Midterm Exam (80 Points Total) | **Leigh Tesfatsion**
DATE: Thursday, March 8, 11:00am | **Econ 308, Spring 2007**

ANSWER OUTLINE

NOTE: Please answer **ALL THREE** questions Q1, Q2, and Q3 included on this test. In answering these three questions, be sure to:

(a) Use this packet for all of your answers. (Show all your work so that partial credit can be given for answers even if some type of error occurs along the way.)

(b) Read each question and question part carefully before you begin your answer.

(c) Define terms and concepts clearly and carefully.

(d) Carefully label all graphs. This includes labels for axis variables as well as labels that carefully identify what is being graphed.

(e) Watch the time – plan, roughly, to allocate 1 minute for each point.

QUESTION 1: [Six Parts A Through F, 30 Points Total, About 30 Minutes]

Consider an economy consisting of three profit-seeking sellers and two profit-seeking buyers. Each seller has an endowment of (identical) apples he is trying to sell, and each seller has a reservation price for each successive bushel of apples he sells. Each buyer would like to purchase apples, and each buyer has a reservation price for each successive bushel of apples he buys.

Table 1, below, presents the specific apple reservation prices (per bushel) for sellers and buyers for each successive bushel of apples they sell and buy, respectively.

Table 1: True Apple Reservation Prices for Sellers and Buyers

Apple Bushels	Seller 1	Seller 2	Seller 3	Buyer 1	Buyer 2
1	\$5.00	\$15.00	\$25.00	\$30.00	\$10.00
2	\$5.00	∞	∞	\$30.00	\$10.00
3	\$20.00	∞	∞	\$30.00	0
4	\$20.00	∞	∞	\$30.00	0
5	∞	∞	∞	0	0
7	∞	∞	∞	0	0
8	∞	∞	∞	0	0

IMPORTANT NOTE:

The **Blank Graphs** provided for Q1:A through Q1:D, below, should be used to provide the requested graphical answers for Q1:A through Q1:D **in clear carefully labeled form**.

If you wish, you can superimpose some or all of your graphical answers for Q1:A through Q1:D on top of each other in one graph instead of graphing each one separately *as long as the resulting graph(s) clearly depict all required graphical answers for Q1:A through Q1:D.*

Q1:Part A (5 Points) Using the information in Table 1, graphically depict below the **True Total Supply Schedule** for this apple market with apple quantity (in bushels) on the horizontal axis and the apple price per bushel on the vertical axis.

Answer Outline for Q1:A

- **Carefully labeled graph (including labels for axis variables and identification of what is being graphed):** 1 Point. See graph below
- **Correct Plot of Data:** 4 Points. See graph below.

Q1:Part B (5 Points) Using the information in Table 1, graphically depict the **True Total Demand Schedule** for this apple market with apple quantity (in bushels) on the horizontal axis and the apple price per bushel on the vertical axis.

Answer Outline for Q1:B

- **Carefully labeled graph (including labels for axis variables and identification of what is being graphed):** 1 point. See graph below.
- **Correct Plot of Data:** 4 points. See graph below.

Q1:Part C (5 Points) Using your findings in parts Q1:A and Q1:B, graphically depict all possible **Competitive Market Clearing (CMC) Points** for this apple market.

Answer Outline for Q1:C

- **Carefully labeled graph (including labels for axis variables and identification of what is being graphed):** 1 point. See graph below.
- **Correct Plot of Data:** 4 points. See graph below.

IMPORTANT POINT: As seen in the graph below, there is a unique CMC point at $(Q^* = 4, P^* = \$20)$. While almost everyone derived the correct CMC quantity $Q^* = 4$, some students asserted that a RANGE of prices greater or equal to \$20 are CMC prices, for example all prices between \$20 and \$30, or all prices between \$20 and \$25.

To see why this inclusion of a RANGE of prices is incorrect for the problem at hand, please go back and check the definition for a CMC point. Graphically, CMC points are INTERSECTION points of the True Total Supply Schedule and the True Total Demand Schedule, with vertical portions included in the plotting of these schedules. The only such intersection point for the problem at hand is the point $(Q^* = 4, P^* = \$20)$.

Intuitively, WHY must these other prices be excluded? Consider, for example, the point $(Q^* = 4, P' = \$30)$. At this point there is an effective "excess supply" in the following sense.

