RATIONAL EXPECTATIONS IN THE CLASSROOM: A LEARNING ACTIVITY

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Abstract

The author describes a technique whereby students truthfully reveal their perceptions regarding the difficulty of an assignment. After completing the assignment, each student guesses his/her class' average score on the assignment. The student is informed that if his/her guess is within one percentage point of the actual class average, then he/she will earn two extra points on the assignment. This mechanism gives each student the incentive to truly express his/her opinion regarding the difficulty of the assignment. The author provides evidence that students, as a group, are quite adept at guessing the class average. In addition to its usefulness in explaining the rational expectations hypothesis, this activity is helpful for assessing the students' perceptions of the difficulty of particular assignments.

Introduction

The assumption that agents use all available information to make predictions about the future is common to many types of economic models. This assumption, denoted "rational expectations" was first introduced by Muth (1961), and is now used, among other places, in game theoretic models, models of financial markets and macroeconomic models. As such, rational expectations can be a topic in a wide variety of courses in economics and finance.

As a subject matter, rational expectations lends itself well to classroom activities, and several pedagogical papers outline active learning approaches. For example, Peterson (1990) presents a simple classroom experiment in which students are given incentives to formulate their own "rational" expectations regarding a policy variable. The experiment illustrates how agents formulate expectations and how those expectations can impact policy. A similar experiment is presented by Hazlett (1996). In Peterson's activity students act as firms and decide how much to produce, while in Hazlett's activity students act as workers and decide how much time to spend working. In both experiments unanticipated changes to the money supply can affect the students' payoffs, either through changes in the firm's real profits or the employee's real wage. Ball and Holt (1998) use an experimental asset market to introduce rational expectations. Their approach illustrates the existence of behavioral discrepancies with the standard theory, as their experiment has the potential to create price "bubbles," or irrational increases in the price of the asset. Strulik (2004) takes a different approach, and shows how to use Microsoft Excel to teach rational

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expectations. He uses some simple backward iteration solution techniques to teach the intuition behind rational expectations.

Bonwell and Eison (1991) recommend that faculty in higher education select teaching strategies that promote active learning. The active learning exercises presented by Peterson (1990), Hazlett (1996) and Ball and Holt (1998) are effective in part because they put the student at the heart of the action. Instead of being passive observers of market activity, these exercises put the student in the role of an active decision-maker in the economy. This change in perspective often gives students a better understanding of the underlying economic theory.

Although the activities presented in each of the previously mentioned papers is novel and effective, each activity also requires significant preparation time, and generally takes most of a class period to complete. In this paper I present a quick and easy way to introduce the intuition behind rational expectations. Although my activity lacks the depth of the approaches mentioned above, its simplicity makes it appropriate for instructors who merely wish to introduce the basic concept of rational expectations without sacrificing an entire lecture. In addition, I show how this activity can be used to help an instructor determine his/her students' overall perception of the difficulty of an assignment or exam.

The Activity

Upon completing a given assignment (usually an exam), each student guesses the score of the class' average on the assignment. The student is informed that if her guess is within x percentage point(s) of the actual class average, she will earn y extra points on the assignment. (The instructor should pick values of x and y that she or he finds appropriate.) Figure 1 shows a sample form from one of my classes. The student is told that she will earn 2 extra points (out of a possible 100 points for the exam) if her guess of the class average is within 1 percentage point of the actual class average. The fact that the student will only earn the bonus if she guesses correctly provides her with an incentive to make the best guess possible; that is, each student has an incentive to take the task seriously.

Figure 1. Elicitation Mechanism

Exam 1 – ECON 201

Professor Calvin Blackwell   Name:_____
24 September 2004   The class average will be: _____

[+2] Bonus: You will receive 2 extra points if your guess for the class average is within 1 point of the true average. Put your guess in the space provided.

Generally I give my first exam approximately four weeks into the semester. Depending upon the class I am teaching, the discussion of the activity occurs when I return the exam (for most classes), or, when I teach principles of macroeconomics, later in the semester when I cover the rational expectations hypothesis.

Extension

For a more sophisticated demonstration of the rational expectations hypothesis, one could run three separate guessing games, and have students' make guesses: *i*) before taking the test, *ii*) after taking the exam (as described above), and *iii*) after talking to their classmates. All three guesses would need to be incentivized in some manner.

