The Rate Of Time Preference, Seat Location Choice And Student Performance In The Classroom

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Abstract

Recent research on the impact of seat location preferences in classes on student performance has yielded conflicting and very divergent results. This study contributes to this strand of literature by controlling for additional variables that could affect student performance. Specifically, in addition to seating location preferences, we propose that student performance may be affected by the rate at which the student values present rewards as opposed to future rewards, self perceived risk aversion, absenteeism, environmental factors and other personal attributes. Using students' final numerical course grades across a sample of economics courses at Farmingdale State College we have found that innate ability measured by cumulative gpa, hours of study before examination, and age affect grades obtained based on a stochastic production function estimation. Furthermore, attendance, the number of semesters at the college, laptop usage in class, perceived risk-aversion, and residency status affect technical efficiency scores. Finally, attendance and age of the student affect seat location preferences.

Introduction

Studies on the relationship between seating location choice in a classroom and student performance have produced contrasting results. While some studies have found a positive relationship between nearness to the front row in a class and a student's grade at the end of the semester after controlling for natural and physical endowments and investments, other studies have found the opposite. This paper contributes to this line of research by investigating the determinants of grade production using a stochastic frontier production function. The argument in support of the choice of a stochastic function is based on the luck element in grades that students obtain in examinations. From the production function, we investigate the relationship between technical efficiency and factors like gender, race, age, and student major. Further, we propose and test the hypothesis that a representative student, who values leisure activities, such as texting in the class, has a higher rate of time preferences and is therefore more likely to sit at the back of the class. These types of behaviors are less likely the back of the classroom.

Several studies have employed the stochastic production function to determine students' performance in schools. For example, Cooper and Cohn (1997) used the method to investigate

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determinants of performances of schools in South Carolina and found classes taught by teachers who received merit awards show greater mathematics and reading achievement gain scores, as do classes with fewer free-lunch students. Similarly, Khan and Kiefer (2007) employed the stochastic production function to compare efficiency in performance of schools managed by non-governmental organizations, the government and the private schools in Pakistan. The “output” is test score and the inputs include student, parent, teacher, and school policy variables. Schools managed by non-governmental organizations are found to be more efficient than the others.

Recent studies focus attention on an array of factors that may affect student performance and outcomes. Studies such as those by Akpalu and Vogel (2010), Armstrong and Chang (2007) and Benedict and Hoag (2004) specifically examine the question of seat location. Akpalu and Vogel (2010) find that the principal determinants of student performance are innate ability measured by gpa, attendance and age. Their study did not find seat location to be statistically significant in predicting individual class grades, it did however find a positive and significant relationship between seating preferences and student gpa. Armstong and Chang’s (2007) study focused upon the relationship between seat location and student performance on standardized computer scored exams. They did not find that seat location influenced student performance. On the other hand, Benedict and Hoag (2004) concluded that student seating preferences did affect student performance as measured by course grade. Specifically, individuals who prefer to sit near the front of the room have a higher probability of receiving As, whereas those who prefer the back have a higher probability of receiving Ds and Fs.

Other studies such as Park and Kerr (1990) evaluate other underlying factors affecting academic performance. They find that the principal factors are cumulative GPA and percentile rank on ACT/entrance exams. Attendance and students’ value of the course have a positive but lesser impact on outcomes. Borg and Stranahan (2002a; 2002b) find that personality type is an important factor affecting academic performance, with introverted personality types performing better than extroverts. A number of other studies such as Arias and Walker (2004), Siegfried and Kennedy (1995), Kennedy and Siegfried (1997), and Siegfried and Walstad (1998) assess the impact of class size on student performance. While Arias and Walker’s (2004) studies do find that small class size has a positive effect on student performance, the other studies suggest that class size does not matter.

A number of other studies have evaluated the relationship between attendance and student performance including Romer (1993), Cohn and Johnson (2006), and Stanca (2006). Romer (1993) finds that attendance does have a positive effect on learning. Cohn and Johnson (2006) find that performance is positively related to attendance across the whole semester. According to Stanca (2006) class attendance, effort and motivation are interrelated and it is still an open question how important attendance is to overall performance. Another factor that may affect student learning and outcomes is student employment status. One recent study by Wenz and Yu (2010) finds that the type of employment a student is engaged in does affect outcomes. Students who work to fully fund their education had lower gpas than their counterparts, while those who work just to complement their educational experiences, i.e. to gain additional skill sets, had relatively higher gpas.

