Economics 402 Assignment 5, due: May 3, 2014 at 4pm

Please submit your answers in a pdf file in the designated dropbox on Angel by the date and time stated above. Assignments that are submitted at least 24 hours prior to the date and time stated above receive a 1 point (=10%) bonus on this assignment. The time recorded by Angel will be taken as the official time. Late assignments or assignments submitted by other means than indicated will not be accepted. If students submit more than one answer, the most recent one will be used for the determination of the assignment grade, including the possible 1 point early submission bonus.

Please leave yourself sufficient time prior to the assignment due date so that if you have trouble submitting the assignment because of computer, personal, or other issues you still have time to seek help and submit the assignment on time.

It is perfectly acceptable and indeed encouraged for you to talk to other students. However, every student should answer the assignment questions independently. Copying is a violation of the university's academic integrity policies and can have serious consequences.

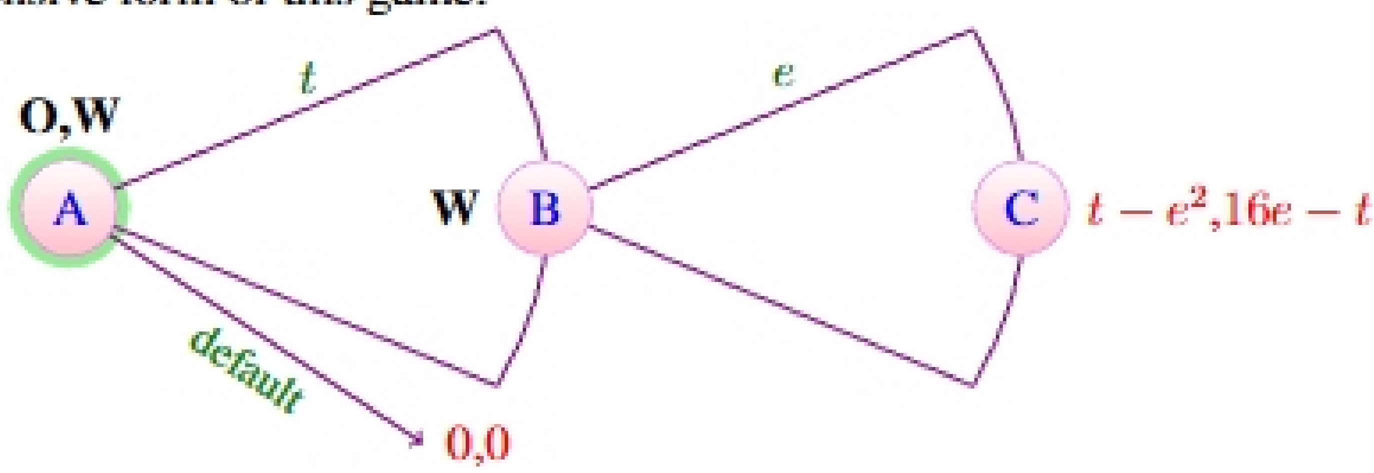
Please show enough of your work to convince the grader that you know what you're doing. So don't just write down 'K is dominated,' but show/argue that K is dominated.

1. Consider a game between an owner O and a worker W. The success of the firm depends on W's effort level $e \geq 0$: O would receive $16e$. W prefers not to exert effort. W's *disutility* of achieving effort level e is e^2 (so W's utility of exerting this amount of effort is $-e^2$). Assume sequential rationality and the standard bargaining solution with equal bargaining power wherever applicable.

   (a) What value of e maximizes the joint payoff of W,O? The joint payoff is $t - e^2 + 16e - t = 16e - e^2$, which is maximized at $e = 8$.

   (b) Suppose that O and W first negotiate a salary t and then O chooses an effort level e.

