Homework 3

Piece Rate Model - Evidence

Problems

(1)* A surgeon has to choose whether to work for a hospital that offers a salary contract or a hospital that offers a piece rate contract. The salary contract pays $5, independent of how many surgeries are performed. The piece rate contract pays $1 for each surgery q, but the physician has to pay $1.5 for the office rent. The expected number of surgeries is the sum of physician's effort e and his ability n (E[q]=e+n), while his cost of effort depends solely on e according to $0.5e^2$. Suppose that the physician effort cannot be observed and that the hospitals and the physician are risk neutral. Which type of contract will a surgeon of ability n=5 select?

(2)* The real estate firm needs to employ a new agent. The expected value of the agent's output (E[pq]) is 10e, while his cost of effort is e^2. The agent's outside option is 5n, where n is his ability. Suppose that the agent's effort cannot be observed and that both the firm and the agent are risk neutral. Explain whether the piece rate contract w=-15+pq would be acceptable to an agent of ability n=1?

(3)* The class size may affect learning outcomes. Specifically, the learning outcome for children in classes with 20 students or less is given by y^1=10+u, while the learning outcome for children in classes with more than 20 students is given by y^0=5+u, where u is the individual student's ability. You learned that the average ability of students in classes with 20 students or less is 4 and the average ability of students in classes with over 20 students is 2. What is the magnitude of treatment and selection effects of being in a class with 20 or less students in the class?

(4)* A patient health outcome y depends on whether a hospital receives the wait time funding. Specifically, y^1=5+ β +u if the hospital receives the funding and y^0=5+u if it doesn't, where u is a variable that varies across hospitals. The observed patient outcome is 8 in hospitals that received the funding. In addition, the average value of u is 1 for hospitals that received the funding and 3 for other hospitals. What is the difference in the observed patient outcome between hospitals who received the wait time funding and those that didn't? How much of this difference is due to the treatment effect, and how much is due to the selection effect?

(5)* The following table gives the potential earnings of university and high-school graduates:

	Earnings if High-School Graduate	Earnings if University Graduate
University Graduates	$50,000	$80,000
High-school Graduates	$30,000	$60,000

a) What is the observed difference in earnings between university and high-school graduates? How much of this difference is the treatment effect and how much the selection effects?
b) Suppose you randomly assign individuals into either high-school or university. Show that this randomization can identify the treatment effect of obtaining the university degree.

(6)* The Ministry of Health conducted an experiment to measure whether fee-for-service physicians (i.e. physicians paid according to a piece rate system) treat more patients than salaried physicians. Prior to the experiment, all physicians were salaried physicians. Physicians were randomly assigned to either the fee-for-service pool of physicians or the salary pool of physicians. The following table shows the results:

	Patients seen per day before the experiment	Patients seen per day after the experiment
Fee-for-Service	18	25
Salary	20	21

a) Does the data support the claim that randomization assigns similar physicians to the treatment (fee-for-service) and control (salary) groups?
b) What do these results say about the productivity difference between the fee-for-service and salary physicians?

(7)* Explain why, in his tree-planting experiment, Bruce Shearer (2002) assigned the same supervisor to both tree planters that were paid hourly wage and tree planters that were paid based on how many trees they plant.

(8)* Allen-Edmonds Shoe Company is a manufacturer of high-priced shoes. For years, it paid its factory employees based on individual output through a piece rate system. In 1990, following the advice of quality gurus, the company abandoned the piece-rate system and started paying employees fixed hourly wages. After the policy change, the average productivity of employees decreased by 10 percent. Discuss whether this result is consistent with economic theory and empirical evidence from Shearer (2002).

(9) Some parents tend to be late in picking their children from day care centers. As a solution, consider implementing a fine for the tardy parents (the fine system) and using a randomized experiment to test whether this solution would work.

a. Clearly define the following terms as they apply to this experiment: unit of observation-outcome – treatment – treatment group – control group.
b. Clearly state the research question in a cause-effect form.
c. Discuss why a comparison of childcare centers that choose to adopt the fine system and childcare centers that choose not to adopt the fine system may not help you uncover the causal relationship of interest in this case.
d. Explain how you would design a randomized experiment for this purpose and why it may help you uncover the causal relationship of interest.
e. Discuss what other confounding factors (i.e. variables that may systematically differ between the treatment and control groups and that may have an effect on the outcome) you would control for in your experiment.

Solutions

(1) The expected utility of selecting the piece rate contract is E[U]=E[w]-c(e). The expected wage is E[w]=a+E[q]=-1.5+e+n, while the cost of effort is $0.5e^2$. If the physician accepts this contract, he will provide the optimal level of effort e* defined by MB(e*)=MC(e*), or 1=e*. Therefore, the expected utility is -1.5+1+n=n-0.5. For a surgeon of ability n=5, this is equal to 4.5. On the other hand, the utility of selecting the salary contract is s-c(e)=5-$0.5e^2$. Given that the physician effort cannot be observed, the optimal level of effort from the physician perspective is then e=0 and the utility from selecting the salary contract is then 5. Therefore, a surgeon with ability level 5 will select the salary contract.

