commerce undergraduate society

COMMERCE MENTORSHIP PROGRAM

FINAL REVIEW SESSION

COMM 295

CMP

PREPARED BY

LUCAS LAZZARONI, December 2021

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Static Games

What is Game Theory: A set of tools used to analyze decision making in situations of strategic interdependence. Basically, anytime there is strategic interaction between two or more parties. In other words, game theory is everywhere! In this course, we primarily focus on how game theory works in oligopolies.

Static Game: Each player acts once and at the same time – best of 1 rock paper scissors.

Dominant Strategy: The strategy that is the best regardless what the other player does.

Dominated Strategy: A strategy you would never play, regardless what the other party choses.

Nash Equilibrium: Each player is doing the best the can, given the other player's strategy. This is the equilibrium because there is no incentive to deviate from the strategy.

Prisoner's Dilemma: Each party has a dominant strategy. The payoffs in the dominant strategy equilibrium are lower for both parties than the payoff in opposite diagonal.

Question – No More Studying: The COMM 295 final is coming up. You are a super bright Sauder snake and realize that, because the course is scaled, if nobody studies for the exam, you will all get fine marks and save lots of time. Otherwise, if everyone studies for the exam, your marks will be, on average, the same as if you didn't study, and you will have wasted all that time that could've better been spent at the frat house. You propose in a big group chat that nobody studies – and everyone says that they agree with you. What will actually happen?

Other Students

You

	Study	*Don't Study*
Study	**-5, -5**	**5**, -10
Don't Study	-10, **5**	0,0

Each party follows dominant strategy of studying. Equilibrium is everyone studies. In other words, your group chat (including yourself) all lied!

Question – Cartels: You are in charge of a restaurant called Jim Morton's beside Sauder. You collude with Quadruple O's, the restaurant next door, to restrict your quantity output of chicken sandwiches to Q=100 (this would push up market prices of chicken sandwiches). Would Quadruple O's honour this agreement?

Jim Mortons

Quadruple O's

	Q=100	*Q=200*	*Q=300*
Q=100	4, 4	2, 5	0, **6**
Q=200	5, 2	**3**, **3**	**1**, 2
Q=300	**6**, 0	2, **1**	0, 0

Note that both restaurants want to produce as much as possible, while hoping the other company produces as little as possible – that way they get all the business! Nash equilibrium of Q=200 for both restaurants giving a profit of 3 each. This is less than the highest payoffs of 4 each in the top left cell.

Maxi-Min Strategy: Apart from the Nash equilibrium, there are other outcomes sometimes used in game theory. In the maxi-min, the player chooses the strategy which maximizes their payoff, assuming the worst case scenario.

Party B

Party A

	Action 1	*Action 2*
Action 1	2, 5	12, 7
Action 2	3, 2	10, 1

In this scenario, if Party A is using the maxi-min strategy they will pick the highest of the worst possible outcomes. The worst outcome for Action 1 is a payoff of 2; the worst playoff of Action 2 is a payoff of 3. Hence, Party A chooses Action 2.

Dynamic Games

Dynamic Game: Players move sequentially, meaning one after another, or repeatedly, a series of simultaneous choices.

Repeated Game: Players move simultaneously over a number of periods. Moves in one period can affect the actions taken in a subsequent period. Collusive behavior is more likely in a repeated game.

Tit-For-Tat Strategy: In a repeated game, the player mimics the action of the other player after the first round.

Kokoro

Kinton

	Price Low	*Price High*
Price Low	10, 10	100, -50
Price High	-50, 100	50, 50

Kokoro and Kinton are ramen restaurants, and their Nash equilibrium would be to both price low (top left corner). If one restaurant prices low while the other prices high, then everyone would just go to the cheaper option. They realize that they will both make more money if they collude and both decide to price high.

Round 1: Kinton prices high, Kokoro cheats and prices low. Payoffs of -50, 100
Round 2: Kinton adopts the tit-for-tat strategy and prices low, regardless of what Kokoro does now, they will make less money than they would with cooperation.

This strategy means that cheating is not profitable.

Repeated Game with End Date: Suppose the game lasts for T periods. In period T, the threat of future punishment is not credible – because there is no next period! Hence, both players price low in round T.

