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ARTICLES

A Critique of Adaptive and Rational Expectations

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In contemporary economic theory, and especially in macroeconomics, expectations are being given a central place. There is virtually no economic model that does not examine how, within a dynamic perspective, the explicit account of individuals' expectations qualifies the conclusions of the static analysis. To a certain extent this prominent place is well founded, for expectations of future events do motivate present actions and thereby influence social phenomena as they occur in reality. However, contemporary macroeconomists go a step further. They also maintain that a specific *model of the formation of expectations* is necessary in order to assess the role played by expectations, and ultimately to build economic theory itself.[1]

The goal of this paper is not to study the foundation of this point of view, or the proper way for economists to fathom the importance of expectations. Its more limited scope is to examine to what extent the two most common models of expectations formation attain their end. This end is to convey and exemplify the role expectations play in the manifestation of even the most basic economic phenomena, such as the determination of quantities produced and the formation of prices.

Expectations are the unobservable opinions about the future that individuals form in their minds. In the absence of a clear-cut conclusion from cognitive sciences as to the objective, observable, determinants of human thoughts, economic models of expectations formation can be but arbitrary assumptions. From this standpoint, these

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[1]Here are two examples of this quasi-unanimously held view: "In short, it is impossible to provide a sensible treatment of macroeconomic theory without resort to some model of expectations formation" (Begg 1982, p. 6). "A clear understanding of macroeconomic phenomena obviously assumes a clear understanding of how forecasts are made" (Malinvaud 1998, p. 23).

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models are in perfect harmony with the prevailing methodology of positivism, which does not inquire about the truth of a hypothesis but verifies whether it works or not in some well-defined way (Friedman 1953). In a sense, what we want to do here is to pursue this positivist stance to its ultimate end in the case of the models of expectations formation, by means of a verification whether these models work or not.

To test this we examine in detail two such hypothetical models: *adaptive expectations* (AE) and *rational expectations* (RE). We do not discuss Hicks' (1939, p. 205) precursory *elasticity of expectations* or *extrapolative expectations* specifically because our general comments about AE extend to them as well and to other similar assumptions, as we will show in the first section. Rational expectations, which has become the standard hypothesis in mainstream economics, is explored in depth. In our section two we examine the various attempts to rationalize rational expectations, while the third and last section will present its true essence and its far-reaching consequences.

The Content and Implications of the Adaptive Expectations Assumption

The hypothesis of adaptive expectations has been proposed in two different contexts: price formation and the determination of (hyperinflationary) monetary equilibrium.[2] In the work of Nerlove (1958), AE served to examine the stability of the equilibrium price in agricultural markets, with reference to the well-known cobweb phenomenon. In the work of Cagan (1973), AE was used as a working test of the hypothesis that the demand for real cash balances is affected by expected price changes.

Adaptive price expectations means that at each new time period the individual revises his expectation of the future price in view of his current expectational error, i.e., the discrepancy between his expectation of the current price and the actual current price. The expectation for the new period is formed as the sum of the past expectation with the expectational error, weighted by a coefficient of revision of expectations.[3] The charm of the AE assumption is the generality of its formulation which allows for various interpretations according to the value given to the coefficient of revision. Simple mathematics show, that if it takes the value of zero, then expectations are independent from prices, i.e., they are *autonomous*. If the coefficient is given the value of one, then the expected future price coincides with the current price, and expectations are then called *static*. For all intermediate values, the expected future price is an arithmetic average between the realized current price and its expected value from the previous period. It is easy to show, through the so-called Koyck transformation, that in this case the expected future price is equivalent to an arithmetic average, with geometrically decreasing weights, of the entire history of actual realized prices. This middle case of *induced* expectations implies that while the individual does revise his expectations according to his errors, he is also sensitive

[2] Broadly speaking, these contexts correspond to a traditional division of economics in price (micro) theory and monetary (macro) theory, inherited from the classical economists. Cf. Rothbard (2004, pp. 268–76) for a critique of this division, an exposition of the crux of the problem, and a suggestion for its solution.

[3] The coefficient of revision is also sometimes referred to as the speed of the adjustment process, for reasons that will become clear from our own exposition.

to the whole trend of prices and not only to the latest realized price. In the own words of the pioneer:

> Expectations of future prices may be autonomous, induced, or divided into two components, one of which is autonomous, the other induced. Induced expectations are the result of movements in past prices. Only induced price expectations are amenable to economic analysis in the present context.... When current price increases, farmers may be expected to discount some of the increase, i.e., they will not believe the permanence of the entire change. Arrow and I have called such induced expectations "adaptive" (Nerlove 1958, p. 231).