Suppose the auctioneer were to set the market price at P' = \$30. Then sellers of SIX units would perceive they could get a POSITIVE Net Surplus by selling their units at P' because P' is above their reservation values. However, only FOUR units would be demanded at the price P' = \$30. Consequently, there is an "excess supply" that would cause the sellers to compete to sell their units. This competition would presumably take the form of sellers bidding down the price, offering to sell their units for less than P' while still staying above their reservation values.

As the price starts to fall, eventually it would hit \$25. At this price, Seller 3 is no longer able to compete through further offered price cuts because \$25 is his reservation value. However, FIVE units would still be in the game at this offered price of \$25 (i.e., this price still exceeds their reservation values), so bidding down the price would continue. When the price falls all the way down to $P^* = \$20$, demand is still at four units, but Seller 1 is no longer able to compete by offering further price cuts because \$20 is his reservation value. It follows that there is no longer any incentive for any seller to offer a lower price, so \$20 becomes the market price. Seller 1 ends up selling three of his four units at this market price, but has no way to offer a lower price to induce the sale of his fourth unit. The demand for the fourth unit is met by Seller 2, whose reservation price of \$15 is below the market price.

You should check that a similar type of argument can be made for the market problem at hand starting at ANY other point than the intersection point ($Q^* = 4, P^* = \$20$). At any such other point, at least one seller (or buyer) would have an incentive to bid down (or up) the price in order to increase his Net Surplus.

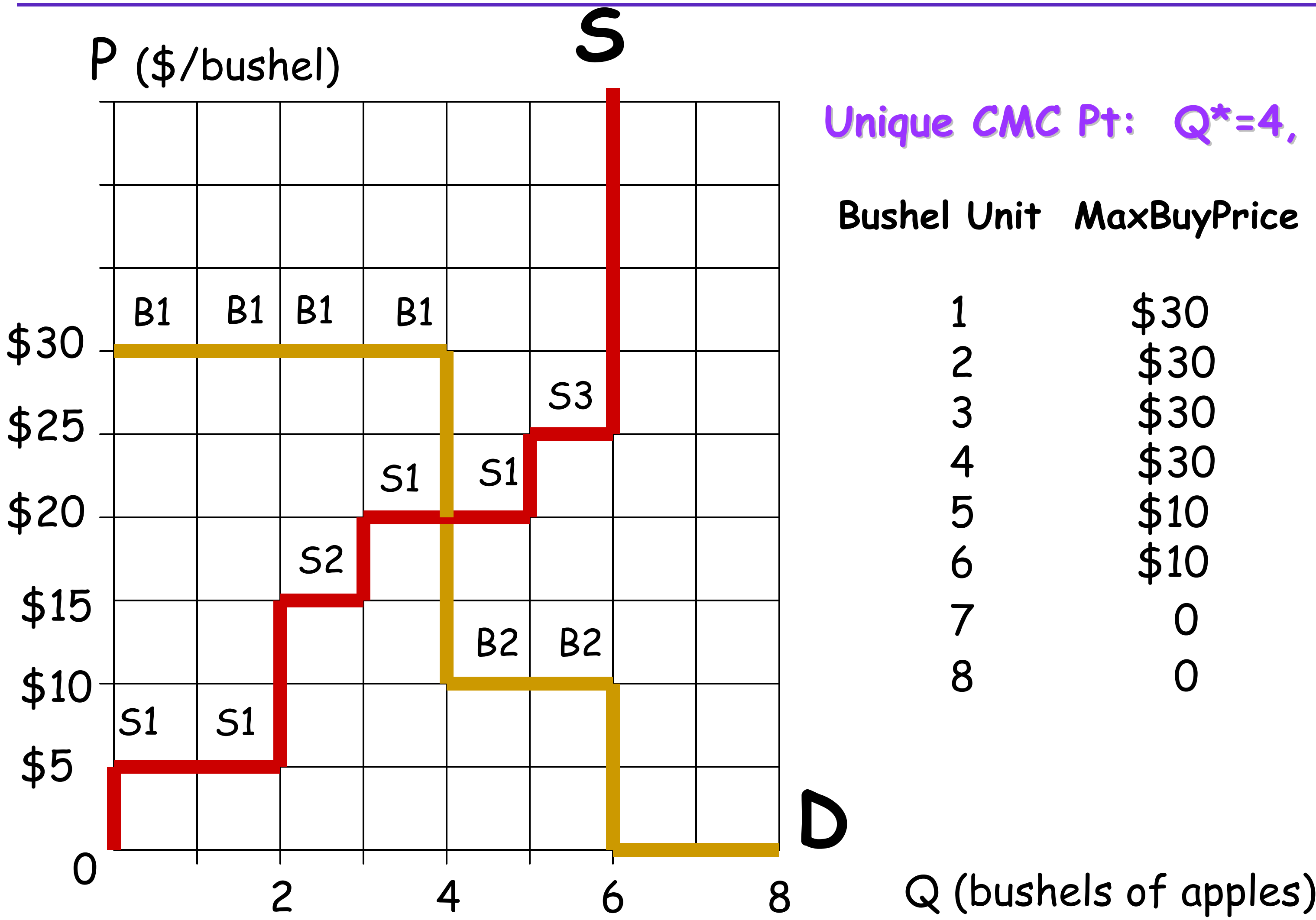
The formal definition of CMC points (as intersection points of the True Total Supply Schedule and the True Total Demand Schedule with any vertical portions included) captures precisely the set of quantity-price pairs at which no surplus-seeking seller (or buyer) has any incentive to bid down (or up) the price.