Our study contributes to this evolving body of research by examining the issue using a stochastic frontier production function. In our analysis, we examine the relationship between factors like gender, race, age, student major, and technical efficiency in grade production. Further, we examine the impact that student behaviors such as texting in the class and other more leisure oriented activities may have on grade production. The rest of this paper is organized as follows. In the next section, we present an overview of the student population group and classes that are used in the analysis. Section 3 presents the econometric model and results of our analysis. The conclusions of our analysis are presented in the final section.

Classes and Students studied

Surveys of students were conducted during the ninth to twelfth week of the fall semester of 2009 in ten different sections of economics courses. There was no prior student selection process, use of pre or post exams, standardized exam instruments or instructor imposed seating charts in any of the classes that were surveyed. These courses included three sections of Principles of Macroeconomics, four sections of Principles of Microeconomics, and one section each of Intermediate Microeconomics, Sports Economics, and Engineering Economics. With the exception of the intermediate microeconomics course, the vast majority of the students enrolled in the surveyed courses were either students satisfying general education (Social Science) requirements or business students for whom the economics courses are required as part of the Business Management and Sports Management programs. In the case of the Engineering Economics course, ninety percent of those students were engineering technology students for whom this course was a required part of their degree program. A small number of students took these courses simply as an elective outside of their primary fields.

The students were given a twenty-five question survey that asked them to provide the following information: age, gender, major, on-campus resident or not, time to commute to the college, grade point average, seat location preference (front, middle or back row), employment status, average number of hours spent studying per week, and several questions related to texting in and out of class, use of a laptop computer in class, several questions related to their rate of time preference, and a question regarding risk aversion level (see Appendix 1). Each survey was coded so that the responses could be matched up with the student's final course grade and class attendance profile at the end of the semester, but individual names and other identifiers were stripped from the data insuring the individual students could no longer be identified. Only students that completed the courses and also completed the surveys were included in the analysis. The attrition rate in courses is quite low in the college and most students who drop out of courses do so well before the final examination week, and mostly for reasons of unsatisfactory performance. The course grade is made up of marks in a final test plus total marks obtained in a number of tests within the semester. Usually tests are announced ahead of time hence high attendance rates are recorded on the day of a test. In addition, a student who misses a test for a good reason is usually given a make-up exam. Not all students that completed the surveys responded to or completed every single question. While instructors provided 230 coded observations on attendance and 219 observations on course grades, student coded responses ranged from 162 students reporting their cumulative gpa, to 223 students providing their age. It should be noted too, that each of the classes under analysis enrolled no more than 40 students.

Cumlative gpa, as Park and Kerr (1990) have demonstrated, is a good indicator of both innate intelligence and a student's pre-existing efforts in a formal educational setting. Here we use self-reported gpa. Some investigators such as Maxwell and Lopus (1994) have suggested that self-reported gpa may suffer from what has become known as the Lake Wobegon Effect (LWE), in that individuals may misreport their gpa at inflated levels. More recent study of this issue by Haley et al. (2010) finds that this effect is overstated in the literature. Their analysis indicates that even if the LWE is present in the data, any bias introduced into the analysis is relatively small and will not qualitatively affect the analysis. Thus, given the issues and problems associated with acquiring gpa from the official records, they suggest that it is completely legitimate to rely on self-reported gpa. Intuitively, this logic applies to all other self-reported data (such as number of text messages exchanged, hours studied before examination, and hours worked) used in this study. Moreover, since the student is neither rewarded nor punished for disclosing this information we have no reason to believe the data is over or under inflated.

Attendance as reported by the instructors is the overall percentage of classes attended by the student during the semester. This is then converted into a dichotomous variable equal to 1 if the student had an attendance record of ninety percent or more, and '0' otherwise. The ninety percent is chosen upon examining the distribution of the data and experimenting with several values. Presumably, greater class attendance leads to better overall performance, though some of the studies discussed previously do not fully support this thesis. Some questions on the survey, such as those regarding age and the number of semesters students have been enrolled at Farmingdale capture various aspects of life experience and acquired skills relevant to education.