Cagan's definition of adaptive expectations is identical, though he applies this formulation not to price levels, but to price changes: "The expected rate of change in prices is revised per period of time in proportion to the difference between the actual rate of change in prices and the rate of change that was expected" (Cagan 1973, p. 37).

In the traditional analysis of the cobweb phenomenon, supply behavior is entirely ruled by the past price, which is as a matter of fact the suppliers' *static* expectation of the current price, while demand responds solely to the current price. Stable equilibrium requires not only that supply and demand are equal, but also that the producers' plans are confirmed in reality. This means that the price expected by suppliers, i.e., the past price, must coincide with the current price. The only new element in Nerlove's more general presentation is the dependency of the supply behavior on adaptively, and not statically, formed expectations of the current price. Nerlove's goal then is to examine how AE modify the dynamic path toward equilibrium. His main conclusion is that "the possibility of stability is much improved when adaptive expectations are assumed," even though it is not certain that it will always take place (Nerlove 1958, p. 233).

When examined more carefully, however, Nerlove's generalization amounts to a very particular transformation of the initial cobweb model. Assuming that the market always equilibrates supply and demand in the short-run, the supply with adaptive expectations turns out to be equivalent to an arithmetic average, according to the coefficient of revision of expectations from above, and for any hypothetical price, of *current supply and past demand* from the traditional model.[4] This has the effect of smoothing the supply behavior, which brings about the higher chances of attaining long-term equilibrium. But what is then, in this formulation of the problem, the specific influence of expectations about current prices? The answer is none. What influences the supply behavior is exclusively the history of past prices. The supposedly forward-looking attitude of suppliers is completely lost.

This is a general criticism we can make to the AE hypothesis. When one states that expectations affect reality, if he assumes them to be adaptive, he is ultimately assuming that history, not expectations, affects the future. Adaptive expectations always boil down to a hypothesis of how past variables affect current variables. Therefore, formalizing expectations adaptively is contrary to the very purpose of building a theory of expectations. No model based upon the AE hypothesis can

[4]Notice that this transformation preserves the value of the long-term equilibrium price.

portray the autonomous influence of expectations on current or future variables. We can even make the more universal criticism that *any hypothetical explanation of expectations by other observable variables can but obfuscate their supposedly independent importance the model purports to exhibit.*

For the sake of a second example, Cagan's study of hyperinflation suffers from the same drawback. Contrary to what Cagan asserts, he is not testing "the hypothesis that changes in real cash balances in hyperinflation result from variations in the expected rate of change in prices" (Cagan 1973, p. 31). His econometric model actually tests the single hypothesis that *past* changes in the price level influence the demand for real cash balances. Then, the current price level is made dependent not upon the expected future price level, but upon its own history, and the role allegedly played by expectations fades away.

Adaptive expectations have not been criticized for this major shortcoming. Rather, economists have seen two other problems with this approach. The mild critics pointed out that the formulation is somehow ad hoc, given that the coefficient of revision is postulated exogenously by the model-builder,[5] and advocated an endogenous theory of expectations. The harsher opponents noticed that expectational errors may be correlated, and especially that expectations may significantly lag behind actual observations in the case of changes in the trend. This has been interpreted as implying that individuals do not learn sufficiently from the past, or that they do not have access to all the pertinent information when making their decisions. In short, the hypothesis of adaptive expectations has been seen as only partially accounting for individuals' rationality, to such an extent that it is now completely superseded by the only alternative that has been proposed since—the assumption of rational expectations. Let us first consider the very meaning of this hypothesis and the various rationales that economists have put forward for its acceptance.

The Rationalization of Rational Expectations

The main idea behind the rational expectations hypothesis is to consistently extend the principle of individual rationality from the problem of the allocation of resources to that of the formation of expectations. The individual is supposed to use all of the available pertinent information when formulating his forecast of prices, interest rates, and even government policies. Since Muth's[6] path-breaking article, economists consider that the most essential pieces of information the individual has use of are the predictions provided by economic theory. It is then easy to show, on the basis of

[5]However, cf. Khan (1977) for a model with adaptive expectations which allows the coefficient of revision to vary with time and/or with other variables. But this modification does not alter the essence of the AE hypothesis, neither does it remove its crucial shortcoming.

[6]To a certain extent, Mills' (1957) analysis of inventory optimization by the firm may be considered as a predecessor. Keuzenkamp (1991) has documented, convincingly, the claim that Tinbergen was the first to introduce the same concept in 1932.

a simple arbitrage reasoning, that individuals' expectations, on average, have to coincide with the predictions provided by economic theory:

> If the prediction of the theory were substantially better than the expectations of the firms, then there would be opportunities for the "insider" to profit from the knowledge—by inventory speculation if possible, by operating a firm, or by selling a price forecasting services to the firms. The profit opportunities will no longer exist if the aggregate expectation of the firms is the same as the prediction of the theory (Muth 1961, p. 318).