(2) The agent's expected utility is E[U]=E[w]-c(e)= -15+10e-e^2. If the agent works for the firm, he will exert the optimal level of effort e* defined by MB(e*)=MC(e*), which gives e*=5. Therefore, the agent's expected utility is -15+10(5)-5^2=10. The agent's outside option, for n=1, is 5(1)=5. Therefore, the agent will accept this piece rate contract rather than pursue his outside option.

(3) The treatment effect is the difference in learning outcomes between two types of classes, holding the student ability constant: y^1- y^0=5. The selection effect is the difference between the observed difference in the learning outcomes and the treatment effect. The observed learning outcome is 10+4=14 in the class with 20 students or less and 5+2=7 in the class with more than 20 students. Therefore, the observed difference is 7, of which 5 is the treatment effect and the remaining 2 is the selection effect.

(4) The observed outcome for hospitals that received the funding is $E[y^1|\text{received funding}]=8$. The observed actual outcome for hospitals that did not receive the funding is $y^0=5+E[u|\text{did not receive funding}]=5+3=8$. Therefore, the observed difference between the two types of hospitals is 0. The selection effect is given by the average difference in u between hospitals that received the funding and those that didn't: $E[u|\text{received funding}]- E[u|\text{did not receive funding}]=1-3=-2$. The treatment effect can be found by using the identity that the observed outcome is the sum of treatment and selection effects, or 0=-2+treatment effect. Therefore, the treatment effect is 2.

(5) (a) The observed outcome is \$80,000- \$30,000=\$50,000. Of this, \$30,000 is the treatment effect (either \$80,000-\$50,000 or \$60,000-\$30,000); the remaining \$20,000 is the selection effect. (b). If individuals are randomly assigned into either high-school or university, then the observed earnings for those who now have high-school is 0.5(\$50,000) + 0.5(\$30,000)=\$40,000, while the observed earning for those who now have university is 0.5(\$80,000)+0.5(\$60,000)=\$70,000. The difference in observed earnings after randomization will therefore yield \$70,000-\$40,000, or exactly the treatment effect.

(6) (a) Yes, since the number of patients seen per day by the treatment and control physicians is similar (19 vs. 21) prior to the experiment. (b) The results indicate that the fee-for-service physicians treat 25 patients per day. The estimate of the number of patients seen by salary physicians is any of 18, 20, or 21, or their average of (18+20+21)/3, which is about 20. Therefore, the fee-for-service physicians treat about 5 more patients per day, an improvement of about 25 percent ((25-20)/20).

(7) Shearer was concerned that even after randomization, his treatment (piece-rate planters) and control (wage planters) groups may systematically be different. For example, suppose that stringent supervisors were assigned to the wage planters and lenient supervisors were assigned to the piece-rate planters. In this case, the number of trees planted by the wage planters would be higher and the number of trees planted by the piece-rate planters would be lower than if they were both assigned the same supervisor. This difference in the number of trees would have nothing to do with how planters are paid. This is an example of how correlation between two variables (how workers are paid and their productivity) does not represent a cause-effect relationship because a third variable (type of supervisor) may affect both variables.

(8) This result is consistent with the economic theory of piece rates when the agent's effort cannot be observed and both parties are risk-neutral. Specifically, the piece rate pay induces the efficient level of effort by effectively renting the job to the worker and letting the worker keep the value of his output. When effort is not observed, the salary contract will elicit less than the optimal level of effort. The direction of the change is consistent with the empirical evidence in Shearer (2002) who showed that the tree planters in B.C. who are paid based on the number of planted trees are more productive than the planters paid by the hourly wage. However, Shearer estimates that the

difference in productivity is about 20 percent, which is more than double what is observed for the case of Allen-Edmonds Shoe Company. The difference in the magnitude can perhaps be explained by the selection effect. For example, some productive workers may not have left the company after the salary system was implemented for reasons other than the change in how the workers are paid.

(9)

a. Outcome could be defined, for example, as the number of days per week that the parents are late. The unit of observation could be defined as the day care centre. The treatment is the presence of the fine system. The treatment group is the group of daycare centers with the fine system in place, while the control group is the group of daycare centers with no fine system in place.
b. Does the fine system for tardy parents (cause) reduce the number of days per week that parents are late in picking their children from daycare centers (effect)?
c. The observed difference in the outcome between the two types of daycare centers may reflect not only the presence of the fine system but also other differences that may affect the outcome, such as the size of the daycare centre and its location and differences in management.
d. You can start with a randomly selected sample of daycare centers, all of which have no fine system in place. Using a random device, you then assign half of these centers to the fine system while the other half continues with no fine system. This may help uncover the causal effect because randomization would help reduce other differences between the centers other than the treatment.
e. Few examples include the size of the centre, its location, the qualification of supervisors, and the average income and education of parents. Each of these factors may have an impact on the outcome and it may also have an impact on the center's decision to implement the fine system.