Q1:Part D: (5 Points) Using your findings in parts Q1:A through Q1:C, graphically depict **Net Seller Surplus** and **Net Buyer Surplus** at any CMC point.

Answer Outline for Q1:D

- **Carefully labeled graph (including labels for axis variables and identification of what is being graphed):** 1 point. See graph below.
- **Correct Plot of Data:** 4 points. See graph below.

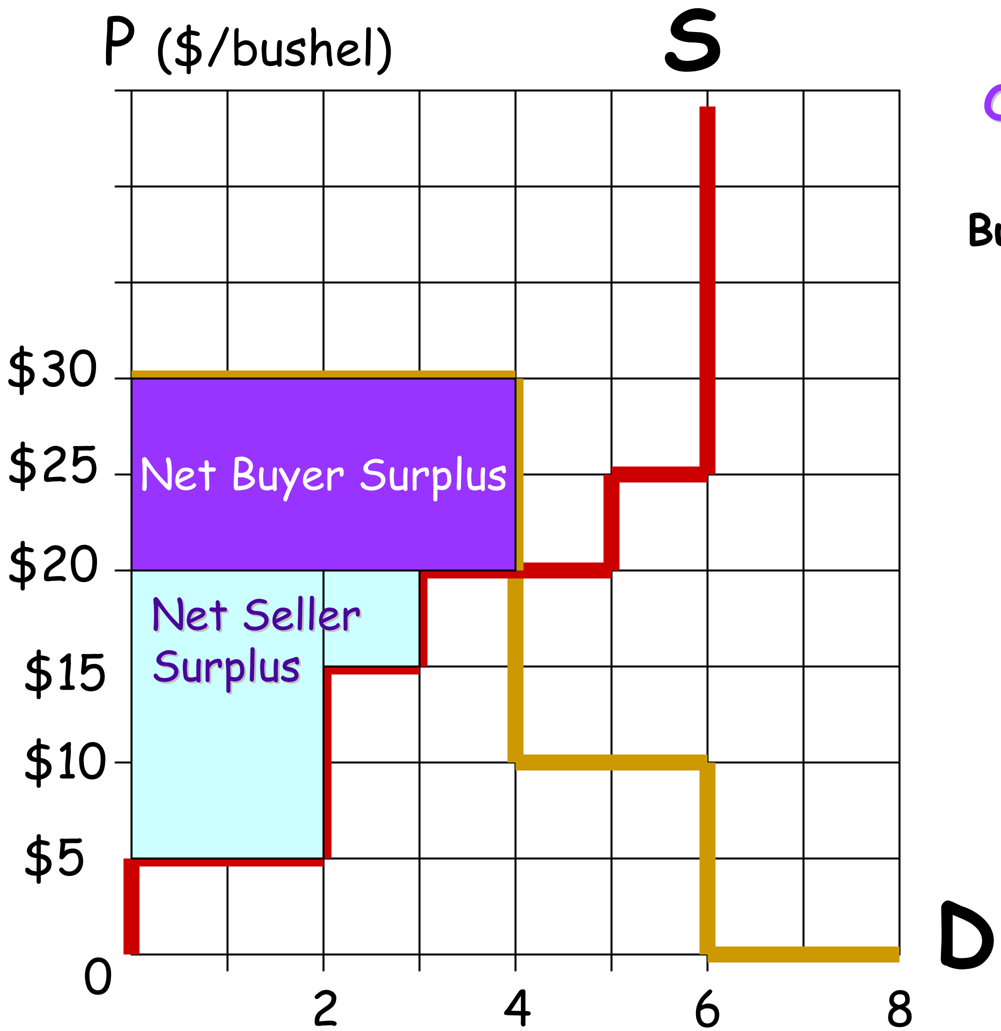
Q1: Graphical Demand & Supply Answers for Parts A, B, and C