It is in this sense that Muth called expectations *rational*: "expectations, since they are informed predictions of future events, are essentially the same as the predictions of the relevant economic theory" (Muth 1961, p. 316).[7, 8]

Since the publication of Muth's article, economists have multiplied the definitions and the meanings implied by the concept of RE to such an extent that an exhaustive classification is certainly impossible. However, it is generally recognized that three definitions are prevalent. The first corresponds to Muth's original approach, according to which all individuals need not possess the same expectations of the objective distribution, but on average, "the weighted arithmetic mean of the expectations is equal to the prediction of the relevant economic model" (Redman 1992, p. 7). The second, narrowest possible, definition imposes that all individuals hold the same subjective probability distributions about future events, which additionally coincide with the objective distribution.[9] The third, weakest, definition merely assumes that individuals make "economically rational expectations" in the sense that they search for and process information only to the point where the

[7]From the very extensive literature on rational expectations, Begg (1982), Sheffrin (1982), Sargent (1993), and Pesaran (1987) are the classical texts. Kantor (1979), Maddock and Carter (1982), and Autume (1986) are other very good presentations. For applications of the hypothesis and a few critical observations, the reader may want to consult the contributions from two seminars dedicated to rational expectations, published by the *Journal of Money, Credit and Banking* (May 1980) and the *American Economic Review* (November 1984).

[8]Within a similar arbitrage-based approach Walters prefers to call such expectations *consistent*. According to Walters, profit-maximizing behavior pushes individuals to consult the best theories available to them, and in this way, by comparing competing and alternative forecasts, choose the best one, i.e., those emerge that do not differ on average from the objective realizations. He applies this approach to a case study based on the quantity theory of money:

> To give a short name to these profit maximizing expectations we shall call them consistent expectations.... Clearly, the actual change of prices differs from the expected change of prices only by a random component ε_t. Thus the expectations are *consistent* in the sense that the evidence adduced from observing the realized values will not on the average contradict the expectations formulated by this model (Walters 1971, pp. 274–75; emphasis in original).

[9]Even within this definition there are at least two versions. The weak version requires that only the conditional expectations (i.e., only the first non-centered moments) coincide, the strong version imposes that all the moments be identical, i.e., the subjective and objective distributions are one and the same. Obviously, the first version allows for distinct subjective distributions among individuals, provided that their conditional expectations are identical.

marginal cost becomes just equal to the marginal gain (Feige and Pierce 1976).[10] We do not need to enter into a discussion of which one of these definitions is the most immune to criticism or is the best according to some other criterion. We only need here to recognize that the RE hypothesis means that individuals' beliefs about the future coincide, be it in toto or for any single individual, with what the future objectively turns out to be. As a matter of fact, the third definition does not deny that this coincidence could happen, it only doubts that it will actually happen given the existence of some costs.

The RE hypothesis has been used first in the framework of the same problem of price dynamics to which Nerlove applied the AE hypothesis. Then, it has been relatively quickly applied in finance where it was used to sustain the claim of markets' efficiency (Grosmann 1976; Kantor 1979). Generally speaking, in price theory a rational expectations equilibrium means that the current price of an asset has already incorporated all the relevant information and that it is equal to the expected discounted future price. Furthermore, this rational expectations equilibrium has been assumed to imply that unknown bits of information are disseminated among market participants: *a rational expectations equilibrium reveals to all traders the information possessed by all of the traders taken together* (Radner 1979, p. 656; emphasis in original). Three distinct rationalizations of the RE assumption, which are not necessarily exclusive, can be identified.

Expectations and Rationality of Action

The first way of justifying the hypothesis of rational expectations is to present it as a coherent, and even unavoidable, extension of the rationality of human action to the sphere of expectations formation. This explanation is common today and is certainly rooted in Muth's seminal paper: "Our hypothesis is based on exactly the opposite point of view: that dynamic economic models do not assume enough rationality" (Muth 1961, p. 316). In other words, individuals' purposeful behavior, by virtue of its own nature, is said to be void of systematic expectational errors. If the same errors repeat over time, the individual could not be considered fully rational.