A number of variables collected capture various aspects of the students' work and study habits, their level of engagement with the courses they are taking, and general attributes and attitudes that they may hold. These variables include their employment status, whether and how much they may text in class, and their rate of time preference (questions related to whether the student would take a $1000 cash card now, or if they would be willing to wait for a card that provides them with $1050 four months in the future), and their degree of risk aversion.

Theoretical framework for the analysis

We hypothesize that the student's final course grade depends upon his/her seat location preference in class and other attributes (i.e., A), e.g. innate ability. These attributes may include personal and environmental characteristics that affect efficient utilization of other grade production inputs. Assume that the distance from any seat in the class to the professor's desk is measurable on a continuous scale. Normalizing the distance to the farthest seat to the instructor's desk as one, let $x_i \leq 1$ be the seat preference of student i in a particular class. Let the score obtained depend on the average number of hours that the student studies for the course (i.e., s). Student i's grade production function is

$$g = g\left(x, s, A\right) \text{, with } \quad g_x \leq 0,\ g_s \geq 0,\ g_{ss} < 0,\ g_{sx} < 0 \text{ and } \quad g_{xx} \geq 0 \qquad (1)$$

where $g_x \leq 0$ is the marginal grade productivity with respect to the normalized distance from the professor's desk. In addition, we have hypothesized that this marginal productivity is non-increasing in increased distance from the desk and that the attributes include the age of the student, his/her cumulative GPA, class attendance rate, self perceived risk aversion, whether the student lives on campus or not, the student's rate of time preference, and the number of years the student has spent in the college.

The student's seat location function arises through a utility maximization process. Assuming the returns to college education are positive (see for example Card 1999 or Katz and Murphy 1992), we postulate that the student derives utility indirectly from the score that he/she obtains in a course. We further hypothesize that students sitting in the rear of the class are more likely to engage in leisure activities, such as texting, sleeping or reading literature that is unrelated to the topic under discussion. As a result, the in-class leisure depends on $1 - x_i$. Using equation (1), the corresponding utility function for the student is

$$u = u\left(g\left(x, s, A\right), l\right) \qquad (2)$$

where $l = l(1-x) = 1-x$, is the distance to the rear of the classroom. Suppose the individual has a fixed amount of time that he or she can allocate to working (k) and studying (s). If the time endowment is normalized to one, then $k = 1-s$. Let the marginal opportunity cost of the time spent on studying be fixed at w. If the individual derives utility from income obtained from working then we can re-specify the utility function as

$$u = u\left(g\left(x, s, A\right), l, w(1-s)\right) \qquad (3)$$

Maximizing equation (3) with respect to x and s gives

$$\frac{\partial u}{\partial x} = u_g . g_x + u_l . l_x = 0 \Rightarrow g_x = u_l \big/ u_g = mrs_{l,g} \qquad (4)$$

$$\frac{\partial u}{\partial s} = u_g.g_s - u_s = 0 \Rightarrow g_s = u_s / u_g = mrs_{s,g} \quad (5)$$

From equation (4), the student will chose a seating position for which, in equilibrium, the marginal gain in grade will equate his/her marginal rate of substitution (*MRS*) between in-class leisure in class and his/her grade. Equation (5) indicates that, in equilibrium, the student will equate his/her marginal gain in the score to the marginal rate of substitution between the proportion of time allocated to studies and the score/grade.

From equation (4), we can derive the comparative statics of x with respect to the composite index A. Thus

$$u_{gg} g_x g_A \ dA - \ u_{gl}.g_x - u_{gg}.g_x^2 - u_g.g_{xx} - u_{ll} + u_{lg} g_x \ dx = 0$$

$$\frac{dx}{dA} = \frac{u_{gg} g_x g_A}{2u_{gl}.g_x - u_{gg}.g_x^2 - u_g.g_{xx} - u_{ll}} \leq 0 \quad (6)$$

From equation (6), given that an attribute improves scores, a student with such an attribute is more likely to sit in the front row relative to the rear row. This is empirically tested.