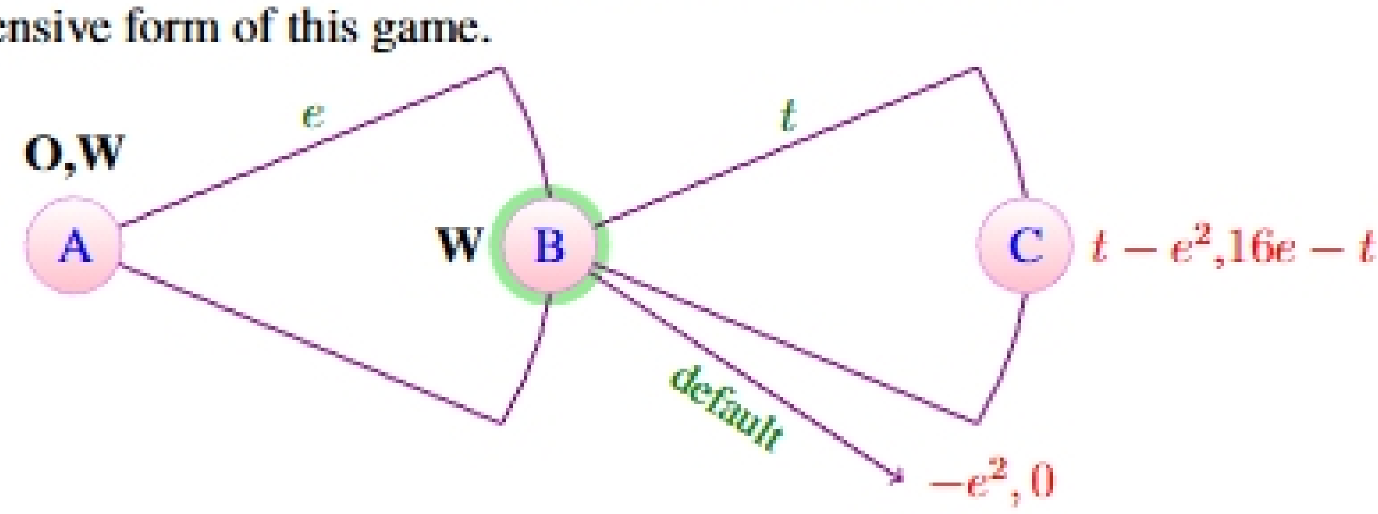
      i. Draw the extensive form of this game.



      ii. What salary will they negotiate? At node B, W cannot do better than choosing $e = 0$, so the payoffs are $(t, -t)$. There is no surplus so $t = 0$.

   (c) Now suppose that W first chooses e and then O,W negotiate a salary t.

      i. Draw the extensive form of this game.



ii. What effort level will W choose? The joint surplus is $t - e^2 + 16e - t - (-e^2 + 0) = 16e$; each gets half of that over and above the default payoff so $t = 8e$. W hence receives $8e - e^2$, which is maximized at $e = 4$.

iii. What do you call the issue that arises here? The holdup problem

(d) Now consider the possibility that W,O first negotiate a salary t that depends on the effort e that W makes, then W chooses an effort level e, and then W receives the salary $t(e)$ from O. So W gets paid more if W's effort is greater. For what function t is the efficient outcome reached? Please remember to use the standard bargaining solution with equal bargaining power for W,O. *There are many possible correct answers.* The easiest way to do this is as follows. If we give W half the surplus regardless of W's effort level then s/he gets $8e - e^2/2$, which is maximized at $e = 8$, as desired. To find $t(e)$ we need $t(e) - e^2 = 8e - e^2/2$, which holds for $t(e) = 8e + e^2/2$.

2. Consider the following stage game.

Stage game

1 \ 2	L	M	R
T	1,1	2,4	1,4
C	0,8	1,1	1,1
D	3,0	0,0	7,0

(a) What are the stage Nash profiles? (T,M), (D,R), and (D,L)

Now consider a repeated game with $T = 2$ and no discounting.

(b) Please identify four pure strategy subgame perfect equilibria in this game in which the profile specified in period 2 does not depend on the profile played in period 1 and compute total payoffs for each player in each case.

(1) (T,M) in period 1; (T,M) in period 2 irrespective of what happened in period 1; (4,8)

(2) (T,M) in period 1; (D,R) in period 2 irrespective of what happened in period 1; (9,4)

(3) (D,R) in period 1; (T,M) in period 2 irrespective of what happened in period 1; (9,4)

(4) (D,R) in period 1; (D,R) in period 2 irrespective of what happened in period 1; (14,0)

You can also use combinations featuring (D,L)

(c) Please identify a pure strategy subgame perfect equilibrium in this game in which the profile specified in period 1 is not a stage Nash profile. Please be very precise in your description. In period 1: (C,L). In period 2: if (C,L) was played in period 1 then (D,R); otherwise (T,M). This is not the only possibility, but the most natural one.