One problem with this justification, if one does not want to charge it with an unjustifiable normative meaning, is that it cannot be derived solely from the axiom of purposeful behavior. To act intentionally means to use means, subjectively judged the most adequate among those available, to attain ends. The rationality of human action establishes nothing as far as the future manifestation of conditions of action or the individual's *ex post* evaluation of means and ends are concerned. It follows then that expectational errors concerning facts and judgments of value cannot be ruled out

[10]This weakest version appeared as a response to one of the criticisms addressed to the RE hypothesis, namely that it presupposes costless collection and processing of information (namely that it assumes collection and processing of information are costless). Among the other problems with which the RE hypothesis is challenged, and well catalogued in Redman (1992, pp. 17–22), are: the necessity of forward solving over all future time; a non-uniqueness problem if the saddlepoint property for stability is not met; inconsistency with uncertainty in historical time; emphasis on future time is too extreme, as was adaptive expectations' emphasis on past time; the narrow version must be linear or it loses its certainty equivalence property; and, a statistical identification problem exists.

solely on the basis of the fact that individuals act purposefully. Intentionality, and that is all that rationality means from the economic point of view, does not entail absence of error, and the omniscience that is thereby implied.

Proponents of rational expectations may accept this critique. However, a second problem occurs, for they then would argue that there is no correlation between the errors of a purposefully behaving individual. Here, again, it is enough to point out in reply that intentionality does not mean that individuals learn immediately from any single error or that the same error could not appear more than once. One may raise many questions regarding this issue. What is the minimum, reasonable, or maximum period of time necessary for learning from errors? In the first place, how long does it take to recognize the error, and then to identify its cause? Furthermore, could not an individual make the same error again, even though he has learned from the past how to avoid it, because conditions of action have changed in such a way that despite his new knowledge he was unable to avoid the error? Beyond these issues, the argument for the absence of systematic errors demands further elaboration when it is applied on the aggregate level.

On the macroeconomic level, i.e., from the viewpoint of the whole economy, the absence of systematic errors means that on average, over time, errors compensate themselves and social events are happening in the way they would have occurred if no error was committed at all. This idea of the mutual compensation of errors, be it in an inter-temporal or inter-personal perspective, cannot be justified at all, and a fortiori on the basis of individual rationality. Any error leads to a distribution of property rights in the community and to a set of production and consumption decisions that are irreversibly different from what they would have been otherwise. Errors simply compound one another, but they cannot compensate one another. In this sense, whether there is correlation between errors or not is an irrelevant issue, for any single error, even unrelated to any other, counts on its own. And since the absence of error cannot be derived solely from the principle of rationality, the RE assumption cannot be set up into a necessary axiom on the basis of this same principle.

Expectations and Economic Laws

A second, much unknown, rationalization of the RE assumption aims at transforming it from a mere hypothesis into a necessary principle, whose rejection would render economic theory impracticable. This line of reasoning has been proposed by Lucas,[11] who begins by asserting that individuals necessarily make expectations about the future: "At a purely formal level, we know that a rational agent must formulate a subjective joint probability distribution over all unknown random variables which impinge on his present and future market opportunities" (Lucas 1983b, p. 223). This point may be easily conceded. But then Lucas continues by

[11] Lucas has also used the rational expectations "principle" as a critique of econometrics. In another of his seminal articles, he pointed out that optimizing individuals anticipate the economic policies followed by governments, and that consequently some parameters, considered as structural in the econometric model, vary as a matter of fact with the particular policy that is implemented (Lucas 1983a, p. 126). This critique has now become commonplace.

stating that future events are either instances of risk, and Muth's hypothesis applies, or they are instances of uncertainty, and economic theory is here helpless for explaining social phenomena:

> Evidently, this hypothesis will not be of value in understanding psychotic behavior. Neither will it be applicable in situations in which one cannot guess which, if any, observable frequencies are relevant: situations which Knight called "uncertainty." It will *most* likely be useful in situations in which the probabilities of interest concern a fairly well defined recurrent event, situations of "risk" in Knight's terminology. In situations of risk, the hypothesis of rational behavior on the part of agents will have usable content, so that behavior may be explainable in terms of economic theory. In such situations, expectations are rational in Muth's sense. In case of uncertainty, economic reasoning will be of no value (Lucas 1983b, p. 223; emphasis in original).

This last point, however, cannot be conceded. Uncertainty is a basic feature of any human action, and to claim that in the case of uncertainty no economic reasoning is of value is tantamount to denying the very possibility of theorizing about social phenomena. Lucas erroneously believes, without even venturing a demonstration, that uncertainty implies that no regularities about patterns of human action can be discovered. As noted by such a proponent of the idea that any human action is colored by uncertainty as Mises, "Praxeological knowledge makes it possible to predict with apodictic certainty the outcome of various *modes of action*" (Mises 1998, p. 117; emphasis added). The discovery of this knowledge and the cases to which it applies are completely independent from the question whether any of these modes of action can or cannot be identified as a class probability.[12] Lucas's willingness to limit economic theory to a theory of regular human behavior based, as by necessity, upon rational expectations is unfounded, for human choice is purely an instance of case probability.

