Tips and Topics for the Final Exam

API 112 / Econ 2020b

The following is a list of some important topics and tools for the final exam. The list is not exhaustive, and knowing all of these concepts doesn't guarantee that you will ace the exam. You will have to ready to solve problems that you haven't seen before, and think creatively. But knowing these concepts will certainly make the exam easier.

Note that the final exam does include material from before the midterm – this material will be roughly 1/3 of the test. Please don't ignore it in your studying. (I recommend reviewing my "Systematic approach to solving games" handout.)

The best indication of the types/difficulty of problems to expect on the final is the types/difficulty of problems on past finals.

Intro to Game Theory:

Framework for Game Theory:
Be comfortable depicting games in both extensive form and normal form. What elements does each form convey? Order of moves? Player's knowledge? Payoffs?

Key Definitions: Know the distinctions between these terms. Know how to give the right answer to the right question!

* Strategy - A complete list specifying which move a player will make in *every possible contingency*, even if the player's earlier move makes a later move unnecessary.
  — HINT: When specifying a player's strategy, you need to specify one move for each distinct information set that a player has. So, a strategy can be specified as: "At info set #1, do X; At info set #2, do Y; etc."
* Move - a single action made by a player at a single node
* Outcome or Payoff - the utility gain/loss that accrues to a player for a given sequence of moves by her and the other players. Sometimes we use money, years in prison, or years of life as a proxy for payoffs; this assumes risk neutrality in that metric.
* Equilibrium - "The combination of *strategies* by all players such that..." (depends on the eqm concept). Remember - the equilibrium is the set of strategies, not payoffs
* Equilibrium Path or Play - The sequence of moves we will see, given the equilibrium strategies of the players. If asked what the equilibrium *outcome* is, you can say what actions are taken on the equilibrium path.

Simultaneous Move Games

Equilibrium Concepts:

* Nash Equilibrium – The combination of strategies by all players such that none has a unilateral incentive to deviate: Everyone is playing a best response to the other player's strategies.
  — Be able to solve for pure strategy and mixed strategy Nash Eq.
* Dominance - Know how to use iterated deletions of strictly dominated strategies to find

an equilibrium. Be comfortable defining and identifying the following:
— Strictly dominant strategy
— Weakly dominant strategy
— Strictly dominated strategy
— Weakly dominated strategy

* Trembling Hand Perfection - know the intuition: THP rules out a player putting positive probability on a weakly dominated action. (Knowing the math is less important.)

* Know when to look for and how to find equilibria in mixed strategies!

* Be able to understand and draw best-response correspondence graphs.

Toy Games - Recognize them and be able to use them for quick reference. What are the Nash Equilibria? Pure strategy or mixed?

* Prisoner's Dilemma
* Matching Pennies
* Meeting in New York

Games of Incomplete Information:

Overview: How do economists and game theorists model uncertainty? Uncertainty about the opponents' payoffs, but not about the possible moves or the order of moves.

Equilibrium Concept:

* Bayes-Nash Equilibrium: Each player's strategy is a best response, maximizing expected payoffs, given available information. Analogous to Nash Eq, under uncertainty.
— Know how to convert games into the Bayesian normal form
— Solve for the critical probability that supports a particular equilibrium.

Dynamic Games

Tools & Definitions: Know what these are, and how to use them.

* Subgame
* Singleton Node
* Information Set

Equilibrium Concept:

* Subgame Perfect Nash Equilibrium (SPNE or SPE):
— Definition: NE within each subgame
— Know how to find it, using backwards induction
— SPE requires strategies to be optimal both on and off the equilibrium path. Nash Eq. is only a best response on the equilibrium path. Explain this difference, using a real game.
— Explain how SPE refines NE (i.e. eliminates "unsatisfying" Nash Equilibria).

Dynamic Games of Incomplete Information, with Beliefs:

Perfect Bayesian Equilibrium:

Adding in beliefs – with what probability do I think that I'm at a particular node in an information set? PBE consists of the following:

— Everyone is playing a best response to their own beliefs.

— Everyone's beliefs *along the equilibrium path* are confirmed by the equilibrium play. (Or more formally, everyone uses Bayesian updating for their beliefs).

— And everyone is optimally responding to the strategies of others.

Examples: "Beer-Quiche"

Overview of Equilibrium Concepts:

You now have four primary equilibrium concepts that do the bulk of the work in game theory:

* Nash Equilibrium
* Subgame Perfect Equilibrium
* Bayesian Equilibrium
* Perfect-Bayesian Equilibrium

For each one, you should:

— Know the definition: "The combination of *strategies* by all players such that... (fill in the blank)"

— How do they fit together? Is a Nash Eq. always a SPE, or vice versa? When are PBE's and SPE's the same?

— Know what kinds of games they are usually most relevant for – full or incomplete info? Dynamic or simultaneous?

— Know the limitations of the tools (when do they give "unsatisfying" equilibria?)

— What refinement tools do we use (trembling hand, intuitive criterion, etc) for each equilibrium concept?

Repeated Games:

Motivation: What kind of results are we trying to explain, using repeated games?

Concepts: Punishment Strategies -

What condition does a successful punishment strategy have to satisfy? We need to make our opponent's optimal strategy to be "Cooperate" instead of "Defect"

* "Tit for Tat"
* "Grim Trigger" (also called "Nash Reversion")

Toy Games: Recognize them and be able to use them for quick reference. What are the Nash Equilibria? What are the Subgame Perfect Equilibria?