Unique CMC Pt: Q*=4, P*= $20

Bushel Unit	MaxBuyPrice	MinSellPrice
1	$30	$5
2	$30	$5
3	$30	$15
4	$30	$20
5	$10	$20
6	$10	$25
7	0	∞
8	0	∞

Q1: Graphical Demand & Supply Answer for Part D (Seller and Buyer Surplus)



Q (bushels of apples)

Only CMC Pt: Q*=4, P* = $20

Bushel Unit	MaxBuyPrice	MinSellPrice
1	$30	$5
2	$30	$5
3	$30	$15
4	$30	$20
5	$10	$20
6	$10	$25
7	0	∞
8	0	∞

Q1:Part E (5 Points)

E.1 - 1 Point Define in words what is meant by **Total Net Surplus** for this apple market.

Answer Outline for Q1:E.1

Total Net Surplus is the sum of Net Seller Surplus and Net Buyer Surplus.

In more detail, Net Seller Surplus is the sum of all of the net surplus amounts extracted by sellers in the market for the units they sell, and Net Buyer Surplus is the sum of all of the net surplus amounts extracted by buyers in the market for the units they buy.

The Net Surplus extracted by an individual seller on each unit he sells is the difference between the price he receives for each unit he sells and his reservation price. The Net Surplus extracted by an individual buyer on each unit he buys is the difference between his reservation price and the price he pays.

Important Remark: For the problem at hand, there is a unique CMC point, hence a unique determination of Net Seller Surplus and Net Buyer Surplus adding up to Total Net Surplus. In a case in which there are several CMC points, the TOTAL NET SURPLUS will be the same at each of these CMC points, but the DIVISION of this surplus between Net Seller Surplus and Net Buyer Surplus can depend on the particular CMC point.

E.2 - 4 Points Explain carefully WHY the Total Net Surplus extracted at any CMC point for this apple market is as large as it can possibly be. That is, explain why the Total Net Surplus extracted at any point OTHER than a CMC point CANNOT BE STRICTLY LARGER than the Total Net Surplus extracted at any CMC point.

Answer Outline for Q1:E.2

The True Total Supply Schedule lines up all supplied units in ASCENDING order of their reservation prices, and the True Total Demand Schedule lines up all demanded units in DESCENDING order of their reservation prices. Consequently, if demands and supplies for units are successively matched for sale from left to right, the units entailing the LARGEST extracted Net Surplus (buyer reservation price minus seller reservation price) are sold first.

It follows that, if the demand-to-supply matching process continues from left to right as long as the extracted Net Surplus remains positive, stopping before the extraction of any "negative" Net Surplus, then the extracted Total Net Surplus will be as large as possible by construction.

By definition, the quantity level Q* corresponding to any CMC point is such that any MORE unit sales of Q would entail either zero or negative extraction of Net Surplus while any FEWER unit sales of Q would leave unextracted positive Net Surplus that is feasible to extract. Consequently, CMC points are points of maximum Total Net Surplus extraction.

Q1:Part F (5 Points)

Suppose the apple market is conducted through an auctioneer, as follows: Sellers and Buyers express (submit) their supply and demand schedules to the auctioneer, who then determines and calls out what the auctioneer believes to be a CMC price based on these expressed schedules.