In addition to merely discarding the possibility of building economic theory based on case-probable events, Lucas's quest for determinate scientific knowledge outshoots the reasonable pretensions of regularity that the social scientist could make. The regularity that Lucas endeavors to uncover, namely the even repetition of phenomena according to a well defined temporal sequence, does not actually have to occur at all in the social realm because of the all-pervasiveness of case probability. This does not imply however that regularity, in the sense of definite causal relationships between phenomena, does not exist. Quite the contrary, these causal relationships are precisely what one would call economic laws, and neither their manifestation nor their scientific discovery depend upon class probability or rationality of expectations. As a matter of fact, many of the economic laws are even independent from expectations themselves, not to speak of the way they are formed. Think for example of the law of decreasing marginal utility, of decreasing returns, of supply and demand, of the essential properties of money, of the law of association, of the impossibility of economic calculation under socialism, none of

[12] For the distinction between class probability and case probability, which to a certain extent reformulates Knight's distinction between risk and uncertainty, cf. Mises (1998, pp. 107–13).

which is contingent upon individuals' thoughts about the future. Therefore, Lucas's attempt to set up the RE hypothesis into a first principle of building economic theory must be recognized as abortive.

Expectations and Equilibrium

The last and third, rationalization considers RE as the proper definition of dynamic equilibrium:

> We need to define a dynamic analogue of the static best response mapping H. This will turn out to be a mapping from a perceived law of motion for the model's endogenous state variables to an actual law of motion.... So optimizing behavior and representativeness of the representative firm induce a mapping H*=T(H), from a perceived law of motion to the actual one. A rational expectations equilibrium is a fixed point of the mapping T: H=T(H)" (Sargent 1993, pp. 8–9).

Sargent, who is one of the most prominent advocates of RE, maintains even that any behavioral foundation of the RE hypothesis would be alien to Muth's original insight.

To describe dynamic equilibrium in terms of fulfilled expectations is not new. There is indeed a long-lasting tradition, which starts with Hayek, Hicks and Hahn, of considering equilibrium as the absence of any discrepancy between expected future and revealed future.[13] The peculiarity of the RE proponents, and that is their distinctive mark from this previous tradition, is to take the absence of expectational errors as a property of expectations themselves. From this perspective, equilibrium becomes all-pervading. An initial problem with this approach that equates reality with equilibrium is its apparent sterility, for what is the point of speaking of equilibrium, when disequilibrium is ruled out from the very beginning? But beyond this, we have to raise the more fundamental question of why equilibrium should be defined as a situation in which expectations turn out correct.

The rationale for this view is rooted in the dissatisfaction provoked by a divergence between the result of an action as expected *ex ante* and the result actually obtained *ex post*. In addition, any discrepancy between the *ex ante* thoughts about the future and the *ex post* future itself is believed to result from an incompatibility between individuals' different plans and to motivate a change in these very plans. The problem here is that, for one thing, discrepancies between expectations and results do not necessarily prevent general equilibrium. In addition, they may not bring about changes in individuals' actions.

Notice first that if one's expectations turn out incorrect, this does not imply in the least that a better course of action was physically available or would have been

[13] In Hicks' words, "the change in prices which occurs is that which was expected.... The degree of disequilibrium marks the extent to which expectations are cheated, and plans go astray" (Hicks 1939, p. 132). Similarly, "The invariance of equilibrium is not now to be found in a constant output and constant prices as in the stationary case, not yet again in a constant rate of change of output and/or prices, but in the constancy of the form of the expectation function" (Hahn 1952, p. 803). Cf. also Hayek (1937, pp. 39–41) and Hahn (1973).

preferable, in value terms, under the revealed reality. The pertinent question is whether *ex post* one discovers that his position would have been improved had a different action been undertaken, whatever the latter's relation to his *ex ante* expectations. And the answer to this question is independent of any comparison between expected future and realized future. It only depends upon a counterfactual comparison between what actually is and what could possibly have been.

As a matter of fact, this very counterfactual comparison is what constitutes the essence of the method of equilibrium analysis. As argued by Hülsmann (2000), this is the only realist approach to the notion of equilibrium that derives directly from the dichotomous nature of choice, according to which any action is either a success or a failure. Equilibrium analysis, then, is the method of comparing a real individual action with its foregone alternatives with respect to their relative importance. An individual will be in equilibrium if he discovers, *ex post*, that he did pursue the most important course of action among those available to him at the time of choosing. To the contrary, disequilibrium means an erroneous judgment as to the relative significance of the different plans.