In round T-1, both players know that the next round both players will price low. Hence, there is also no threat of future punishment and both players price low. T-2, T-3, T-4, etc…

Therefore, the prisoner's dilemma cannot be avoided.

Sequential Game: There is an order of play in this dynamic game. This could mean the players take turns, or they both choose one action in one period simultaneously (like how much to produce) and choose a different action in another period (how much to invest).

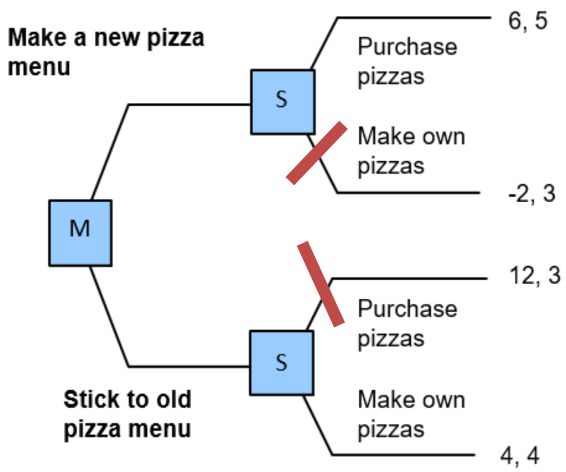
Stackelberg Oligopoly: A sequential game in an oligopoly where there is a leader (acts first) and follower.

- The leader sets the output first, and then the follower makes its best response to the leader's selection.
- If the leader can predict what the follower will do, then the leader can choose their output level to manipulate their follower and benefit at their expense.
- First mover has an advantage.

Question – Pizza Case Comp: Sauder is hosting a big case competition and can either order pizza from Mercante or make their own pizzas. Sauder would prefer Mercante make a new and improved pizza menu as some students didn't like the old pizzas.

Mercante can choose to make a new pizza menu or stick with their old menu.

Solve the game tree.



Mercante knows that if they make a new menu, they will profit 6. If they do not make a new menu, they will only profit 4. Therefore, Mercante makes a new pizza menu (top branch).

Note about solving Stackelberg algebraically:

- The leader's profit function will only contain q_1, not q_2
  - For example: $\pi_1 = q_1[10 - q_1 - (4 - 0.5q_1)] - 2q_1$
- Then maximize by taking derivative
  - $d\pi_1/dq_1 = 6 - q_1 - 2 = 0 \Rightarrow q_1^* = 4$
- Substitute $q_1^* = 4$ into best response curve of firm 2 to obtain firm 2's quantity
- Substitute the two quantities into demand function to obtain price

Credible Threats: For a threat to be credible, the rival must believe that it is in the player's best interest to use it.

Commitment: Changes a non-credible threat into a credible threat.

- E.g., Vancouver only has enough teenage girls to host one pop concert per month. If Taylor Swift privately says she will move first by announcing a new concert in Vancouver in February, Adele must believe Taylor Swift has no other choice and will actually announce it, or else Adele will also announce that it will move first and announce her own tour in Vancouver.

- How can Taylor Swift make her statement credible? Commitment!
  - Expensive pre-launch advertising campaign
  - Pre-book a concert venue

- Complete Payoff Matrix for concert problem and identify Nash equilibrium:
  - Assume cost of pre-booking BC Place is 5m for either artist
  - Profits before paying BC Place is 4m for each artist if they both host a concert
  - Profits before paying BC Place is 9m if only one artist hosts the concert

Taylor Swift

Adele

	No Tour	*Tour in Vancouver*
No Tour	0,0	**0**, **4**
Tour in Vancouver	**4**, **0**	-1, -1

