

# Usefulness of Adaptive and Rational Expectations in Economics

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## Abstract

This paper provides a statistical reason and strong econometric evidence for supporting the adaptive expectations hypothesis in economics. It points out why the rational expectations hypothesis was embraced by the economics profession without sufficient evidence. Finally it will summarize the conditions under which these two competing hypotheses can be used effectively.

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In section 1 of this paper I will provide a statistical reason and strong econometric evidence for supporting the adaptive expectations hypothesis in economics. In section 2, I will point out why the rational expectations hypothesis was embraced by the economics profession without sufficient evidence. Finally I will summarize the conditions under which these two competing hypotheses can be used effectively.

## 1 Evidence and statistical reason for supporting the adaptive expectations hypothesis

Adaptive expectations and rational expectations are hypotheses concerning the formation of expectations which economists can adopt in the study of economic behavior. Since a substantial portion of the economic profession seems to have rejected the adaptive expectations hypothesis without sufficient reason I will provide strong econometric evidence and a statistical reason for its usefulness in this section.

The adaptive expectations hypothesis states that the expected value of an economic variable  $Y_p$  (for permanent or expected income introduced by Friedman (1957)) is formed adaptively by the following equation, with  $t$  denoting time and the time for the current period suppressed:

$$(1) \quad Y_p - Y_p(t-1) = b(Y - Y_p(t-1))$$

By simple algebra and repeated substitutions, the equation becomes

$$(2) \quad Y_p = bY + (1-b)Y_p(t-1) \\ = bY(t) + b(1-b)Y(t-1) + b(1-b)^2Y(t-2) + \dots$$

This is a weighted average of past observations of the economic variable with geometrically declining weights. Thus the adaptive expectations hypothesis states that expectations of an

economic variable be formed as a sample mean of past observations with geometrically declining weights.

**Hypothesis A:** Economic agents form their expectation of an economic variable by taking a sample mean of past observations.

**Adaptive Expectations Hypothesis:** As a special case of Hypothesis A when applied to time series observations, the sample mean is a weighted mean which gives less weights to past observations at time  $t-k$  that decline geometrically with lag  $k$ .

The statistical justification for the behavior stated by Hypothesis A is contained in basic statistics textbooks. I will provide econometric evidence for Hypothesis A, namely, economic agents do behave as the statistics textbooks advise. Once Hypothesis A is accepted as a good behavioral assumption, I will cite additional evidence and statistical reason for supporting the behavior as stated in the Adaptive Expectations Hypothesis.

To begin with some evidence supporting Hypothesis A, I have used data on the price  $p_t$  at the end of year  $t$  and dividend  $d_t$  distributed during year  $t$  for blue chip stocks in Taiwan to perform the following regression

$$(3) \log p_t = 2.610(0.075) + 0.281(0.089) \log d_t + 0.414(0.098)[\log d_t - \log d_{t-3}] \quad R^2 = .111$$

In (3) the standard error of each regression coefficient is in parentheses. The economic hypothesis for this regression is that log price is a linear function of log dividend and the expected rate of growth of dividends. The justification of this economic hypothesis is that stock price is a given function of expected future dividends and this function is approximated by the function stated above. In the above econometric example both explanatory variables are

statistically significant although the value of  $R^2$  is low partly because I did not use year dummy in this regression. There were 445 observations covering years from 1971 to 2010. The important point to note in this regression is that the expected rate of growth of dividend as a variable affecting stock price can be estimated by the rate of growth in the last three periods, or by a mean of growth rate of the last three years (times the constant 3), as suggested in Hypothesis A. This regression explains the Taiwan data for more than 50 companies over three decades very well. (Data for individual companies usually span a shorter period than the entire sample period.) To find out whether this econometric example is valid in general, the reader can perform similar regressions, with a dummy variable added to represent time, by using annual data for blue chip stocks traded in a major stock exchange in the world. Negative results would count as evidence against the Hypothesis A.

Secondly as evidence supporting the adaptive expectations hypothesis I will cite two references. Chow (1989) provided very strong econometric evidence supporting the adaptive expectations hypothesis against the rational expectations hypothesis for the present-value model. This model was applied to explain stock price as a discounted sum of expected future dividends and to explain long term interest rate as a sum of expected future short-term interest rates. The econometric evidence supporting the adaptive expectations hypothesis against the rational expectations hypothesis is very strong. Without asking the reader to refer to Chow (1989) let me explain why the hypothesis of rational expectations is strongly rejected by the data.

An implication of the present value model of stock price is

$$(4) \quad p_t = bE_t(p_{t+1} + d_t).$$

Stock price  $p_t$  at the beginning of year  $t$  equals discounted expected sum of stock price  $p_{t+1}$  at the beginning of year  $t+1$  and dividend  $d_t$  of year  $t$ . The expectation here means the subjective expectation of investors who are willing to pay  $p_t$  now because they think that a year from now the stock price  $p_{t+1}$  and dividend  $d_t$  will be such that their discounted sum will equal the current price  $p_t$ . To test the rational expectations hypothesis we need to have an econometric model to generate the mathematical expectation  $E$  in equation (4), now interpreted as mathematical expectation rather than the subjective expectation of the investors. That is to say, the econometrician who needs to find out whether the hypothesis of rational expectations is a good way to estimate the subjective expectation in equation (4) is required to have an econometric model to forecast the future  $p_{t+1}$  and future  $d_t$  as yet to be distributed during year  $t$ . There is no reason to believe that the expected values so estimated will have a sum, after discounting, which equals the actual current price  $p_t$ . Chow (1989) provides strong evidence showing the discrepancy between  $p_t$  and its estimate by rational expectations.

