Homework 1

ECON 315 Spring 2021

Due by 11:59 PM Wednesday, March 24, 2021 by PDF upload in Blackboard Assignments

Concepts and Critical Thinking

Question 1

Explain the difference between Pareto efficiency and Kaldor-Hicks efficiency. Give an example of an action or a policy that is a Kaldor-Hicks improvement but not a Pareto improvement.

Question 2

Explain some differences between the Common Law tradition and the Civil Law tradition. How is this distinction *different* from the differences between Civil law and Criminal law?

Question 3

Explain two normative guidelines for designing an efficient legal system, depending on transaction costs. You book calls these the Normative Coase and Normative Hobbes theorems.

Question 4

Explain the difference between a *property rule*, a *liability rule*, and an *unalienability rule*. Under an efficient legal system, in what circumstances would each type of rule be used?

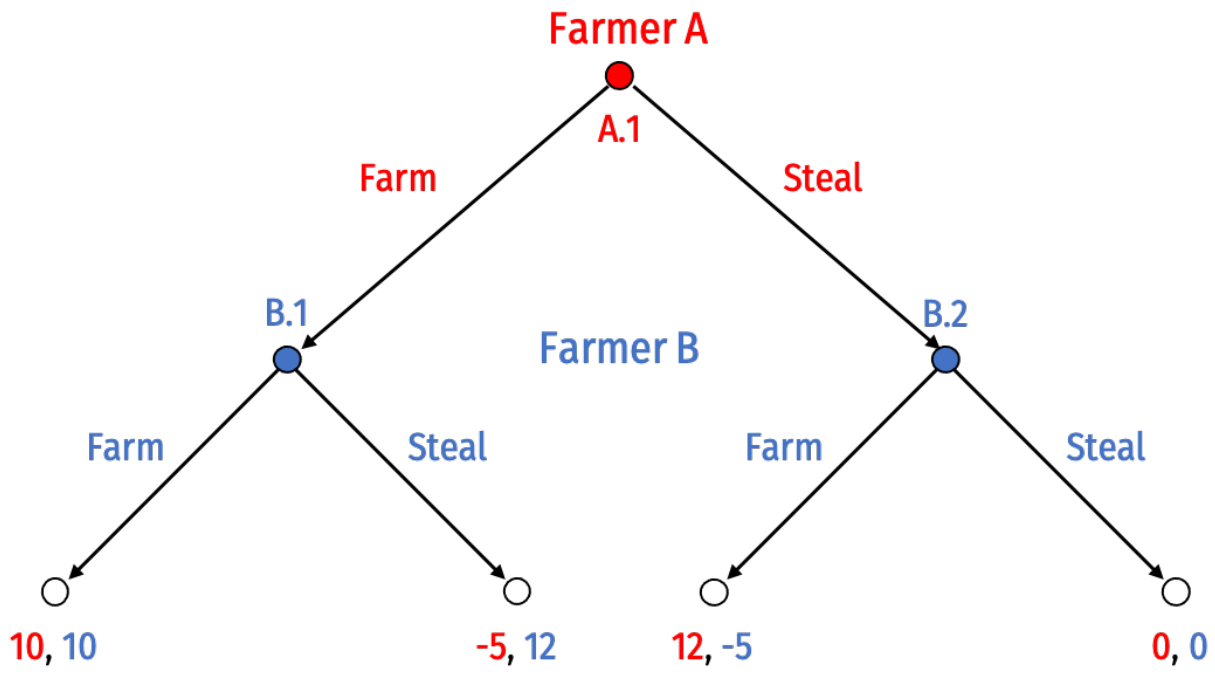
Question 5

Explain the major differences between patents, copyrights, trademarks, and trade secrets. You do not need to go into detail, but what does each type of intellectual property cover, and how does each basically work?