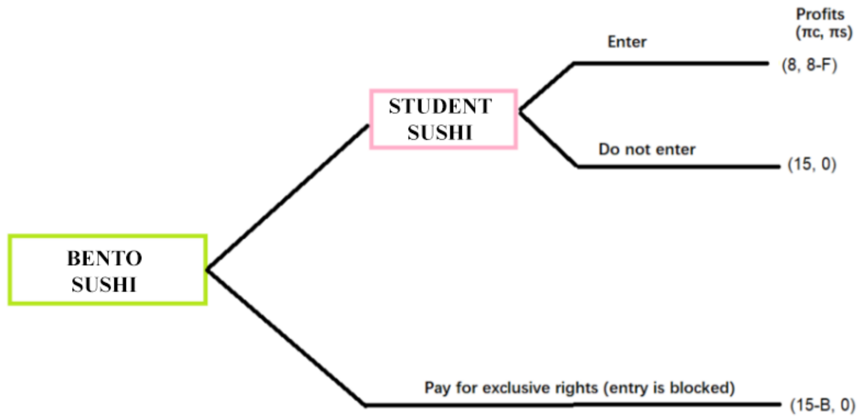
There are 2 Nash equilibria. Hence, Taylor has to make her entry credible so Adele stays away – hence, the result would be the top right cell where Taylor Swift profits 4m and Adele profits 0m.

Entry Deterrence: In some instances, a firm, especially an incumbent, may be able to strategically act in such a way that prevents rivals from entering the market.

1. Paying to Prevent Entry – Incumbent pays a certain amount to prevent entrance
2. Limit Pricing – Setting low enough price (or high output) sot that another firm cannot enter profitably
3. Reputation Effects in Repeated Games – If a game is repeated, and the new firm does not know the payoffs of the incumbent, then the incumbent can deter entry by fighting (similar to #2) regardless of whether it is actually profitable or not. The incumbent develops a reputation for being a tough competitor.
4. Investments to Lower Marginal Cost – Incumbent invests to lower their marginal costs, therefore becoming harder for any new firms to compete against.

Question – Sushi Store: Student Sushi is a new restaurant looking to open up a store at Sauder. Bento Sushi, who is already at Sauder, can pay Sauder for the exclusive rights to be the only sushi shop around.

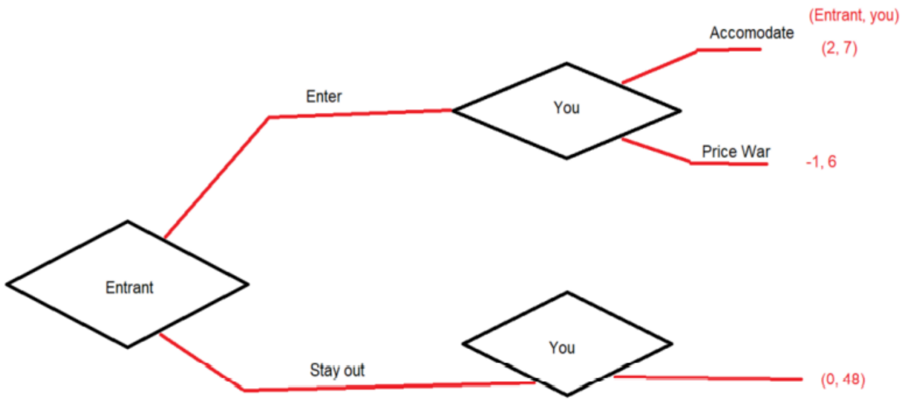
F = Fixed cost of Student Sushi ; B = Payment to Sauder for exclusive rights



What range of values for F and for B would effectively block entry?
F >= 8 or B<= 7 (for values where F<7)

Would Student Sushi enter the market if F = 4? How much profit would each firm make?
Assuming Bento Sushi did not pay for exclusivity rights, Student Sushi would enter and make a profit of 4.

Question – Price War: You own a convenience store in West Point Grey. Another entrepreneur is considering opening a rival convenience store. You threaten with a price war if the other firm opens.



Will he believe your threat – i.e., is the threat credible?
NOT credible. The entrant knows that if they enter, you have an incentive to accommodate.

How much are you willing to pay to keep the entrant out of the market?
Up to 41 (difference between stay out profit and accommodate profit)

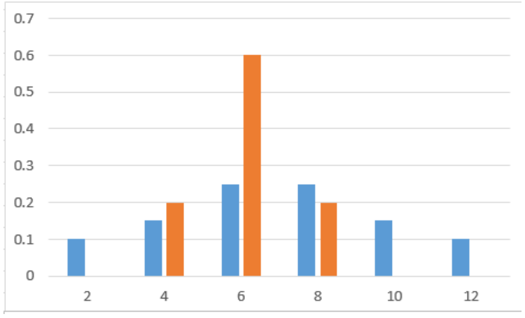
Will your offer be accepted?
Only if the offer is greater than 2, because the entrant knows it will make profit of 2 if they enter.