* Repeated Prisoner's Dilemma - Finite # period
* Repeated Prisoner's Dilemma - Infinite # periods, with discount rate

Information Economics

Adverse Selection (Readings: MWG pp. 437-450, lecture notes chapter 3):

* Basic Elements
  — One player or group (A) has information that the other (B) doesn't
  — The lack of information constrains the behavior of B, because B can't distinguish between the different types of A (ability, quality, health, etc.)
  — The resulting equilibria will be inefficient and reduce overall surplus (therefore "adverse"). Inefficiencies are usually due to beneficial transactions foregone, mismatch, or wasteful transactions.
* Quick Examples
  — Takeover Game
  — Lemons & Used Car Market
* Labor Market Selection
  — Be able to calculate the conditional expectation function: "What average level worker do I get, for a particular wage?"
  — Be able to graphically and algebraically find competitive equilibria. Which equilibria are stable? When will there be no equilibria (market collapses)?

Signaling (Readings: MWG pp. 450-460, lecture notes chapter 4):

* Basic Elements
  — One player or group (A) has information that the other (B) doesn't
  — Player(s) A take action to convey the information to player B, using a signal (education) that is correlated with the parameter of interest (ability)
  — The resulting equilibria may or may not be relatively more efficient than the non-signaling case, but there will usually be some winners and losers from signaling. Costly signals themselves introduce new inefficiencies (e.g. In Spence model, $ and pain spent on school)
  — PBE will be the equilibrium concept; we may end up with unsatisfying equilibria, based on unreasonable beliefs off the eqm path.

* Spence Education Model:
  — Know how to draw the indifference curves, based on ability and education level
  — What do the Incentive Compatibility Constraints look like (graphically, and algebraically)?
  — Solve for the range of possible separating equilibria
  — Solve for the existence of possible pooling equilibria
  — What assumptions underlie the model (about the costs and benefits of education)? What happens to the basic results if you alter these assumptions?
  — Know how to apply the intuitive criterion and the equilibrium dominance refinement

Screening (Readings: MWG pp. 460-466 & 488-501, lecture notes on screening and comments on competitive insurance model, Salanie pp. 18-26 & 47-52):

* Basic Elements
  — One player or group (A) has information that the other (B) doesn't
  — Player B takes action to induce A to reveal the hidden information
  — The resulting equilibria may or may not be relatively more efficient than the non-screening case

* Health Insurance & Competitive Screening (Rothchild-Stiglitz Model):
  — Know how to draw the indifference curves, based on probability of illness
  — What does a budget constraint look like for actuarially fair insurance?
  — What do the Incentive Compatibility Constraints look like on the graph?

* Monopolistic Screening:
  — Which constraints will bind? Be comfortable explaining why.
  — How does the screening outcome compare to the First-Best case (full info)?
  — What are the efficiency implications?

Moral Hazard / Principal-Agent Problem (Readings: MWG pp. 478-488, lecture notes on principal-agent, Salanie pp. 107-122):

* Basic Issue: Principal hires agent to work on her behalf, but agent's actions are unobserved. What contract will provide the optimal set of incentives to the agent? Contrast the results with the 1st-Best outcome (when effort is observable).

Standard P-A Model - Effort Aversion.
* Risk neutral Principal, risk averse Agent
* Effort is correlated with outcome, but not perfectly
* Higher effort is less enjoyable for worker

CENTRAL TRADE-OFF: "Proper Incentives vs. Risk-Spreading" - Riskier contracts provide stronger incentives for higher effort, but require higher expected wages due to A's risk aversion.

BASIC APPROACH:
1) For each possible effort level, maximize expected profit (or minimize expected wage) subject to Participation Constraint (1) and ICC's (N-1, where N is the number of actions)
2) Calculate expected profit under each effort level, and pick the best contract.

* The optimal wage schedule for inducing low effort is a flat wage.
* The optimal wage schedule for inducing high effort pays more for outcomes that are stronger signals of high effort. Know what the Monotone Likelihood Ratio Property (MLRP) says, and what it implies about the optimal wage schedule for inducing high effort.

Multitasking Model:

* This builds on the principal-agent problem: now instead of observing and contracting on the outcome (*V*), the principal contracts on some other performance measure (*P*, a signal of the outcome).

* Basic setup (understand intuitively what these equations mean; note that a, f, and g are vectors):

$V(a, \varepsilon) = f * a + \varepsilon$

$P(a, \varepsilon) = g * a + \varepsilon$

$b_p^* = [S_p \cos(\theta)] / [S_p + r]$

* b_p^* is the optimal level of the performance bonus to the agent
* S_p is the signal to noise ratio (how indicative of actual effort is the performance measure?)
* θ is how distorted P is (how different is P from V?)
    * What does it mean when $\theta = 0$? When $\cos(\theta) = 0$? When $\cos(\theta) < 0$?
* r is the coefficient of absolute risk aversion (how risk averse is the agent?)

Be able to intuitively explain how b_p^* varies with each of these parameters.

Social Choice & Voting *(will only appear as an extra credit problem)*

The issue: How do we aggregate preferences across society as a whole, to enact an optimal policy? The ideal social choice rule captures the "true public preference" under any circumstances, and does not provide any incentive for strategic voting.

Definitions:

* Condorcet preferences / Condorcet cycle
* Borda count
* Pairwise majority voting
* Condorcet winner

Mays Theorem - What are the axioms? What are the results?

* Be able to define the axioms:
    — Symmetry among agents
    — Neutrality among alternatives
    — Positive responsiveness

Arrow Impossibility Theorem - What are the axioms? What are the results? What are the implications?

* Be able to define the axioms:
    — Unrestricted domain for preferences
    — Social welfare functional is rational (complete and transitive)
    — Paretian
    — Pairwise independence (IIA)
    — Non-dictatorship