(d) Compute total payoffs for each player for the subgame perfect equilibrium you found in question 2c. (7,8)

3. Professor P (player 1) advises PhD student S (player 2). Each week P must decide whether to exert high (H) or low (L) effort at a cost of 2 and 1, respectively. Simultaneously, S must make the same decision at a cost of 3 and 1, respectively. If S exerts high effort then P receives 3 irrespective of P's effort level. If P exerts high effort then S receives 10 irrespective of S's effort level. Neither receives anything if the other does not exert high effort. For example, with (H,L) the payoff is $(0 - 2, 10 - 1) = (-2, 9)$. Both use the same discount factor $0 < \delta < 1$.

(a) Please write down the normal form for the stage game.

Stage game

P \ S	H	L
H	1,7	-2,9
L	2,-3	-1,-1

(b) Please identify all pure strategy stage Nash profiles. Only (L,L)

(c) Which strategy profile in the stage game corresponds to both players cooperating? (H,H)

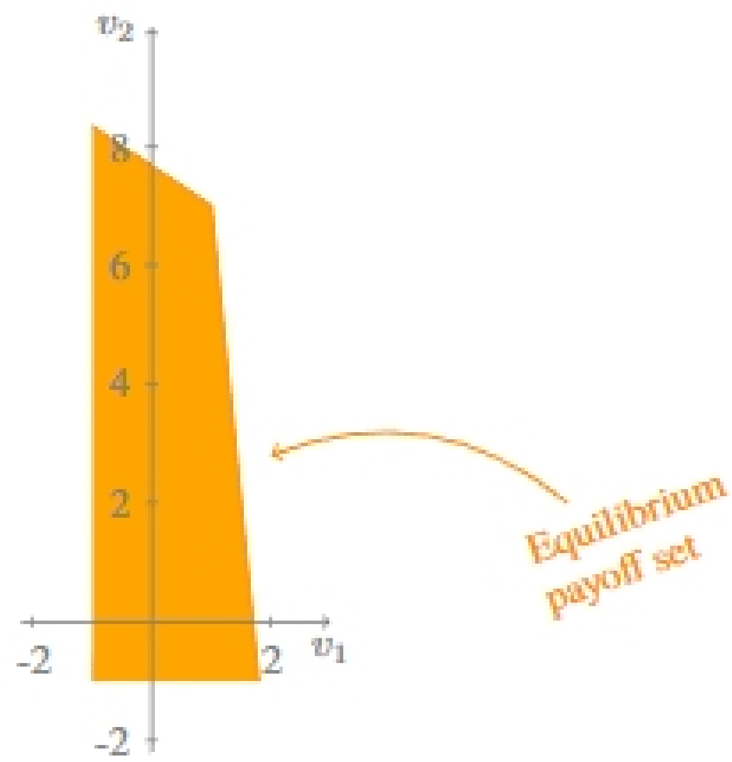
Please consider only infinitely repeated games with grim trigger strategies from hereon.

(d) Please determine the cooperator, deviator, and punishment payoffs for P. For what value of δ does P have no reason to deviate from the strategy profile in the infinitely repeated game (with the displayed stage game) that specifies the strategy profile in your answer to 3c in every stage game? $u_1^c = 1$, $u_1^d = 2$, $u_1^p = -1$. Deviating gains 1, but loses 2 every period in the future, so $1 \leq 2\delta/(1-\delta)$, i.e. $\delta \geq 1/3$.

(e) Please answer 3d again, but now for S instead of P. $u_1^c = 7$, $u_1^d = 9$, $u_1^p = -1$. Deviating gains 2, but loses 8 every period in the future, so $2 \leq 8\delta/(1-\delta)$, i.e. $\delta \geq 1/5$.

(f) So for what value of δ is the strategy profile in the infinitely repeated game that specifies your answer in 3c as the strategy profile in every stage game a subgame perfect equilibrium? $\delta \geq 1/3$

(g) Please draw the equilibrium payoff set. Please make sure it is very clear what the corner points are.



(h) Please explain the folk theorem in your own words.