The statistical reason for the adaptive expectations hypothesis is simple. Statisticians take a sample mean to predict a future observation as suggested in Hypothesis A. In time series data, they will give more weights to recent observations when using a mean to predict a future observation. The adaptive expectations hypothesis simply states that economic agents behave like good statisticians.

The second reference consists of three studies of log stock price as a linear function of expected log dividend and expected growth of dividends, with both expectations assumed to be formed by adaptive expectations. The equation determining log stock price is

$$(5) \log p_t = \delta E_t \log d_t + \alpha E_t g_t + \gamma$$

where  $g_t$  denotes the rate of growth of dividend. The three studies are summarized in Chow (2007, chapter 14). They cover respectively stocks traded in the New York, Hong Kong and Shanghai stock exchanges and show strong econometric evidence supporting the econometric model (5). They show econometric support for the adaptive expectations hypothesis in so far as this hypothesis is used to form the expectations in (5). A skeptic of adaptive expectations in this case may perform similar econometric analyses using data for other stock markets.

Finally I present a logical argument supporting the adaptive expectations hypothesis. If economic agents use past trend to project into the future (to form expectations of the future), a skeptic of adaptive expectations has to present strong evidence that the past trend cannot be projected by using geometrically declining weights as stated by the adaptive expectations hypothesis. The task for the skeptic is to reject the null hypothesis of using a set of geometrically declining weights to estimate the expected variable in question. He may be able to show in a few econometric studies that some other weighting scheme (such as applying equal weights in my stock price example presented earlier) is econometrically better. But if he rejects the adaptive expectations hypothesis for economic research in general his task is to show that in most empirical studies yet to be performed the use of geometrically declining weights would be statistically rejected. The fact that I just presented strong econometric evidence in Chow (1989) and Chow (2007) to support the use of geometrically declining weights as specified by the adaptive expectations hypothesis makes the task of the skeptic difficult.

## 2. Insufficient evidence supporting the rational expectations hypothesis when it prevailed

The popularity of the rational expectations hypothesis began with the critique of Lucas (1976) which claimed that existing macro econometric models of the time could not be used to evaluate

effects of economic policy because the parameters of these econometric models would change when the government decision rule changed. A government decision rule is a part of the environment facing economic agents. When the rule changes, the environment changes and the behavior of economic agents who respond to the environment changes. Economists may disagree on the empirical relevance of this claim, e.g., by how much the parameters will change and to what extent government policies can be assumed to be decision rules rather than exogenous changes of a policy variable. The latter is illustrated by studies of the effects of monetary shocks on aggregate output and the price level using a VAR. Such qualifications aside, I accept the Lucas proposition for the purpose of the present discussion.

Then came the resolution of the Lucas critique. Assuming the Lucas critique to be valid, economists can build structural econometric models with structural parameters unchanged when a policy rule changes. Such a solution can be achieved by assuming rational expectations, together with some other modeling assumptions. I also accept this solution of the Lucas critique.

In the history of economic thought during the late 1970s, the economics profession (1) accepted the Lucas critique, (2) accepted the solution to the Lucas critique in which rational expectations is used and (3) rejected the adaptive expectations hypothesis possibly because the solution in (2) required the acceptance of the rational expectations hypothesis. Accepting (1) the Lucas critique and (2) a possible response to the Lucas critique by using rational expectations does not imply (3) that rational expectations is a good empirical economic hypothesis. There was insufficient evidence supporting the hypothesis of rational expectations when it was embraced by the economic profession in the late 1970s. This is not to say that the rational expectations hypothesis is empirically incorrect, as it has been shown to be a good hypothesis in many applications. The

point is that the economic profession accepted this hypothesis for general application in the late 1970s without sufficient evidence.

### 3. Conclusions

This paper has presented a statistical reason for the economic behavior as stated in the adaptive expectations hypothesis and strong econometric evidence supporting the adaptive expectations hypothesis.

To recall the acceptance of the adaptive expectations hypothesis by the economics profession before the Lucas (1976) critique, as a graduate student at the University of Chicago I learned the adaptive expectations hypothesis from Friedman (1957) when this Nobel prize work was in progress. I applied adaptive expectations and a partial stock adjustment model to study the demand for automobiles in the US in Chow (1957) for my PhD dissertation. The use of adaptive expectations can also be found in related works by fellow students as published in Harberger (1960). By the time the Lucas (1976) critique appeared the economics profession had routinely applied adaptive expectations in their work. The references are too numerous to be cited here.

Secondly, this paper has pointed out that there was insufficient empirical evidence supporting the rational expectations hypothesis when the economics profession embraced it in the late 1970s. The profession accepted the Lucas (1976) critique and its possible resolution by estimating structural models under the assumption of rational expectations. But this does not justify the acceptance of rational expectations in place of adaptive expectations as better proxies for the psychological expectations that one wishes to model in the study of economic behavior. The acceptance of the rational expectations hypothesis also accounted for, partly at least, the



proliferation of macroeconomic models (see Chow (1997)) built upon dynamic optimization on the part of economic agents under the assumption of rational expectations.

For the purpose of finding good proxies for psychological expectations as required in the study of economic behavior, adaptive expectations should be used whenever the economist believes that the economic agents in question form psychological expectations by taking a mean of past values with geometrically declining weights. He should use rational expectations if he believes that his econometric model can generate mathematical expectations that are closer to the psychological expectations of the economic agents than the assumption of adaptive expectations can. It would also be of interest for the economist to compare the two expectations hypotheses as was done in Chow (1989).

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