



An Example of Signaling



- What should I apply? MBA or Econ PhD?
- What's the most important factor if I apply?
- Are foreigners/females discriminated against?
- Is mathematics needed in graduate school?
- Is MA (at NTU) required before I enter PhD?
- How should I prepare myself now?

# What Program Should I Apply?

- MBA or Econ PhD?
- This depends on Your Career Interest
- · However, MBA is NOT for "newly graduates"
  - MBA is designed for people who have worked for years and are heading for top management
  - They teach "undergraduate level Economics", but
  - · tie it with actual working experience
  - Socializing with other CEO-to-be's is a bonus

## What Program Should I Apply?

- Econ PhD provides you the rigorous training to modern "economic analysis" techniques
- This is used by
  - Academics (Economics, Public Policy, Law, etc.)
  - Economics Consulting Firms
  - Public Policy Evaluation
  - Financial Companies (like Investment Banking)
  - International Organizations (APEC, IMF, etc.)

## Most Important Factor

- What is the Most Important Factor when I Apply for Graduate School?
- Petersons Guide surveyed both students and admission committee members (faculty)
- They find that both agree No.1 factor is:
   Letter from someone the committee knows
- Why is this No.1?
- Credible Signaling!

# Most Important Factor

- No.1:
  - Letter from someone the committee knows
- Who are the people committees know?
- What if I cannot find someone to write?
- Find Other "Credible Signals"!
  - GPA?
  - GRE or TOEFL?
  - Other Distinct Features?

#### Discrimination and Gender

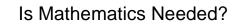
- Are Foreigners or Females Discriminated Against?
- Foreigners:
  - Different Programs have different policy
  - UCLA (8/35) vs. MIT (25/30)
- Women: Only 16% of the Faculty are Female

   Does the market favor women? Maybe...
  - Comparison: 33% Math Professors are Female

#### Is Mathematics Needed?

- Advice for Econ PhD Applicants:
   Take a heavy dose of mathematics during
- undergraduate. ~ Peterson's Guide • So, the answer is generally "yes."
  - There is a "gap" between undergrad & graduate...
- However, the ability to find economic intuition behind the math is even more essential

   My first year micro comp. experience...
- They need Bilingual People!



- What Kind of Math is Needed?
- Advanced Calculus Score 80 or higher
   The <u>thinking process</u> required for you to score 80 is what's important
- Linear Algebra Basic Tool for Econometrics
- Mathematical Statistics Econometrics
- The more the better, but mastering these three is better than being a jack of all traits...

#### Is MA required before I enter PhD?

- No. Top-10 schools admit only PhD students. – Chicago: We'll give you a master if you can't finish.
- However, you might not be able to survive studying both math & economics in English...
- Hence, a MA might help since
  - MA classes are similar to PhD classes
    You might not be sure if you want to go for PhD
- Condition on passing 1st year comp's, MA is unnecessary, but you may want to hedge...

#### How Should I Prepare Myself Now?

- Create Credible Signals!
- Such As:

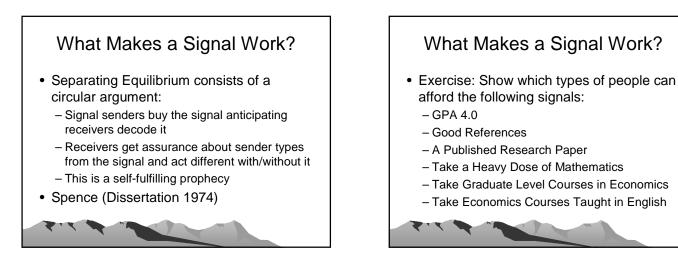
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- GPA 4.0
- Good References
- A Published Research Paper
- Take a Heavy Dose of Mathematics
- Take Graduate Level Courses in Economics
- Take Economics Courses Taught in English



## What Makes a Signal Work?

- A Signal must be affordable by certain types of people
  - Cost < Benefit (if receivers "decodes" it)
- A signal must be too expensive for players of the wrong type to afford
  - Cost > Benefit (even if receivers "decodes" it)
- Separating Equilibrium: Those who buy and those who don't are of different types



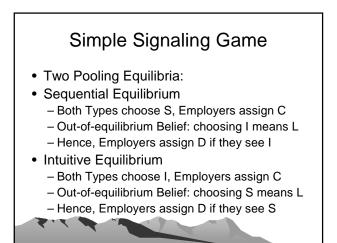
# Theory of Signaling

- Harsanyi (MS 1967-68)
  - Types: Privately observe a move of "Nature"
- Bayesian-Nash Equilibrium (multiple!)
  - Separating Equilibrium
  - Pooling Equilibrium
  - Semi-pooling Equilibrium
- Refinements: Sequential, Intuitive, Divine, Universal Divine, Never-Weak-BR, Stable