Estimation of the empirical model

For any given combination of inputs, the Stochastic Frontier Production Function (SFPF) assumes the realized production (say test scores) of an economic unit (say a student) is bounded above by the sum of a parametric function of known inputs each associated with unknown parameters, and a random error corresponding to measurement error of the level of production or other factors (Battese and Coelli, 1993). Thus, the greater the amount by which the realized production falls short of this stochastic frontier production, the greater the level of technical inefficiency. Given the variables of interest, we specify the stochastic production function as:

$$g_i = f(x_i, s_i, \mathbf{A}) Exp(v_i - u_i), \quad (7)$$

where v_i is a normally distributed error term (i.e., $v_i \sim N(\mu, \sigma^2)$) and u_i is a one sided error with a positive mean and variance (Aigner, Lovell and Schmidt 1977; Kumbhakar and Tsionis 2006; Lothgren 1997). Note that from equation (7), technical efficiency is measured as

$$\theta_i = \frac{g_i}{f(x_i, s_i, \mathbf{A}) Exp(v_i)} = Exp(-u_i).$$

Thus, a hundred percent efficiency score indicates performance on the frontier (i.e., best performance possible, given the available inputs) and zero percent, on the other hand, indicates weakest performance. The stochastic frontier production function has also been employed (e.g. by Cooper and Cohn 1997) to investigate determinants of achievement gains of the South Carolina educational system.

To estimate equation (7), questionnaires were administered to 230 students taking principles of economics, intermediate macroeconomics, sports economics and engineering economics. The descriptive statistics of the data collected are presented in Table 1. A typical classroom in the college is rectangular in shape with no rising-stairs and has a capacity of 40 seats arranged in 6 columns and 7 rows (with 2 seats missing in two of the columns). A class normally has one entrance which is situated at the front corner of the class. Students sitting at the first two rows are designated as “sitting in front”, those in the last two rows are considered “sitting at the back” and the rest are classified as “sitting in the middle”.[1] The mean percentage score of the students is 79.23 percent and the mean cumulative GPA is above 3.0. On the average, each student has spent about 3 semesters at the college and takes approximately 14 credits during the semester. Furthermore, 39 percent of the students sit in front. From our sample, 8.5 percent use laptops in class, very few (4 percent) perceive themselves as risk averse, 9 percent live on campus, and approximately half (44 percent) have relatively higher rate of time preferences (i.e., prefer rewards now to the future). Our sample has more females (59 percent) than males (41 percent) and less than 8 percent were unemployed or did not work. Of the number employed, more than a third work fulltime. Furthermore, the average age is approximately 22 years, with relatively low standard deviation of 5.4 implying the individuals ages are close to the mean.[2]

Table 1. Descriptive Statistics of variables used in the regressions

Variables	**# of obs**	**Mean**	**SD**
Grade	219	79.23	14.94
Present at all classes (=1, 0 otherwise)	230	0.257	0.438
No. of semesters in FSC	218	2.975	2.176
Cumulative GPA at FSC	162	3.046	0.576
Total # of semester credits	222	13.856	2.682
Use laptop in class (=1, 0 otherwise)	223	0.085	0.421
Perceived self as risk-averse(=1, 0 otherwise)	199	0.040	0.197
Sit in front(=1, 0 otherwise)	196	0.388	0.488
Age of student	222	21.599	5.436
No. of hours the student study before exam	197	3.022	4.220
Student live on campus(=1, 0 otherwise)	223	0.094	0.293
Student has higher rate of time preference(=1, 0 otherwise)	216	0.444	0.498

Table 2 has the results of the estimated stochastic production function of the scores. The R-squared indicates that about 30 percent of the variability of the dependent variable is explained by the explanatory variables, which is quite high for survey data (see e.g., Stanca, 2006; and Cohn and

Johnson, 2006). Also the Wald Chi-square statistics (Prob> F = 0.00) indicates that the line is a good fit. Moreover, the likelihood ratio test strongly confirms that the level of technical efficiency varies

Table 2. Stochastic Frontier Production Function of Marks Obtained for Spring 2010 Semester

Variable	**Coefficient**
log(Cumulative GPA at FSC)	**0.025** (3.77e-06)***
log(Age of student)	**-0.003** (5.7e-08)***
log(No. of hours the student study before exam)	**0.006** (1.02e-07)***
Constant	**0.993** (1.23e-05)***
σ_μ^2	-2.668 (0.121)***
σ_v^2	-38.483 (285.308)
Lambda ($\lambda = \sigma_u / \sigma_v$)	5.98e+07 (0.059)
Mean Efficiency	0.82
Wald Chi-square (3) = 1.00e+10 (**Prob > 0.00**)	
Likelihood-ratio test: $H_0 : \sigma_\mu = 0$, Chi-square = 44.22 (**Prob> 0.000**)	