Problems

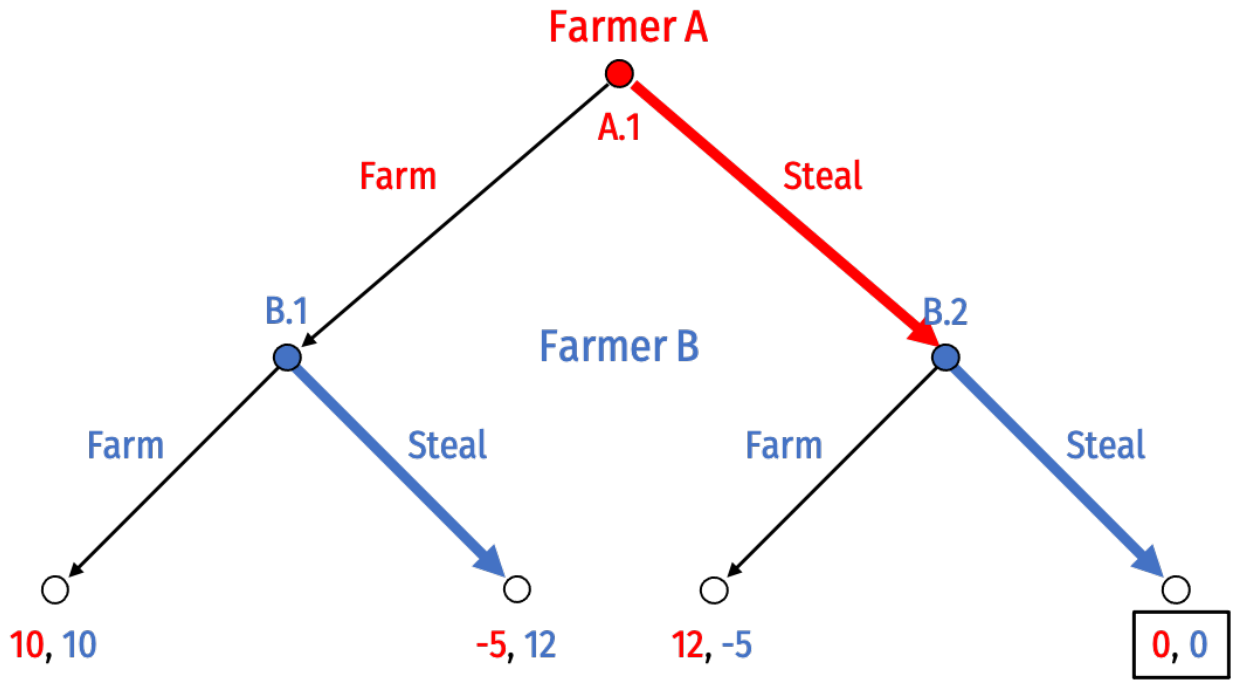
Question 6

Consider the farm or steal game that motivated our discussion of property in lesson 2.1, but recast as a *sequential* game. Farmer A decides to farm or (commit to) steal *first*, and then given this decision, Farmer B decides to farm or steal.



Part A

Solve this game for the rollback equilibrium using backwards induction. Prune the game tree as you do so.



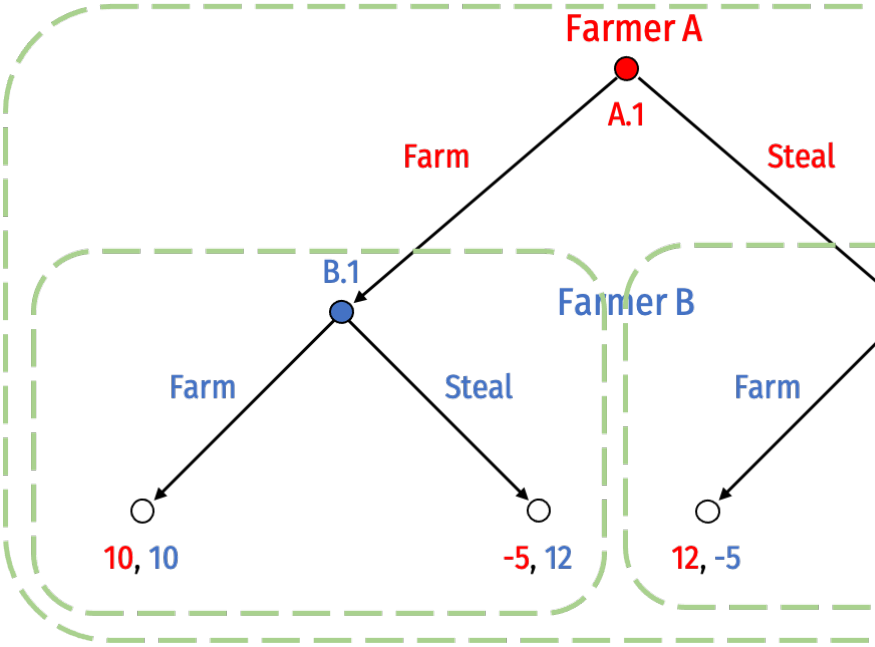
To solve via backwards induction, start at the terminal nodes at the bottom, and determine what decisions the last-mover will make at their decision nodes, and given that, work your way up to earlier decision nodes.