Now, notice that within this line of thought, two colloquial and common ways of describing equilibrium exist: to say either that plans match reality, or that no error has been committed. However, there must already be a nascent contradiction here, for *plans carried out are reality.* To say therefore that plans match reality is either a pleonasm, or a mischaracterization. To see that the latter is the case, we must understand the meaning of error in the economic sense. Error consists in not following an action that is more important than the one actually carried out. Therefore, to asses error (and success), we must indulge in a counterfactual comparison between the present action, i.e., current reality, and foregone actions, i.e., would-be-possible but unrealized realities. It follows that to compare expectations about the future with the future itself is irrelevant for equilibrium analysis. Such a comparison is not directly derived from the dichotomous nature of action, and as such turns out to be an arbitrary criterion for an implicit normative judgment on the efficiency or optimality of the current situation.

A further implication of this conclusion is the fact the correctness of expectations is not even a sufficient condition for general equilibrium. It is not because one's expectations are correct that his plan does not go astray in the economic sense. A comparison between reality imagined *ex ante* and results obtained *ex post* that shows that both are identical may be of importance for the individuals' psychological equilibrium, for the coming true of dreams is indeed crucial for mental health. However, economic analysis deals with action itself. Of relevance for the present discussion is the observation that it may well turn out that *ex post* the individual is dissatisfied with the plan itself in comparison with other plans *ex ante* available, even though the *ex post* results of this one plan match the *ex ante* expectations perfectly well. A fortiori, economic—and not technological—compatibility between individuals' various plans is therefore not necessarily guaranteed if expectations turn out to be correct.

Finally, the ambition to integrate historical time into the analysis through the very distinction *ex ante/ex post*, which is a cornerstone of dynamic analysis, is actually misdirected. As a matter of fact, within the issue of the correctness of expectations, the *ex ante/ex post* opposition refers exclusively to a mental process of comparison

between the content of one's thoughts about a future datum and the reality of that datum. And this is a problem of knowledge, as Hayek foresaw it, not a problem of human action in the temporal flux.

At the end of our overview of these three attempts to set RE up as a necessary principle or unavoidable assumption, we conclude that RE must still be examined as an independent and contingent hypothesis. This naturally raises the question of its status, in particular is it a mere theoretical tool, or rather does it have an empirical content about individuals' actual expectations?

Rational Expectations: A Theoretical Research Tool or an Empirical Assumption

It is clear from the previous attempts at justification, that the RE hypothesis is suggested as the right tool for conducting research, especially within a dynamic perspective. Shall we consider it a technicality no time-involving theoretical economic model could avoid? This is one way of seeing the RE assumption, and it has been adopted by a notorious advocate: "Partly because it focuses on outcomes and *does not pretend to have behavioral content*, the hypothesis of rational expectations has proved to be a powerful tool for making precise statements about complicated dynamic economic systems" (Sargent 1993, p. 23; emphasis added). This view is certainly consistent with contemporary positivist methodology, especially as popularized by Friedman (1953), according to which assumptions do not need to be empirically true in order to have a valid scientific content. All that a positivist economist might require from an assumption is to somehow yield an empirically useful prediction of future events. From this standpoint, the denial to interpret the RE assumption as saying something concrete about the way individuals actually do form their expectations is relevant to a broader epistemological approach.

Therefore, once the methodology of positivism is accepted, the RE hypothesis could not be deemed unrealistic, for such a charge has no credibility within this paradigm. However, one can go a step further, and investigate the logical implications of that hypothesis. To assume that individuals systematically and unmistakably anticipate the future implies that the future is systematically and unmistakably known to them at the very moment of action. If this were true, individuals would be automatons. If such complete certainty were possible: "We would know all of our future actions and their exact outcomes. In such a world, nothing could be learned, and accordingly, nothing would be *worth knowing*" (Hoppe 1997, p. 49; emphasis in original). The RE hypothesis is then self-contradictory, for how could a proper tool of scientific research deny the very goal of research, i.e., the acquisition of new knowledge? Besides the invalid justifications it has received, as we have shown, it does not logically stand on solid ground.

