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Econ 304—Bethany College

**Lecture 12: Simultaneous-Move Games II**

1. The Prisoner’s Dilemma: Cartels

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| --- | --- | --- | --- |
|  | | Microsoft | |
| High Price | Low Price |
| Apple | High Price | 40, 40 | 0, 60 |
| Low Price | 60, 0 | 15, 15 |

1. The Prisoner’s Dilemma: Arms race

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| --- | --- | --- | --- |
|  | | Pakistan | |
| Peace | War |
| India | Peace | 5 , 5 | -5 , 10 |
| War | 10 , -5 | -1 , -1 |

1. The Prisoner’s Dilemma: Tuna fishing

|  |  |  |  |
| --- | --- | --- | --- |
|  | | Japan | |
| A Little | A Lot |
| China | A Little | 3, 3 | 0, 5 |
| A Lot | 5, 0 | 1, 1 |

1. Solution: Repeat the game
   1. This is the most natural way to add cooperation in the Prisoner’s Dilemma: have *repeated play*—playing the same game with the same players multiple times.
   2. If the value of future cooperation is large, then each player will fear defection (or cheating) since neither player wants to be locked into that equilibrium for many periods.
      1. *Trigger strategy*—a result of a game “triggers” a period of punishment of a particular length. If you don’t cooperate once, I will refuse to cooperate with you for, say, three more games.
      2. *Grim strategy*—once there is a single non-cooperative play, the other player never cooperates again.
      3. *Tit-for-tat*—a non-cooperative play immediately follows another non-cooperative play but no longer than one game. (Though if there is non-cooperation in the following game, tit-for-tat would trigger again.) In international politics, it is sometimes called a proportional response.
   3. How many times the game is repeated matters.
      1. If it is repeated *finitely*—or both players know how many games they will play—then cooperation can and will break down as you approach the last game.
      2. But if the game is repeated *infinitely*—both players will either never stop playing the game or both don’t know when they will stop—then cooperation can persist. There is always the threat of the trigger strategy.
2. Opportunity cost with interest rates
   1. People have a tendency to discount the future. Money now isn’t as good as the same amount as money later. Since you know that money you have now could be worth more later if you invest it, this makes a lot of sense.
   2. *Present value* (PV) is the current value of some future payment, or the cash flow (CV). The expression (1 + r)n represents our opportunity cost.
      1. If I promise to give you either 93 cents now or 100 cents in 1,000 years (assuming you know you will live that long), what would you rather take?
   3. Here is the equation for present value:
   4. Present value equations are often used to see if an investment is worth the effort or risk. If a potential borrower promises people their $5,000 investment will be worth $5,500 in 10 years, but the interest rate is 3% (meaning the present value of that later payoff is only worth $4,093), the savers will know they will get a better deal if they simply take the five grand and invest it at the 3% interest.
      1. Since PV is often calculated with a “risk free rate” (usually a US government bond, since that is so unlikely to default), even if the present value of the investment is higher, the investor may decide to play it safe, depending on how willing she is to shoulder risk.
3. Game theory
   1. We can use present value to help us understand game theory.
   2. But since money now is worth more than money later, it might be worth cheating even with a trigger strategy in place.
   3. Consider an Apple/Microsoft PD game:

|  |  |  |  |
| --- | --- | --- | --- |
|  | | Microsoft | |
| High Price | Low Price |
| Apple | High Price | 40, 40 | 0, 60 |
| Low Price | 60, 0 | 15, 15 |

* 1. Suppose that this game achieves High/High through one of these strategies. Will defection ever occur?
  2. Cheating once

1. If Apple plays Low, it *gains* a payoff a 20 (getting 60 rather than 40). In the next period, it switches back to High to re-establish collusion, losing 40 (since Microsoft punishes by going to Low price).
2. The present value of 40 is 40/(1+r). When is 20 > 40/(1+r)?
3. When r > 1.00. It takes a very large interest rate (100%) to cheat once.
   1. Cheating forever
4. Suppose Apple isn’t interested in re-establishing collusion. When it goes Low the first time, it will gain 20. Thereafter, it will stay Low, losing 25 each period (its payoff will be 15 rather than 40 it could have gotten with cooperation).
5. When is 20 > 25/(1+r) + 25/(1+r)2 + 25/(1+r)3 + 25/(1+r)4 + …?
6. Mathematically we know this infinite sum converges to 25/r; you should cheat if r > 1.4, or 140%.
7. Note this is same result as the grim strategy.