE are consistent. This means that expectations about the same variable formed at different points in time must be consistent with each other. This implies that they must differ only by new information. Given that this information is unpredictable, they differ only by a random term.
These three properties guarantee that the RE is optimal. In fact the optimality of the RE is determined by the fulfillment of these three properties. This point opens several interesting questions to the REH. For example, what is the minimum amount of information required for the REH in order to generate expectations that are optimal (rational)? What cognitive abilities does the REH require from the economic agents? Or more generally, what is the process of learning implicit in the REH? These questions need to be addressed before REH may be used in empirical estimation.

CONCLUSION

Expectational behaviour is a very important aspect of economic behaviour. In consequence, economic theories are very sensitive to the way the economic model are formulated and applied in empirical work. Without proper understanding of the expectation formation, empirical estimation may provide misleading policy prescriptions.
This paper is a critical review of the literature related to expectation formation of economic agents. Sometimes expectations are static in the sense that economic agents do not learn from past experience. Sometimes, they adjust their future expectation on the basis of past experiences. Adaptive expectation hypothesis models expectations by adjusting past experiences. Expectation about future events may also be formed rationally. The rational expectation hypothesis attempts to model expectation by assuming rationality of the economic agents. It emphasizes that economic agents form their expectations by using their knowledge of correct structure of the economy and other relevant information, and by processing this information in an efficient way. Essentially, it says that people do not make systematic mistakes. The idea about rational expectations implicitly assumes the availability of a set of information and of a particular learning process. This guarantees that the rational expectation is unbiased, orthogonal, and consistent.

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