Based on your findings from parts Q1:A through Q1:E, does **Seller 2** have an incentive to report an expressed supply schedule to the auctioneer that **deviates** from his true supply schedule, given that all OTHER sellers and buyers report their true supply and demand schedules to the auctioneer?

If your answer is yes, explain the exact nature of this desirable deviation for Seller 2. If your answer is no, explain why no such desirable deviation exists for Seller 2.

Answer Outline for Q1:F

Key Observation: Under the assumptions of Q1:F, the Auctioneer sets a uniform price for the entire market.

That is, based on the demand and supply information supplied to him, the Auctioneer forms a Total Supply Schedule and a Total Demand Schedule and determines their intersection point(s) – which by definition constitutes the CMC points as he perceives them. He then calls out a CMC price corresponding to one of these CMC points. This CMC price is then the "market" price for the purchase and sale of bushels of apples, meaning there is only one price charged for bushels of apples in the market.

As established above for Part Q1:C, if all sellers and buyers report their true supply and demand schedules, then there is a unique CMC point at $(Q^* = 4, P^* = \$20)$. Consequently, the Auctioneer would call out the price \$20.00.

Assuming (as is usual in economics) that the goal of sellers is to maximize their extracted Net Surplus (profits), Seller 2 would only have an incentive to unilaterally deviate from reporting his TRUE supply schedule to the Auctioneer if by doing so he could increase his extracted Net Surplus (profits) above what he gets by reporting his true supply schedule.

S2 cannot change the amount he has for sale (one unit), meaning he cannot increase the number of units sold. Also, he cannot change his true reservation price for the sale of this unit (\$15.00).

Consequently, the only way S2 could possible increase his extracted Net Surplus is to somehow get the Auctioneer to announce a price HIGHER than the CMC price $P = \$20$ while still ensuring that his one unit for sale remains "inframarginal" (to the left of the intersection of the resulting Total Supply Schedule and the Total Demand Schedule).

Unfortunately for S2, there is no way for him to do this.

If S2 RAISES his own offered price to a price GREATER THAN \$20, then the Auctioneer would perceive BOTH units offered for sale by S1 at a price of \$20 to have lower reservation values than the unit offered by S2. Consequently, S2's unit would become extramarginal (unsold) and both of S1's units would become inframarginal (sold). S2 would therefore end up with a zero Net Surplus.

Conversely, if S2 offers any price LOWER than \$20, then the CMC point is unaffected, hence in particular the CMC price of \$20 is unaffected. It follows that S2 gets the SAME Net Surplus as before.

It follows that S2 has no incentive to deviate from the reporting of his True Supply Schedule, assuming all he cares about is his Net Surplus (profits).

QUESTION 2: [Five Parts A through E, 30 Points Total, About 30 Minutes]

Consider a firm that includes two workers, WORKER1 and WORKER2. Each worker has two action choices: WORK (exert high work effort), or SHIRK (exert low work effort).

The possible actions by WORKER1 and WORKER2, and the payoff levels attainable by these workers under their possible action choices, are summarized in the following **Payoff Matrix**, where the payoffs are of the form (WORKER1 payoff, WORKER2 payoff). Both of the workers are assumed to know this payoff matrix. Until supposed otherwise (in Part E below), assume this game between the two workers is only played once.

		WORKER2	
		Work	**Shirk**
WORKER1	**Work**	**(20,20)**	**(-60,0)**
	Shirk	**(70,-50)**	**(0,10)**

Q2:Part A [4 Points] For each action pair that WORKER1 and WORKER2 might choose, carefully define **in words** what it would would mean to say that this action pair:

(i) is a Nash equilibrium (NE);

(ii) is Pareto efficient (PE).

Answer Outline for Q2:A Please refer to the class lecture notes titled "Game Theory: Basic Concepts and Terminology" available at the on-line Econ 308 Syllabus (Section II) and directly accessible at

http://www.econ.iastate.edu/classes/econ308/tesfatsion/gamedef.pdf

As defined in these notes, an action pair for the current game is a *Nash Equilibrium* if neither worker has any incentive to deviate from his current action given that the other worker does not deviate. And an action pair for the current game is *Pareto efficient* if there exists no other feasible action pair for which each worker would attain at least as high a payoff and at least one worker would obtain a strictly higher payoff.