So start with Farmer B, who at node B.1 can choose to Farm (and earn 10) or Steal (and earn 12). They will Steal. At node B.2 Farmer B can choose to Farm (and earn -5) or Steal (and earn 0). They will Steal. I have highlighted these optimal choices on the game tree in blue (alternatively, you can cross out the non-highlighted branches.)

Now move to Farmer A, who at node A.1 can choose to Farm or Steal. If A Farms, they know B will Steal; and if A Steals, they know B will Steal; so really the decision for A is between Farming and earning -5 (since B will respond with Steal), or Stealing and earning 0 (since B will respond with Steal). So A will Steal.

This is the outcome: A will Steal and B will Steal.

Part B



Circle (or describe) all subgames of this game.

There are three:

1. The game itself (initiated at A.1)
2. The subgame initiated at B.1
3. The subgame initiated at B.2

Part C

Carefully convert this game from extensive form to strategic form. (Be mindful of how many potential strategies each player has!)[1] **Find any Nash equilibria in strategic form.** Farmer A only has two possible strategies based on their single decision node A.1:

1. Farm
2. Steal

Farmer B, however, has $2^2— = 4$ possible strategies, based on their two decision nodes (B.1, B.2) which have two possible choices each. For convenience, I denote each strategy as an ordered pair of what choice

[1] Hint: This will not look exactly like the payoff matrix in the slides!

they would select at decision nodes (B.1, B.2), for shorthand, F stands for Farm, S stands for Steal:

1. (Farm, Farm)
2. (Farm, Steal)
3. (Steal, Farm)
4. (Steal, Steal)

Representing this in strategic form:

Farmer A \ Farmer B	(F, F)	(F, S)	(S,F)	(S,S)
Farm	10, 10	10, 10	-5, 12	-5, 12
Steal	12, -5	0, 0	12, -5	0, 0

Using best-response analysis, I have highlighted each player's best response to each strategy of the other player by underlining the associated payoff. Nash equilibrium requires all players to be playing mutual best responses to each other. We can see there is only a single Nash equilibrium:

1. {Steal, (Steal, Steal)}

Farmer A plays Steal, and Farmer B plays (Steal, Steal - i.e. always Steal).