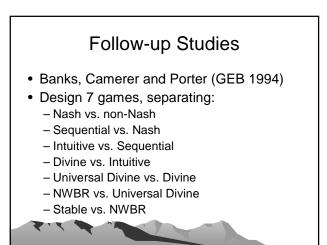
# Simple Signaling Game

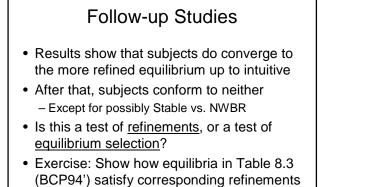
- Brandts and Holt (AER 1992)
- Worker Types are H or L with (2/3, 1/3)
- Seeing own type, Workers can choose to S (skip) or I (invest in education)
- Seeing this action, Employer assign the worker to a D (dull) or C (chanlenging) job
- Employer payoffs are 125 if she assigns D to L types and C to H types

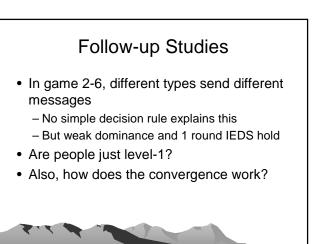
	Simple Signaling Game									
	<ul> <li>Workers get 100 doing C and 20 doing D</li> <li>L types get additional 40 for taking action S</li> <li>H types get 40 for taking action I, 20 for taking S</li> </ul>									
-		Action s	eeing S	Action seeing I						
		Cs	DI	CI	D <sup>s</sup>					
-	Type L	140, 75	60, 125	100, 75	20, 125					
	Туре Н	120, 125	20, 75	140, 125	60,75					
	A.4 4									



Simple Signaling Game										
	Mess Ty		Action	Type	Equilibrium Predictions					
Periods	I H	I L	C   I	D S	Intuit.	Seq.				
1-4	100	25	100	74	100	0				
5-8	100	58	100	100	100	0				
9-12	100	75	98	60	100	0				
Sugges	t Action	s: "C	S, D   I'	,						
1-4	50	13	60	46	100	0				
5-8	75	33	33	67	100	0				







# Follow-up Studies

- More studies on learning:
- Brands and Holt (IJGT 1993)
  - Subjects lead to play less refined equilibrium
  - Why? Initial random play produces history that supports the non-intuitive equilibrium
- Anderson and Camerer (ET 2000)
  - EWA yields  $\delta$ =0.54 (0.05); does better than choice reinforcement ( $\delta$ =0) & weighted fictitious play ( $\delta$ =1)

#### **Specialized Signaling Games**

- Potters and van Winden (IJGT 1996)
   Lobbying
- Cadsby, Frank & Maksimovic (RFS 1990)
   Corporate Finance
- Cooper, Kagel, Lo and Gu (AER 1999)
   Ratchet Effect
- Cooper, Garvin and Kagel (Rand/EJ 1997)
   Belief Learning in Limit Pricing Signaling Games

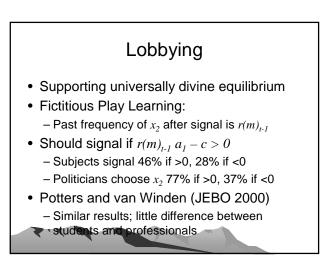
#### Lobbying: Potters & van Winden (IJGT 1996) • Lobby group is type *t*<sub>1</sub> or *t*<sub>2</sub> with (*1-p*, *p*)

- Lobby group can send a signal (cost *c*)
- Politician chooses action  $x_1$  or  $x_2$  (match type)

Туре	No s	ignal	Costly Signal			
туре	$x_I$	<i>x</i> <sub>2</sub>	$x_{I}$	<i>x</i> <sub>2</sub>		
$t_{l}(1-p)$	0, <i>b</i> <sub>1</sub>	<i>a</i> <sub>1</sub> , 0	-c, b <sub>1</sub>	<i>a</i> <sub>1</sub> - <i>c</i> , 0		
$t_2(p)$	0, 0	<i>a</i> <sub>2</sub> , <i>b</i> <sub>2</sub>	<i>-c</i> , 0	$a_2 - c, b_2$		
A.L. 4						

## **Lobbying** • For $\beta = \frac{pb_2}{(1-p)b_1} < 1$ ; there are 2 equilibrium: • Pooling: Lobby groups both don't send signal • Politician ignores signal and chooses $x_1$ – Intuitive, divine, but not universally divine • Semi-pooling: type $t_2$ always send signal • Politicians mix $x_1$ , $x_2$ with $(1-c/a_1, c/a_1)$ if signal • type $t_1$ mixes by sending signal with prob. $\beta$ – Universally divine

		Lo	obbyir	ıg			
Treat	Sigr	nal Freq.	$(t_1, t_2)$	$x_2$ Freq. (no sig., sig)			
ment	β	Actual	Pred.	$c/a_1$	Actual	Pred.	
1	0.25	38, 76	25,100	0.25	2, 5	0,25	
2(2c)	0.75	46,100	75,100	0.25	3, 79	0,25	
2a(6c)	0.75	83, 93	75,100	0.25	11, 54	0,25	
3	0.25	16, 85	25,100	0.75	0, 53	0,75	
4	0.75	22, 83	75,100	0.75	5, 80	0,75	
Aver.	0.25	27, 81	25,100	0.25	5, 46	0,25	
Aver.	0.75	50, 92	75,100	0.75	2, 66	0,75	



# Corporate Finance

- Cadsby, Frank & Maksimovic (RFS 1990)
- Firms are either H or L with (½, ½)
   Worth B<sub>H</sub>, B<sub>L</sub> if carry project; worth A<sub>H</sub>, A<sub>L</sub> if pass
- Need capital *I* to finance the project
- Investors can put up I and get S shares
- Exercise: When will there be pooling, separating, and semi-separating equilibria?