Q2:Part B [**4 Points**] Using your definitions in part Q2:A, and the payoff matrix depicted above, determine for **each** of the **four** possible action pairs for WORKER1 and WORKER2:

(i) whether the action pair is or is not a NE.

(ii) whether the action pair is or is not PE.

Answer Outline for Q2:B

- **Action Pair (Work,Work):** NOT a NE; IS a PE
- **Action Pair (Work,Shirk):** NEITHER NE NOR PE
- **Action Pair (Shirk,Work):** PE but NOT NE
- **Action Pair (Shirk,Shirk):** NE but NOT PE

Q2:Part C [**4 Points**] Most economists would argue that there is a uniquely rational outcome for this once-played game between WORKER1 and WORKER2. Explain in what sense this game might be said to have a uniquely rational outcome.

Answer Outline for Q2:C

Shirk is a DOMINANT STRATEGY for Worker 1 in the once-played game, meaning it is Worker 1's best response to ANYTHING that Worker 2 does. Since Worker 2 knows the Payoff Matrix, he can figure this out. Given that Worker 1 is thus likely to play Shirk, the best response for Worker 2 is also to Shirk. Consequently, most economists argue that (Shirk,Shirk) is the uniquely rational outcome for the game, in the sense that it is the unique outcome of logical calculations.

Q2:Part D [4 Points] Define IN WORDS what is meant by *coordination failure* in a general game situation. Is coordination failure a possible outcome in the above worker game? Justify your answer.

Answer Outline for Q2:D

As defined in the class lecture notes titled "Notes on Game Theory...", *Coordination Failure* refers to a situation in which one is in a Pareto-dominated Nash equilibrium. Less formally, one is in a situation in which no individual has any incentive to deviate from his current strategy, given everyone else sticks with their current strategy, yet there is another feasible configuration of strategies for all players in which everyone would be at least as well off and someone would be strictly better off.

As determined in Q2:B, (Shirk,Shirk) is a Nash equilibrium that is Pareto-dominated by (Work,Work). Consequently, if the workers end up at the action pair (Shirk,Shirk), they are in a situation of coordination failure. Unfortunately for the workers, as seen above in Q2:C, it might be difficult to avoid ending up at coordination failure if both workers "rationally" reason their way to a choice of action.

Q2:Part E [14 Points] Suppose, instead, that WORKER1 and WORKER2 *repeatedly* choose between their two feasible actions at the beginning of every day, and the payoff matrix above depicts the daily payoff to the two workers as a result of these daily choices.

E.1 Carefully explain how WORKER 1 and WORKER2 could use some form of **Roth-Erev reinforcement learning (RL)** to choose their daily actions.

E.2 Could this use of Roth-Erev RL in REPEATED game play decrease the chances (relative to the one-play game) that WORKER1 and WORKER2 become stuck in a situation of coordination failure? Discuss.

GENERAL REMARK ON THE EVALUATION OF Q2:E ANSWERS

Please refer to the required class notes for Section III.A of Econ 308 titled "Notes on Learning" and "Learning Algorithms: Illustrative Examples" for detailed discussion and illustrations of Roth-Erev Reinforcement Learning (RL).

Answers for Q2:E will be evaluated on the following basis: (a) demonstrated understanding in part Q2:E.1 of the meaning of Roth-Erev Reinforcement Learning (7 Points); (b) organization and logical clarity of discussion in part Q2:E.2 regarding possibility of avoiding coordination failure through repeated game play (5 points). (c) relevance/interest of conjectures in part Q2:E.2 regarding the possibility that the specific use of Roth-Erev RL in repeated game play might (or might not) decrease the chances of coordination failure (2 Points).

Answer Outline for Q2:E.1

Students should explain carefully the basic steps a worker would need to follow to apply Roth-Erev RL. This explanation could be given for one of the workers and then extended by analogy to the other worker. For example, consider Worker1.

Suppose the action domain for Roth-Erev RL for Worker1 is taken to be {Work, Shirk}. Worker1 would then need to start by assigning initial choice propensities $q_1(0)$ and $q_2(0)$ to Work and Shirk, respectively. For example, Worker1 might set these propensities equal to the average 7.5 of the payoffs $\{20, -60, 0, 70\}$ he attains under the four possible situations he could find himself in:

$$q_1(0) \;=\; 7.5 \quad \text{and} \quad q_2(0) \;=\; 7.5 \quad . \tag{1}$$

A higher level than 7.5 would lead to increased experimentation across his two possible actions and a lower level would lead to decreased experimentation.