But what if one disagrees with positivism or would dare, for other reasons, to care about the empirical correctness of the hypothesis. That it is contradictory with knowledge itself already means that it could not be true. It would then not come as a surprise to find out that a series of empirical studies have already concluded that it is contrary to fact: "In conclusion, it seems to me that the weight of empirical evidence is sufficiently strong to compel us to suspend belief in the hypothesis of rational expectations, pending the accumulation of additional empirical evidence" (Lovell 1986, p. 122). It is worth noting that the tests reviewed by Lovell include samples

that refer to a large range of economic agents, in particular firms, individuals, and the government itself. Five years later, matters were still the same, as shown by a study on life expectancies: "Our findings provide little support for the proposition that persons in our sample have rational expectations about their *ultimate* expected age of death" (Pollock and Suyderhoud 1992, p. 323; emphasis in original). More recently, it even has been argued that the very conclusions of dynamic models assuming rational expectations are contrary to reality: "the dynamic implications of many of the specifications that assume rational expectations and optimizing behavior are often seriously at odds with the data" (Estrella and Fuhrer 2002, p. 1013). It is hence clear that if taken as an empirical behavioral assumption, the RE hypothesis is plainly false; if considered only as a theoretical tool, it is unfounded and self-contradictory.[14]

Now that we have clarified the status and the validity of the RE assumption, it is necessary to continue our inquiry with an appraisal of the assumption's very meaning. This hypothesis actually states that there is a congruence between human thoughts about the future and future reality. A few economists have noticed, from different perspectives, that this is ultimately an assumption about learning: "I would say that the rational expectations view of the motion of the economy has to come to grips with two problems: one is learning, and the other—a logically prior problem—is, learning what?" (Phelps 1992, p. 136). In addition, it has been estimated that all of the "optimality" properties of RE hold only if individuals form their expectations on the basis of the relevant model that truly describes objective reality and the motion of the economy (Pesaran 1987, pp. 26–31).[15] We will now further examine the content of the RE hypothesis in order to see to what extent the issue of the relevant model is indeed problematic.

The Essence and Consequences of Rational Expectations

From the outset, one may think that the advocates of the RE hypothesis do not, simplistically, maintain that whatever individuals think will happen does happen. Is it not obvious that my thinking of possessing 100 bottles of Dom Pérignon and of an exchange ratio of 95 euros per bottle in 1 month can bring about neither the objective existence of this property nor the objective price? However, the RE hypothesis ultimately boils down to this exact assumption that thoughts determine reality. In order to demonstrate this, we have to discover which subjective beliefs and which objective reality conforms to one another in the opinion of the advocates of RE. In other words, in which direction does the causality go?

[14]Here, the reader may want to be reminded of Ludwig von Mises' two requirements of a hypothesis: "With regard to unsolved problems, various hypotheses are permissible provided they do not contradict logic and the uncontested data of experience" (Mises 1998, pp. 89–90).

[15]In mathematical terms, rational expectations are a probabilistic estimator of future variables. Then, according to an elementary conclusion of inference theory, the estimator is optimal, in the sense of being efficient and unbiased, only if the model is correctly specified.

To begin with, the RE hypothesis presupposes the existence of a relevant model describing the objective reality, in the light of which, we are told by Muth, Lucas, and Sargent, the formation of expectations consistent with reality may be postulated. We do not need to enter into a discussion of whether the "objective probability distribution" describing reality implies a categorical rejection of uncertainty *à la* Lucas and whether by objective probability one means statistical frequencies. The only crucial point from the standpoint of a theory of expectations is that in this case the individuals' expectations have no influence whatsoever on the relevant model itself, which otherwise would not be objective. Therefore, if we are taught that it is the objectively given distribution of property and prices that determines the subjects' beliefs about it, expectations have no place at all in economic theory, which is constructed independently from them.

The RE hypothesis would then appear as contrary to the initial purpose of its proponents. For this hypothesis to be of any value in the description of the actual evolution of the economy, and given its content, it must be presumed that it is the objective probability distribution that conforms to the subjective individual distributions. To put it differently, it must be presumed that subjective beliefs alone determine objective reality. Two consequences of this highly exaggerated representation of the influence of expectations can be noted. On the one hand, the crucial and necessary intermediacy of actual actions is being forced out of economic analysis. On the other hand, from a truly consistent RE perspective, the question of the true model becomes irrelevant, for any model must be true once individuals are supposed to have formed rational expectations in compliance with it. An implication of this conclusion is that rational expectations cling to all models, even though they may have opposite conclusions.

An empirical illustration of this conclusion is the fact that the RE hypothesis is admitted by the New Classical School, which believes that governmental policy is inefficient, as well as by the New Keynesians, who maintain the diametrically opposite position. In both cases, the RE hypothesis is used to show that the results arrived at by the model are brought about immediately, without any need to wait for actual exchanges or consumption and investment decisions to be made. Lucas, Sargent, and Wallace, extending the work of Friedman and Phelps, have shown that there is no trade-off between anticipated inflation and unemployment even in the short run (Friedman 1968; Lucas 1972, p. 114; Lucas 1975, p. 1119; Sargent and Wallace 1975, p. 247). In their view, even in the short run, money is neutral from the very moment that individuals fully anticipate the consequences brought about by an increase in its quantity, which is indeed the case once expectations are assumed rational.