## **Corporate Finance**

- Example:
- L types worth 375, 50 (with/without project)
- H types worth 625, 200 (with/without project)
- Capital *I* = 300
- Separating equilibrium: S=0.80
- Pooling equilibrium: *S*=0.60
- Semi-pooling equilibrium: S=0.68
- Exercise: Show that these are equilibria!

#### Corporate Finance

- Cadsby et al. ran 10 sessions (Table 8.11)
- Results support equilibrium (pooling if multi.)
  - When unique pooling: all firms offer shares
  - When unique separating: Initially, both offer (pool), but H types learn not to offer (separate)
    When multiple: Converge to pooling equilibrium
- Cadsby, Frank and Maksimovic (RFS 1998)
   Add costly signals (see Table 8.12 for results)

#### **Ratchet Effect**

- Cooper, Kagel, Lo and Gu (AER 1999)
- Firms are either H or L with (1/2, 1/2)
- Choose output level 1~7
- Planner choose "easy" or "tough" target
   Set "easy" if P( L | output ) > 0.325
- Pooling Eq: L chooses 1 or 2; H pools with L
- Myopic K firms: Naively pick 5 (& get "tough")
   Exercise: Prove these with payoffs in Table 8.13.

#### Ratchet Effect

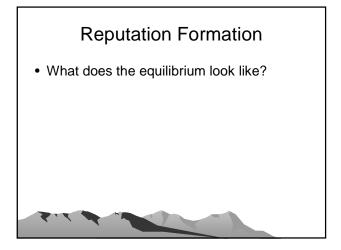
- 70~90% L firms choose 2
- Most H firms choose 2 or 5
- Period 1-12: 54-76% myopic →80% tough
- Period 13-36: Convergence to pooling
- Big context effect only for Chinese manager
   Provides language to folster learning from exp.
- Cooper, Garvin and Kagel (Rand/EJ 1997)
   Belief Learning in Limit Pricing Signaling Games

#### **Reputation Formation**

- Camerer and Weigelt (Econometrica 1988)
- 8 period trust game
- Borrower: "normal" (X) or "nice" (Y)
- (New) Lender each period: Lend or Don't
- Borrower chooses to Default or Repay

   Normal types default; nice types repay

Lender	Borrower	Lender	Borrowe	er Payoff
Strategy	Strategy	Payoff	Normal	Nice (Y)
Lend	Default	-100	150	0
	Repay	40	60	60
Don't	-	10	10	10



R	ound	1	2	3	4	5	6	7	8
2 5	Predict	100	100	100	100	64	64	64	64
3-5	Actual								
	Predict	100	100	100	64	64	64	64	64
6-8	Actual								
0.10	Predict	100	100	100	64	64	64	64	64
9-10	Actual								

R	ound	1	2	3	4	5	6	7	8
25	Predict	100	100	100	100	64	64	64	64
3-5	Actual	94	96	96	91	72	59	38*	67
	Predict	100	100	100	64	64	64	64	64
6-8	Actual	96	99	100	95*	85*	72	58	47
0.40	Predict	100	100	100	64	64	64	64	64
9-10	Actual	93	92	83	70	63	72	77	33

Con	ditiona	al Fr	equ	enc	y of	Re	рау	/ (by	/ X)
R	ound	1	2	3	4	5	6	7	8
25	Predict	100	100	100	81	65	59	44	0
3-5	Actual								
6-8	Predict	100	100	73	68	58	53	40	0
0-0	Actual								
9-10	Predict	100	100	73	67	63	56	42	0
9-10	Actual								
*				2					

R	ound	1	2	3	4	5	6	7	8
2 5	Predict	100	100	100	81	65	59	44	0
3-5	Actual	95	97	98	95*	86*	72	47	14
6-8	Predict	100	100	73	68	58	53	40	0
6-8	Actual	97	95	97*	92*	85*	70*	48	0
0.40	Predict	100	100	73	67	63	56	42	0
9-10	Actual	91	89	80	77	84*	79*	48	29

# **Follow-up Studies**

- Neral and Ochs (Econometrica 1992)
   Similar repeated trust games
- Jung, Kagel and Levin (Rand 1994)
   Entry deterrence in "chain-store paradox"
- Camerer, Ho and Chong (JET 2002) – Sophisticated EWA (strategic teaching!)



#### Conclusion

- Cooper, Garvin and Kagel (EJ 1997)
  - "We do not suggest that game theory be abandoned, but rather as a descriptive model that it needs to incorporate more fully how people actually behave."
- Possible improvements:
- QRE, level-k or Cognitive Hierarchy
- Learning (EWA or belief learning)