Uncertainty

Uncertainty: Most decisions we make will have some form of uncertainty – think of booking travel during COVID-19. Resultingly, firms can exploit our fear by charging a premium for a less uncertain outcome – insurance is one example. If you're afraid your flight will be cancelled because of a border closure, you can pay a premium for travel insurance. The more risk averse we are, the higher premium we are willing to pay for certainty.

Expected Value: The weighted average resulting from all possible outcomes.

Variability: Deviations in actual payoff relative to their expected payoff. The greater the variability, the greater the risk. Variance and standard deviation measure this variability. Standard deviation is the square root of variance.

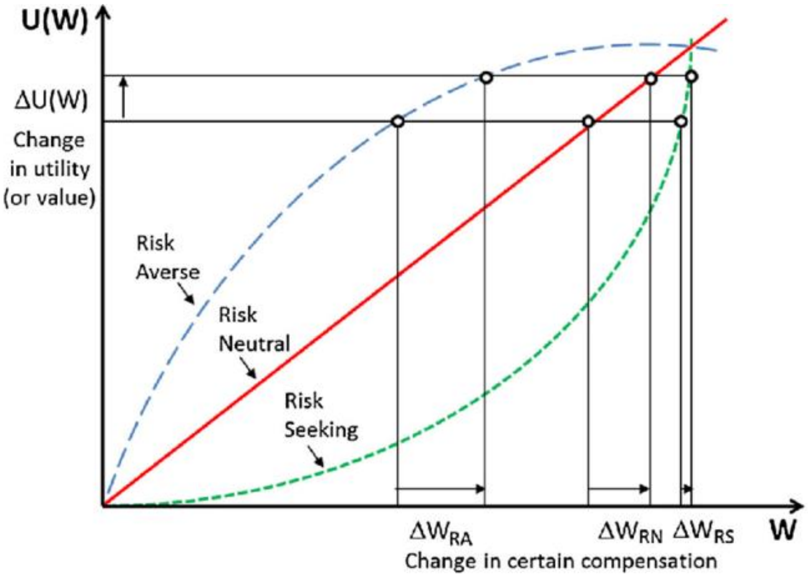


In graph, orange has EV of 6, but less variability than blue, which has EV of 7. Which strategy would you choose?

Risk Aversion: Unwilling to take a "fair bet" – wants less risk.

- Utility function is concave to the wealth axis; utility will rise with wealth, but at a diminishing rate.
- Risk preferring or risk seeking is the opposite.

Risk Premium: The excess return required to compensate a decision maker for taking risk.



Question: You have some money and can invest it in one of two options:

- US Treasury bond, future wealth equal to $100,000 with zero risk
- Tesla stock, future wealth equal to $175,000 with 0.6 probability and $50,000 with 0.4 probability.

What are the expected values of each option?

Bond: $100,000

Tesla: 0.6 x $175,000 + 0.4 x $50,000 = $125,000

You choose to invest in the Treasury Bond. How large is your risk premium?

If you invested in Tesla, you'd make an EV of $25,000 more. You have essentially forfeited $25,000 in order to avoid taking the extra risk – therefore your premium is at least as large as $25,000.

Are all investors who choose Tesla over the Treasury Bond risk preferring?

NO – the expected return and the risk are both higher. Therefore, based on this information alone, we cannot say whether all investors are risk preferring.

If the EV of Tesla was LOWER than the Treasury Bond, while still being risky, then YES, investors who chose this option would be risk preferring.

Adverse Selection

Asymmetric Information: One player knows more than the other player. There are two types of asymmetric information: hidden characteristics (adverse selection) and hidden actions (moral hazard).

Adverse Selection: Buyers and sellers have different information, therefore players may selectively partake in trades at the expense of other parties that do not have equal information. In certain transactions, this means that the seller can take advantage because they know more about the good being sold (used car salesman). Asymmetric information can lead to market failure.