Standard errors in parentheses. ** significant at 5%; *** significant at 1%.

across the scores hence the stochastic frontier estimation is desirable. The variables that are statistically significant in explaining the scores are the Cumulative GPA, the number of hours a student studies before taking the examination, and the age of the student. All three explanatory variables were significant at the 1 percent level. The proxy for innate ability (i.e., CGPA) and the hours of study have a positive impact on scores, while older students have lower scores, on average. From the elasticity coefficients, a 10 percent increase in the CGPA or hours of study before exams, on the average, increases the score mark by 0.25 percent and 0.06 percent, respectively.[3] This implies that, all other things being equal, innate ability as well as the effort students invest in studies are both important in determining the overall course grade. Secondly, relatively younger students performed better than older ones with a corresponding elasticity coefficient of -0.003. It is noteworthy that although the coefficients are statistically significant, the impacts of the corresponding variables on scores are very small. Interestingly, the mean efficiency score is 0.82, which is very high, indicating the performance of most students is at the frontier. Thus, the students on the average have the capacity to increase their performance by 18 percent.

Furthermore, we explore the determinants of technical efficiency among the students. Thus, we regressed the technical efficiency scores on several variables. The results are reported in Table 3. From the results, the R-Square indicates that about 22 percent of the variability of the technical efficiency is accounted for by the explanatory variables. Contrary to our expectation, students who were present at all classes performed worse than students who missed some classes. Specifically, on

Table 3. Determinants of Technical efficiency in total marks scored for Spring 2010 Semester

Variables	**Coefficients**	**Elasticity**
Present at all classes (=1, 0 otherwise)	**-0.153** (0.075)**	-0.169
No. of semesters in FSC	**-0.019** (0.005)***	-0.074
Total No. of semester credits	-0.0008 (0.003)	
Use laptop in class (=1, 0 otherwise)	**-0.082** (0.024)***	-0.006
Perceived self as risk-averse(=1, 0 otherwise)	**-0.117** (0.040)***	-0.008
Seat in front(=1, 0therwise)	0.015 (0.020)	
Student live on campus(=1, 0 otherwise)	**-0.001** (0.0004)***	-0.001
Student has higher rate of time preference(=1, 0 otherwise)	**0.032** (0.019)*	0.019
Constant	**1.012** (0.080)***	
Observations	**112**	
R-squared	**0.22**	

* significant at 10%; ** significant at 5%; *** significant at 1%. Robust standard errors in parentheses

average, being present at all classes lowered the efficiency score by 17 percent. Thus students who attend all classes, on the average, have 17 percent lower scores than their counterparts who skip some classes. This finding contrasts those of previous studies (see e.g., Moore, 2006). Secondly, students with more semesters at the college had lower efficiency scores, with a corresponding elasticity of -0.07. This finding possibly stems from the increasing number of hours that students at the college work on average as they spend more semesters in the college. The correlation between working fulltime and the number of semesters spent at the college is positive (0.39) and statistically significant at the 1 percent level. Thirdly, students who use laptops in class or live on campus had lower efficiency scores. A plausible explanation is that the laptops are used for leisure activities such as checking email and browsing sites unrelated to the lectures. Unfortunately, this could not be verified from our data since we did not ask the students to indicate the activities the laptops were used for while in class. The negative relationship between multi-tasking and performing in class has also been found by Ellis et al. (2010). It is also possible that students who live on campus spend a lot more time socializing than studying for examinations. Furthermore, it is interesting that the students who perceived themselves as being risk averse performed worse than risk-loving students; and those who are more uncertain about the future (or value benefits today more than the same benefits in the future) perform relatively closer to their frontier, on the average. Most importantly, seat location preference does not explain efficiency scores. In the following regression we explore the determinants of the decision to sit in front and the results are presented in Table 4. We found that older students are more likely to sit in front, and a 10 percent increase in age will increase the probability that a student sits in front by 13.7 percent on the average. Moreover, a 10 percent increase in class attendance, on the average, increases the probability that a student will sit in front by 33 percent.