Part D

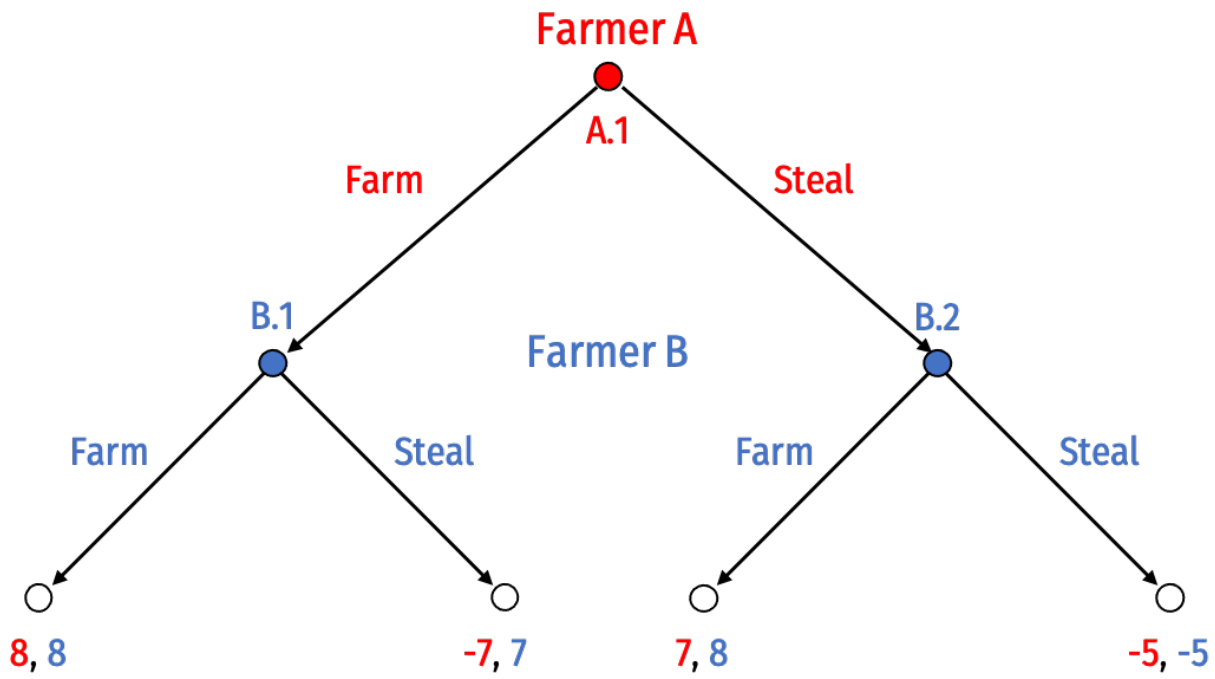
What is the subgame perfect Nash Equilibrium? Why? The single Nash equilibrium identified in Part C, {Steal, (Steal, Steal)}, is subgame perfect. For proof, see the answer to A, which shows this strategy to be sequentially rational (and the rollback equilibrium). This strategy is a Nash equilibrium in all possible subgames, i.e., in any of the three possible subgames, no player would want to deviate from this strategy set.

Part E

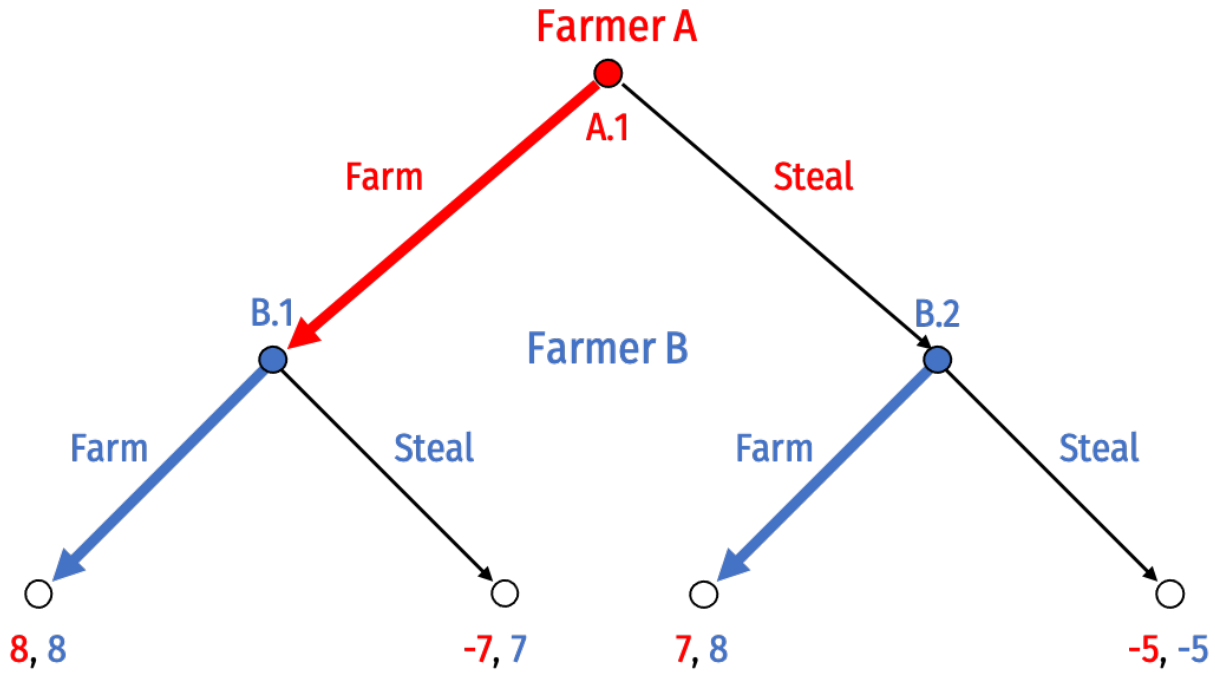
Suppose before the game begins, Farmer B promises Farmer A that if Farmer A *farms*, Farmer B will *farm* as well. What should Farmer A make of this? This is clearly not a credible promise. If by any means the game reaches B.2, it is always in the interest of Farmer B to Steal. So playing Farm would not be a Nash equilibrium in that subgame, since Farmer B would want to switch to Steal.

