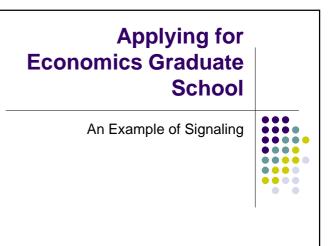
Signaling Joseph Tao-yi Wang 10/27/2010



Questions

- 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!

Is Mathematics Needed?



- 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:
- GPA 4.0. ranked 1/160
- Good References
- A Published Research Paper
- Take a Heavy Dose of Mathematics
- Take Graduate Level Courses in Economics
- Take Economics Courses Taught in English

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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

What Makes a Signal Work?



- Separating Equilibrium consists of a circular argument:
 - Signal senders buy the signal anticipating receivers decode it
 - Receivers get assurance about sender types from the signal and act different with/without it
 - This is a self-fulfilling prophecy
- Spence (Dissertation 1974)

What Makes a Signal Work?



- Exercise: Show which types of people can afford the following signals:
 - GPA 4.0, ranked 1/160
 - Good References
 - A Published Research Paper
 - Take a Heavy Dose of Mathematics
 - Take Graduate Level Courses in Economics
 - Take Economics Courses Taught in English

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

- Workers get 100 doing C and 20 doing D
- L types get additional 40 for taking action S
- H types get 40 for taking action I, 20 for taking S

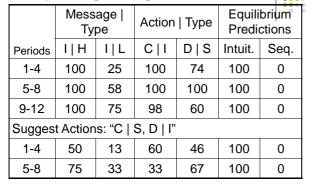
	Action seeing S		Action seeing I		
	Cs	D^I	C_{l}	Ds	
Type L	140, 75	60, 125	100, 75	20, 125	
Туре Н	120, 125	20, 75	140, 125	60,75	

Simple Signaling Game



- Two Pooling Equilibria:
- Sequential Equilibrium
 - Both Types choose S, Employers assign C
 - Out-of-equilibrium Belief: choosing I means L
 - · Hence, Employers assign D if they see I
- Intuitive Equilibrium
 - Both Types choose I, Employers assign C
 - Out-of-equilibrium Belief: choosing S means L
 - Hence, Employers assign D if they see S

Simple Signaling Game



Follow-up Studies



- Banks, Camerer and Porter (GEB 1994)
- Design 7 games, separating:
 - Nash vs. non-Nash
 - Sequential vs. Nash
 - Intuitive vs. Sequential
 - Divine vs. Intuitive
 - Universal Divine vs. Divine
 - NWBR vs. Universal Divine
 - Stable vs. NWBR

Follow-up Studies



- Results show that subjects do converge to the more refined equilibrium up to intuitive
- After that, subjects conform to neither
 - Except for possibly Stable vs. NWBR
- Is this a test of <u>refinements</u>, or a test of <u>equilibrium selection</u>?
- Exercise: Show how equilibria in Table 8.3 (BCP94') satisfy corresponding refinements

Follow-up Studies



- In game 2-6, different types send different messages
 - No simple decision rule explains this
 - But weak dominance and 1 round IEDS hold
- Are people just level-1?
- Also, how does the convergence work?

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 δ =0.54 (0.05); does better than choice reinforcement (δ =0) & weighted fictitious play (δ =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 and van Winden (IJGT 1996)



- Lobby group is type t_1 or t_2 with (1-p, p)
- Lobby group can send a signal (cost c)
- Politician chooses action x_1 or x_2 (match type)

Type	No s	ignal	Costly Signal		
Туре	x_1	x_2	x_1	x_2	
$t_1(1-p)$	0, <i>b</i> ₁	<i>a</i> ₁ , 0	$-c, b_1$	a_1 - c , 0	
$t_{2}\left(p\right)$	0, 0	a_2, b_2	-c, 0	a_2 - c , b_2	

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 x₁
 - Intuitive, divine, but not universally divine
- Semi-pooling: type t₂ always send signal
- Politicians mix x_1 , x_2 with $(1-c/a_1, c/a_1)$ if signal
- type t_i mixes by sending signal with prob. β
 - Universally divine

Lobbying



LODE	yyıııç	J					
Treat	Signal 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	
Avei.	0.75	50, 92	75,100	0.75	2, 66	0,75	

Lobbying



- Supporting universally divine equilibrium
- · Fictitious Play Learning:
 - Past frequency of x₂ after signal is r(m)_{t-1}
- Should signal if $r(m)_{t-1} a_1 c > 0$
 - Subjects signal 46% if >0, 28% if <0
 - Politicians choose x_2 77% if >0, 37% if <0
- Potters and van Winden (JEBO 2000)
 - Similar results: little difference between students and professionals

Corporate Finance

- Cadsby, Frank & Maksimovic (RFS 1990)
- Firms are either H or L with (1/2, 1/2)
 - Worth B_H , B_L if carry project; worth A_H , A_L 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 (½, ½)
- 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

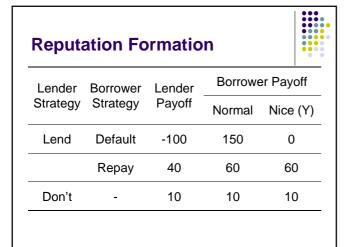


- 70~90% L firms choose 2
- Most H firms choose 2 or 5
- Period 1-12: 54-76% myopic →80% tough
- Period 13-36: Convergence to pooling
- Big context effect only for Chinese manager
 - Provides language to folster learning from exp.
- Cooper, Garvin and Kagel (Rand/EJ 1997)
 - Belief Learning in Limit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

Reputation Formation



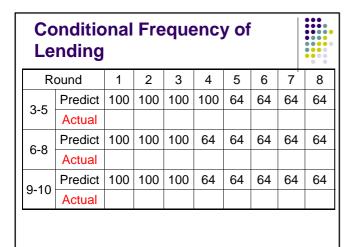
- Camerer and Weigelt (Econometrica 1988)
- 8 period trust game
- Borrower: "normal" (X) or "nice" (Y)
- (New) Lender each period: Lend or Don't
- Borrower chooses to Default or Repay
 - Normal types default; nice types repay

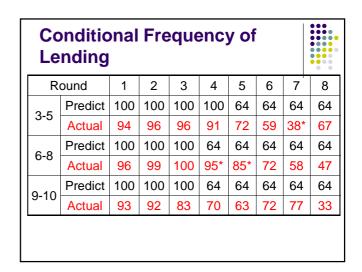


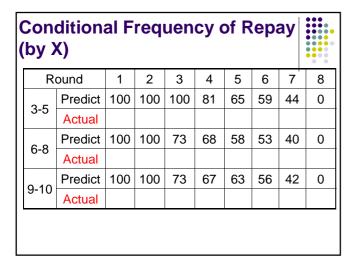
Reputation Formation



- What does the equilibrium look like?
- Last Period: Lend if $P_8(nice) > \tau = 0.79$
 - "normal" borrowers default; "nice" ones repay
- Period 7:
 - "normal" borrowers weigh between default now (and reveal) and default later







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Round		1	2	3	4	5	6	7	8
3-5	Predict	100	100	100	81	65	59	44	0
	Actual	95	97	98	95*	86*	72	47	14
6-8	Predict	100	100	73	68	58	53	40	0
	Actual	97	95	97*	92*	85*	70*	48	0
9-10	Predict	100	100	73	67	63	56	42	0
	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)