Table 4. Logit regression for the Choice of Front Seat

Variables	**Coefficient**	**Elasticity**
Class attendance rate	**5.567**	**3.306**
	(2.074)***	
Cumulative GPA at FSC	0.165	
	(0.376)	
Total No. of semester credits	0.096	
	(0.061)	
Perceived self as risk-averse(=1, 0 otherwise)	-0.228	
	(0.817)	
Age of student	**0.094**	**1.367**
	(0.032)***	
Student has higher rate of time preference(=1, 0 otherwise)	0.626	
	(0.410)	
Constant	-9.937	
	(2.827)***	
Observations	123	
Pseudo R-squared	0.10	

* significant at 10%; ** significant at 5%; *** significant at 1%. Robust standard errors in parentheses.

Conclusions

This study sought to investigate the determinants of student performance in Economics employing a stochastic frontier production function. We found that scores or grades obtained were positively affected by both innate ability and effort invested by the student. However, older students performed worse than their younger counterparts. The mean efficiency score was very high (82 percent). Regarding the determinants of technical efficiency, students who were present at all classes, had spent more semesters at the college, used laptops in class, perceived themselves as risk-averse or lived on campus had lower technical efficiency scores. On the other hand, students who were more uncertain about the future (or valued benefits today more than same benefits in the future) perform relatively closer to their frontier, on the average. Seat location was not statistically significant in the technical efficiency estimation. A separate Logit analysis of seating preferences indicated a positive relationship with attendance and age.

ENDNOTES

1. The question on the survey asks students to identify where they normally sit in class. Since none of the classes surveyed employed any type of enforced seating chart or scheme, students were free to choose from all available seats at any point during the semester. Applying the concept of revealed preference to students responses suggests that a student's indicated seat location is a good indicator of their specific preference to be in the front, middle or back of the room.
2. The following are additional statistics from the data. On the average, 29 percent of the students consider themselves risk loving; 67 percentage are neutral and only 4 percent are risk averse. The mean individual discount rate obtained through the experiment is 9.6 percent, which is much higher than average official lending rates at the commercial banks. Furthermore, the average number of text messages sent out by the students within the semester is approximately 9 while the maximum messages sent out are approximately 13.
3. Note that since letter grades are based on numerical scores, a small change in such a score could results in a change in a grade level.

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Appendix 1: Survey Instrument

	Survey Questions
1.	What is your age (please indicate in years)?
2.	What is your major at Farmingdale State College?
3.	Do you live on campus?
4.	If you do not live on campus, how much time does it take you to commute to class?
5.	Are you currently taking a math class?
6.	If yes to the preceding question, what is the course?
7.	What is the highest level mathematics course that you have ever taken?
8.	If you intend to have a minor, what will it be?
9.	How many semesters have you been enrolled at FSC?
10.	Is FSC your first college?
11.	What was your high school GPA?
12.	What is your college cumulative GPA?
13.	Have you ever received or sent a text message in this class?
14.	How many text messages, on the average do you send our or receive when you are in this class?
15.	What is the highest number of text messages that you have sent out or received in this class?
16.	Are you employed fulltime or part-time?
17.	How many credits are you taking this semester?
18.	How many hours on the average do you study before taking each test in this course?
19.	If the course does not require an in-class test, how many hours on the average do you spend on major assignments for the course?
20.	Please indicate the position of your seat (i.e. where you normally sit in class) from the front row (front, middle, or back)
21.	Do you use a laptop computer in class?
22.	What is the maximum number of hours you studied before taking a test in the course?
23.	Suppose that FSC wants to implement two scholarship schemes, **A** or **B** to supplement students' expenses on food, textbooks, etc. on campus. The two schemes cost the same amount of money. Which of the following would you vote for? **Scheme A** would provide you with a $1000 Cash Card that could be used to buy such items on campus this month (please note that the card does not expire) **Scheme B** would provide you once with a $1050 Cash Card that could be used to buy such items on campus next semester (i.e. in 4 months time, and note that the card does not expire.
24.	If you are to quote a value for Alternative B that will make you exactly as happy as choosing alternative A, what value will that be?
25.	Do you consider yourself to be risk loving, risk neutral, or a risk averse person?