Part F

Suppose the farmers set up a property system like we discussed in class. Administering property rights costs 2, and the penalty for theft is -5. The new game looks like this:



Find the rollback equilibrium using backwards induction. Prune the game tree as you do so.



Solving similarly to part A, we get the outcome where both players Farm.

Part G

Convert this game to strategic form. Find any Nash equilibria. Which is/are subgame perfect, and why? Representing this in strategic form:

Farmer A \ Farmer B	(F, F)	(F, S)	(S,F)	(S,S)
Farm	8, 8	8, 8	-7, 7	-7, 7
Steal	7, 8	-5, -5	7, 8	-5, -5

Using best-response analysis, I have highlighted each player's best response to each strategy of the other player by underlining the associated payoff. Nash equilibrium requires all players to be playing mutual best responses to each other. We can see there are three Nash equilibria:

1. {Farm, (Farm, Farm)}
2. {Farm, (Farm, Steal)}
3. {Steal, (Steal, Farm)}

Only the first is subgame perfect. This is a Nash equilibrium in all possible subgames, and you can see this strategy set is sequentially rational by seeing this is exactly the rollback solution to part F.

The second (where Farmer B's strategy is to Farm if A Farms and Steal if A Steals) is not subgame perfect: if the game ever reaches node B.2 (if A Steals), B would not want to Steal, they would want to switch to Farm to earn 8 instead of -5.

The third (where Farmer B's strategy is to Steal if A Farms and Farm if A Steals) is not subgame perfect: if the game ever reaches node B.1 (if A Farms), B would not want to Steal, they would want to switch to Farm to earn 8 instead of -5.

Question 7

A railroad operates trains on a route that runs adjacent to farmland, where farmers are growing wheat. Occasionally, sparks from the railroad cause the wheat to catch fire. Suppose that sparks cause $1,000 worth of crop damage. The railroad could install spark arresters that would prevent fires at a cost of $300. Farmers could install a fence that would prevent fires at a cost of $800.

Part A

What would the classic Pigouvian approach to understanding and solving this dilemma be? The Pigouvian approach would likely identify the railroad as being the injurer creating a negative externality on the farmers, and would compel the railroad to internalize their external cost by imposing a tax (or damages) on the railroad equal to the $1,000 damages they cause from the sparks.

Part B

Regardless of the rule, what is the efficient outcome, and why? It is most efficient for the railroad to install the spark arresters. This avoids a $1,000 harm at a $300 expense, which is cheaper than if the farmers were to avoid the $1,000 harm by spending $800 with the fence.

Part C

The farmers sue the railroad. For each of the following parts, explain what the consequences are under each scenario, and the resulting payoffs to each party. Assume transaction costs are zero, and in the event of a bargain, assume parties split the cooperative surplus evenly.

i. The court grants farmers a property right to spark-free crops and issues an injunction against the railroad operating in the area. The railroad will install the arresters to avoid creating any crop damage.