Discussion

The true class average of the assignment, which in this instance is also the true population average of the activity, is represented by $\bar{\rho}$, where

$$\bar{\rho} = \frac{1}{N}\sum_{i=1}^{N}\rho_i \qquad (1)$$

with ρ_i representing the true student score on the assignment of the ith student where *i* refers to the ith student with $i = 1,\ldots, N$ and *N* being equal to the total number of students involved in the activity, and is thereby equal to the population of the activity.

Analogously, $\bar{p}$ is the average of the students' guesses of what they think will be the true class average of the assignment and is represented by the following equation:

$$\bar{p} = \frac{1}{N}\sum_{i=1}^{N}p_i \qquad (2)$$

p_i representing the guess of the true class average of the assignment of the ith student.

If we assume the ith student has rational expectations in regards to his/her estimate of the true class average of the assignment p_i, then, the expectation of p_i must be equal to $\bar{\rho}$, although any particular p_i may be incorrect. Hence, p_i may be defined as

$$p_i = \bar{\rho} + u_i \qquad (3)$$

where u_i is the error term whose magnitude could have a range of (-100, 100) and has a mean of zero and finite variance[2]. More formally, $u_i \sim (0, \sigma^2)$, which implies:

$$E(p_i) = E(\bar{\rho} + u_i) = E(\bar{\rho}) + E(u_i) = E(\bar{\rho}) + 0 = E(\bar{\rho}) \qquad (4)$$

Equation (4) is the application of the rational expectations hypotheses to this activity, which can be statistically tested with the following equation:

$$\bar{p} = \bar{\rho} \qquad (5)$$

Once the true class average, $\bar{\rho}$, and the average guess of the true class average, $\bar{p}$, are calculated the comparison of these two statistics[3] provide the grist for the in-class discussion to come. The preceding exposition is intended for my academic audience, and is un-necessary for principles students. I recommend that this activity be done in classes of at least 15 students so that the statistical properties of equation 5 can be reasonably approximated by the normal distribution. Generally, the more students involved the better.

When I reach the point in my class when we are covering the topic of rational expectations, I ask the students to mentally recall the process by which they formulated a guess.

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[2] Please note that this variance is a function of the information available to the students. The rational expectations hypothesis states that agents efficiently use new information, so as that information increases, the variance should decline. Therefore, if the extension mentioned earlier, then the variance should decline at each stage, i.e., from guessing the average with no information, to guessing the average after the exam, to guessing the average after taking the exam and discussing it with the class.

[3] Before returning the students' exams, I make certain to record on a spreadsheet each student's grade on the exam and his/her guess as to the class average.

Usually this process involves primarily their own perception of the difficulty of the exam, but it may also involve their perceptions of other students' abilities and preparedness. I then point out that there is no benefit to falsifying one's guess – the student can only earn extra credit by correctly guessing the average. At this moment in the discussion I then tell the students that there is a natural way to aggregate this information – to look at the average guess and compare it to the true class average. I present this information and then we discuss why it matches or not. Normally, the match is close, within three percentage points. I then point out that the mechanisms of finding the class average guess and rational expectations are quite similar; that is, both mechanisms involve aggregating all the information available, even if that information is not available to each individual, and that the aggregated information (or the "rational expectation") is usually quite accurate.

If time permits, a follow-up exercise (Figure 2) can be presented to the students. One approach is to have the students attempt to answer the question below on their own and then have students form pairs and compare their answers. This approach works well even in large classes.

Figure 2. Follow-up Exercise

The Iowa Electronic Markets allow students to place "bets" on the outcomes of U.S. Presidential elections. Specifically, the markets allow students to predict the percentage of the popular vote each candidate will win in the general election. The more accurate the prediction, the more money the student wins.
- ☐ According to the Rational Expectations Hypothesis, what will be the relationship between the market's prediction and the actual outcome?
- ☐ In fact, this market is one of the most accurate predictors available. Is this consistent with the Rational Expectations Hypothesis? Explain.

The results from my Principles of Macroeconomics course during the fall semester of 2004 are quite typical. I taught two sections, one with 37 students and one with 51 students. In the smaller section, the class average for the first exam ($\overline{\rho}$) was 78.4%, while the average guess ($\overline{p}$) was 78.7%, with 9 students correctly guessing within one point of the actual average.[4] However, in the other section, $\overline{\rho}$ for the first exam was 73.6%, while $\overline{p}$ was 81.0%, a much larger difference.[5] In addition, only 2 students correctly guessed within one point of the actual average. Interestingly, for this second class, $\overline{\rho}$ on the next exam was 73.41%, while $\overline{p}$ was 75.7% and 13 students correctly guessed within one point of the actual average, indicating that the students got better at guessing as they became more familiar with the task.[6] In any event, no matter how closely the actual average and the average guess match, the instructor will have some interesting material to discuss. For example, the instructor can discuss the fact that a rational expectation is still an expectation, and thus contains an element of randomness, and so may not always be correct. Instructors with a behavioralist bent may want to talk about what the results say about the rationality of real people and their ability to use information effectively.