Let's say you run a tech start-up. There are two types of workers you can hire, 50% of each:

- Good workers, worth $20/hour to your company
- Bad workers, worth $10/hour to your company

If a firm cannot determine which workers are good and which are bad, what will they be willing to pay? Actuarially fair price (expected value, 50% probability of each type) of $15.

Resultingly, good workers are underpaid by $5, and bad workers are overpaid by $5. There is cross subsidization.

What would happen if good workers will refuse to apply for a job that pays less than $18/hr (reservation price)?

Good workers will not apply to the job, so a bad worker is hired with 100% probability instead of a 50% probability.

This creates market failure as the whole job pool entirely consists of bad workers. The market failed because, even though your company is willing to pay more than the good workers desire (willing to pay $20; they only want $18), no good workers are hired.

Question – Tech Wages cont'd: Ignoring the previous example, now assume there are an equal number of each type of worker (high, medium, and low productivity workers). What is the equilibrium wage?

Type	Reservation Wage	Value to Firm
H	18	20
M	13	15
L	8	10

1/3rd probability each – EV to firm = 15
If firm offers $15, H workers, who require at least $18, will self-select out of applying.
New EV with only M and L workers is 12.5, but if the firm offers $12.5, M workers will self-select out of applying.
New EV with only L workers is 10. Only L workers apply.
Equilibrium is 10 (8 could be correct too, but the assumption is that firms will compete with each other by bidding up the price of labour up to their value to the firm)

Reducing Adverse Selection: Generally, there are two mechanisms which can be used to reduce adverse selection:

- Restricting opportunistic behavior
  Adverse selection can be eliminated by preventing people from self-selecting out. Think of ICBC car insurance. Even if you're a great driver or you only drive 2 days a year and you don't think it's worth it to get insurance, it is still mandatory to buy insurance.

- Equalize information
  A firm with limited information can screen to gain more information. Returning to the Tech Wages example, the firm may require applicants to submit their transcript and resume so they have a better grasp who are the H, M, and L workers.

Signaling: Parties with private information may want to convey that information by signaling.

In the Tech Wages example, high quality workers want the tech firm to know they are high quality. If the tech company knows the worker is high quality, they are willing to pay $20/hr instead of the actuarially fair value of $15. By contrast, a low quality worker would not want to signal that they are low quality.

Signaling helps reduce adverse selection, but it is costly for the high-quality agent. I.e., it costs the high quality worker time and effort to prepare a resume, prepare for a job interview, etc.

Signals only work if the cost of signaling is relatively low for high-quality agents and relatively high for low-quality agents. If not, a low-quality agent could just mimic a high quality agent.

Moral Hazard & Agency

Moral Hazard: Asymmetric information can also lead to moral hazard – an incentive for one player to expose themselves to risk because they do not bear the full cost of such risk.

Suppose an insurance company, InsureCo, sells you home burglary insurance for $400/month. If your home is burgled, the full cost of damages will be covered, no questions asked.

If not for insurance, you would be very careful to lock your doors, pay extra for a home security system, etc. But because you have that guaranteed insurance, you are reckless.

Both you and InsureCo end up with the least desirable outcome – they make no money and you aren't insured. The moral hazard caused the market to fail.

Question – Lazy CEO: Each cell shows the profit the firm makes before paying the CEO, for different combinations of luck and effort from the CEO.

There is a 50% chance of good luck and 50% chance of bad luck. The CEO's cost of effort is 0 for low, 10 for medium, and 30 for high.

	Bad Luck (50%)	Good Luck (50%)
Low Effort	20	40
Medium Effort	40	80
High Effort	80	100

If you offer the CEO a fixed wage of 20, how much effort will he put?
Net return from: Low effort: 20, Medium effort: 20-10 = 10, High effort: 20-30 = -10
CEO will choose low effort.

If you offer the CEO 40% of net income, but no fixed wage, how much effort will he put?
Net return from:
Low effort = 30 x 0.4 = 12
Medium effort = 60 x 0.4 – 10 = 14
High effort = 90 x 0.4 – 30 = 6

CEO will choose medium effort