Similarly, from a Keynesian perspective the RE hypothesis shows that economic policies will actually be more effective in the sense that their results manifest themselves faster:

> Take the case of an aggregate demand deficiency in a Keynesian model. The usual argument is that monetary expansion will work through affecting interest rates so that gradually the economy shifts to a higher output level. With rational expectations the shift to the new level would be extremely rapid. If businessmen understand the economic implications of expansionary government policy,

> they can expand their output in anticipation of those effects rather than waiting for the rise in demand to be obvious in the market. In that case, far from policy being impotent, rational expectations may make policy *more* effective (Maddock and Carter 1982, p. 48; emphasis in original).

In sum, since producers believe in some virtues of deficit spending as described in an economic model, these virtues become real, here and now.

It is evident that rational expectations are a catch-all hypothesis, which may indiscriminately cling to any model in order to justify its conclusions as being derived directly from human rationality. It is sufficient to postulate beliefs about the actual relation between economic variables, and then to presume these beliefs rational, in order to arrive at the conclusion that the relation is true and objectively revealed immediately. The RE hypothesis, very different from the AE hypothesis, goes much beyond its purpose. It does not circumscribe the real influence of expectations, it postulates that everything depends upon expectations. However, rational expectations does not explain why this is so, it merely claims that subjective beliefs shape reality *in the pattern presumed by the model-builder*. The RE hypothesis thus greatly contributes to the persisting split of economic science in various schools, each finding support in this approach of modeling expectations. It is nevertheless evident that the presumed relationship between beliefs and reality is unsustainable. Let us demonstrate it for the case of the two examples cited above.

It is not because individuals believe that money is neutral that it is indeed neutral. The expectation of increasing prices cannot bring about higher prices without actual exchanges being performed with the additional quantity of money.[16] The same quantity of money cannot be used in more than one exchange at a time, therefore such exchanges are necessarily successive. It follows that prices, even if their increases are correctly anticipated by individuals, do not increase simultaneously and hence bring about a distribution of property different from that which would have prevailed even if the quantity of money had not been made greater. The conclusion that money is not neutral is completely independent of what its expected effects are, and already included in the very nature of money (Mises 1980, pp. 160–62).

Similarly, it is not because individuals believe that government deficits increase production that they do indeed. Production can only be increased if present consumption is decreased so that higher savings make possible an increase in capital accumulation. The mere belief that there are more capital goods available as indicated by an artificially lower interest rate may indeed convince entrepreneurs to start additional production processes. However, the actual absence of more capital goods sooner or later will be revealed through the physical impossibility to finish all production processes, and this conclusion is independent of one's beliefs.

[16]This is a point that Friedman seems not to take into consideration seriously, when he analyzes the consequences of a continuous increase in the quantity of money: "What raises the price level, if at all points markets are cleared and real magnitudes are stable?" The answer is, "Because everyone confidently anticipates that prices will rise" (Friedman 1969, p. 10; emphasis added).

To sum up, the RE hypothesis does not add a single new shred of knowledge to economic science.[17] It merely legitimizes all existing and any future economic theories through the fallacious assumption that subjective beliefs, particularly in these theories, determine objective reality, particularly as shaped by the latter theories. This second way of formalizing expectations does not fall prey to the major drawback of the AE hypothesis which was to obliterate the whole issue. Nevertheless, it is equally counterproductive for, concerning the influence of expectations, it assumes anything possible but explains nothing.

Conclusion

Our critical appraisal of the most common models of expectations formation establishes that they fail to exemplify the influence that expectations exert upon economic phenomena. Despite the fact that our analysis focused only on two very specific, although widespread, hypotheses about how expectations are formed, a generalization can confidently be drawn.

Any model of expectations formation, whether exogenous, such as the AE assumption, or endogenous, such as the RE assumption, by its very nature cannot help but explain expectations by other variables or by relations between variables. Thus, any such model is necessarily contrary to the very purpose of the explicit introduction of expectations into economic analysis. Expectations have to be considered as an ultimate given, if it is their influence, and not the influence of their determinants, that the economist wants to examine. This conclusion naturally leads to how expectations are related to individual choice. This problem however is outside the scope of the present article.

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[17] G.L.S. Shackle maintains the same view, in a charming way which does not allow omission here:

> If at some time my skeleton should come to be used by a teacher of osteology to illustrate his lectures, will his students seek to infer my capacities for thinking, feeling, and deciding from a study of my bones? If they do, and any report of their proceedings should reach the Elysian Fields, I shall be much distressed, for they will be using a model which entirely ignores the greater number of relevant variables, and all of the important ones. Yet this is what 'rational expectations' does to economics (Shackle 1984, p. 393).

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