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[4] Testing equation 5 with a simple t-test results in accepting the null hypothesis (p-value = 0.506).
[5] Testing equation 5 with a t-test here results in rejecting the null hypothesis (p-value = 0.0001).
[6] Testing equation 5 with a t-test here again results in rejecting the null hypothesis, but at a lower level of significance (p-value = 0.001).

In more advanced classes, or if time permits, I may use this activity to discuss some subtler points regarding rational expectations. The first point deals with the effect of more/improved information. Here I can use the data from extension mentioned earlier, in which the students were polled three about the class average. As time progresses the students possess more information, so the rational expectations hypothesis (which posits that information is not wasted, i.e. used optimally) predicts that the accuracy of the students' guesses should increase, and the variance of those guesses should decrease. This prediction from the rational expectations hypothesis can be tested against the students' data. Furthermore, this information should be incorporated optimally, i.e., by using Bayes Rule. Depending upon the course, a discussion of Bayes Rule and its relation to the rational expectations hypothesis may be appropriate.

The second point regards the assumption of common knowledge. The simplest version of rational expectations assumes all agents have the same information. In this activity, each student has a unique information set (because she knows her own ability and preparedness better than she knows her fellow students' abilities and preparedness). However, this situation is generally the case in other real world situations (e.g., stock trading when some traders have inside information) in which agents are assumed to use rational expectations.[7]

The third point is that even when the assumption is not an accurate reflection of the world, if the predictions based on that assumption are accurate, we can still be satisfied with the assumptions. Often during the course of the discussion, students question whether or not individuals are actually as "rational" as the rational expectations hypothesis assumes. I then typically present both sides of this ongoing debate. First, I discuss why someone might make a mistake. Here I draw on the students' personal experiences (we have all seen other people do mysterious things!) and discuss some research about forecasting that seems to indicate there are systematic biases. For example, Maki and Berry (1984) show that students have difficulty predicting their own performance, Grimes (2002) finds economics students to be overconfident when asked to predict their own grades on a future exam, and Balch (1992) concludes that overconfidence in one's own ability increases as ones' ability decreases!

I then move the discussion to the common arguments for rationality: that occasional mistakes do not imply irrational decisions, that mistakes are not systematic, that irrationality will be disciplined and driven out by the market. There is ample evidence (though not conclusive) supporting these arguments. For example, Berg, Nelson and Reitz (Forthcoming) show that the predictions of the Iowa Electronic Markets are more accurate than polls for predicting presidential elections. Dwyer, Williams, Battalio and Mason (1993) show that experimental subjects make predictions in a manner consistent with rational expectations. Finally, I bring up one of the key differences in these two strands of research: the existence of incentives. I point out that when incentives are introduced, many (although not all) of the "irrational" results go away.[8] I like to remind students that incentives matter, and that if I want to influence students' behavior in a particular way, I need to provide the proper incentives.

A different type of discussion could result if this exercise were used in an econometrics or statistics course. The instructor could use the generated data to test the rational expectations hypothesis (as in footnotes 3 - 5) with a t-test or the data could be used to test for

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[7] This situation is similar to the assumption of asymmetric information made by Lucas in his 1973 paper on the Phillips curve.

[8] See Fehr and Tyran (2005) for a more detailed discussion of how incentives and institutions relate to "irrationality."

overconfidence, for example, by regressing actual student scores on predicted scores or mean squared error.

Lagniappe

This mechanism can serve a second purpose – to help a professor gauge the difficulty of an assignment or exam. Because the student has no incentive to bias his or her guess[9], the average guess contains information on how each student believed the class would perform as a whole. Low average guesses indicate poor expected performance, and could be indicative of a difficult or confusing assignment. This information is potentially useful to all professors, but especially to new instructors who may have difficulty calibrating the difficulty of their exams and assignments.

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[9] We all know the favorite answer students give to the question, "How hard was the exam?"
"It was really hard, professor!"