Railroad payoff: -300 Farmers payoff: 0 Joint payoff: -300

ii. The court grants the railroad a property right to run the trains regardless of interference. There is a bargain to be made here, with the cooperative surplus being $500 — the difference between the Railroad's cost of avoiding the harm and the Farmers' cost of avoiding the harm. Another way to look at this: the Railroad is willing to accept at least $300 to install arresters and the Farmers are willing to pay up to $800 for the Railroad to install arresters, rather than build the $800 fence.

Assuming they split this surplus, each gains $250. In other words, the Farmers will pay the railroad $550 ($300+$250) to install arresters.

Railroad payoff: 550-300 = 250 Farmers payoff: -550 Joint payoff: -300

iii. The court adopts a liability rule, and awards damages to the farmers that the railroad must pay. The Railroad faces a choice: (1) to do nothing, causing $1,000 of damages, which it must pay to the Farmers or (2) to install the arresters at a $300 expense. Since the latter is cheaper, it will install arresters.

Railroad payoff: -300 Farmers payoff: 0 Joint payoff: -300

Notice in all the above outcomes, the joint payoff is -300, and the arresters (least-cost method of avoiding harm) are always installed.

Part D

Suppose instead, transaction costs are *high*, and *no* bargains will occur. What will happen under each rule:

i. Railroad has the right to run its railroad regardless of crop damage. The Railroad will do nothing, why should they do anything? Since the Farmers are unable to bargain with the Railroad, they could no nothing and suffer $1,000 of damages, or they could spend $800 to build the fence, which is what they will do.

Railroad payoff: 0 Farmers payoff: -800 Joint payoff: -800

This is inefficient — Farmers are spending $800 to avoid a $1,000 when it could be avoided for $300. Notice the joint payoff is lower than in Part C by exactly 500, the amount of the cooperative surplus.

ii. Court issues an injunction against the Railroad.

The railroad must install arresters if it hopes to keep operating, so it will spend $300 installing them.

Railroad payoff: 0 Farmers payoff: -300 Joint payoff: -300

This is the efficient outcome.

iii. Court awards damages against the Railroad. The railroad could do nothing, causing $1,000 of damages which it would have to pay, or install arresters for $300, which it would rather do.

Railroad payoff: 0 Farmers payoff: -300 Joint payoff: -300

This is also an efficient outcome.

Which outcome is most efficient? As we can see, when transaction costs are too high and parties will not bargain, the choice of rule matters for efficiency. The court must determine which party can prevent the harm at the lowest cost. In this case, it is the Railroad installing arresters, so the court should award rights to the Farmers. In this particular case, it does not matter whether this is a property or liability rule, the railroad will always install the arresters.

Part E

Redo part D, but assume the crop damage is only $100.

i. Under Railroad's rights, again the Railroad has no reason to do anything. This causes $100 of crop damage. The farmers could build their $800 fence to stop the damage, but the damage is only $100. The farmers simply take the $100 hit.

Railroad payoff: 0 Farmers payoff: -100 Joint payoff: -100

This is the most efficient.

ii. Under the injunction against sparks, the Railroad is forced to install arresters to keep operating. It will spend $300 on arresters.

Railroad payoff	0
Farmers payoff	-300
Joint payoff	-300

This is less efficient than (i).

iii. Under a damages rule, the Railroad could do nothing, cause $100 worth of damages, and pay that to the farmers; or it could prevent damage with $300 arresters. It would rather do nothing, cause the damage, and then compensate the farmers.

- Railroad payoff: -100
- Farmers payoff: 0 (-100+100)
- Joint payoff: 0

This is equally efficient to (i).

As we can see, like the previous question, it will matter for efficiency what the court decides. Again, the Railroad is the least-cost avoider of the harm (arresters cost $300 vs. the $800 farmers fence), but we can now see that an injunction will be less efficient than a damages rule. The damages rule allows the Railroad to pick whichever is cheaper (more efficient): to do nothing to prevent harm and compensate, or invest in avoiding harm (the arresters). Because arresters are more expensive than the damage the sparks cause, it is actually efficient *not* to internalize the externality and to continue causing the sparks.