Worker1 would also need to specify the way in which his initial choice propensities $q_1(0)$ and $q_2(0)$ are transformed into initial choice probabilities. For example, suppose he uses the following simple transformation:

$$\text{Prob}_j(0) = \frac{q_j(0)}{\sum_{n=1}^{2} q_n(0)} \quad = \quad 1/2 \quad , \quad j = 1, 2 \quad . \tag{2}$$

Finally, Worker1 would need to specify values between 0 and 1 for the Roth-Erev experimentation parameter ϵ controlling the degree of "spillover" and for the Roth-Erev recency parameter ϕ controlling the degree of "forgetting" in the propensity updating equation.

Given these specifications, Roth-Erev RL for Worker1 would proceed as follows. At the beginning of Day 0, Worker1 selects an action (Work or Shirk) in accordance with the probabilities determined by (2). In effect, he flips a fair coin and chooses "Work" if the coin lands heads and "Shirk" if the coin lands tails. Worker2 proceeds in an analogous way to choose an action. Based on these two actions, payoffs result for each worker in accordance with the given payoff matrix.

Let the action chosen by Worker1 for day D=0 (either Work or Shirk) be denoted by a_k, so that "k" corresponds to the actually chosen action, and let the payoff received by Worker1 at the end of day D=0 following the choice of the action a_k be denoted by r_k. Worker1 then updates his initial choice propensities $q_1(0)$ and $q_2(0)$ to new choice propensity values $q_1(1)$ and $q_2(1)$, as follows:

$$q_j(1) \;=\; [1-\phi]q_j(0) \;+\; r_k[1-\epsilon] \quad \text{if} \;\; j = k \;\; ; \tag{3}$$

$$q_j(1) \;=\; [1-\phi]q_j(0) \;+\; r_k\epsilon \quad \text{if} \;\; j \neq k \;\; . \tag{4}$$

Finally, Worker1 updates his choice probabilities as follows in preparation for choice of action on the next day D=1:

$$\text{Prob}_j(1) \;=\; \frac{q_j(1)}{\sum_{n=1}^{2} q_n(1)} \quad , \quad j = 1, 2 \quad . \tag{5}$$

At the beginning of the next day D=1 he then chooses an action in accordance with the updated probabilities (5), gets a resulting payoff, again updates his choice propensities, and again updates his choice probabilities. And so forth and so on for each successive day D.

Answer Outline for Q2:E.2

If the two workers in the game at hand could somehow end up with action choice probability distributions that assign a relatively high probability to the action choice "Work," then they could avoid getting stuck at (Shirk,Shirk) and hence avoid coordination failue. Consequently, there is at least a chance that the use of Roth-Erev RL in REPEATED game play for the game at hand could permit the avoidance of coordination failure.

Note, in particular, that Worker2 has no incentive to deviate individually from the (Work,Work) action pair. On the other hand, Worker1 does have an incentive to deviate from the (Work,Work) action pair. Hence Worker1 could potentially mess up the chances of attaining the socially efficient (Work,Work) action pair and hence of attaining avoidance of coordination failure.

However, the only payoff that dominates the (Work,Work) payoff for Worker1 is the (Shirk,Work) payoff when Worker1 manages to play Shirk while Worker2 plays Work. But the payoff for Worker2 given the action pair (Shirk,Work) – namely, -50 – is so much worse than the payoff of 10 he receives for (Shirk,Shirk) that is it difficult to believe that Worker2 would ever evolve a choice probability that permits the payoff of -50 to persistently occur.

Bottom Line: It would be interesting to examine more carefully, through both analysis and carefully designed computational experiments, exactly what types of outcomes occur in the game at hand when the workers use Roth-Erev RL applied to the action domain $\{Work, Shirk\}$ under various specifications for the initial action choice propensities, the propensities-to-probabilities transformation, the experimentation parameter, and the recency parameter.

ADDITIONAL REMARKS:

By specifying the action domain for Roth-Erev RL for each worker to simply be the set $\{Work, Shirk\}$, it is guaranteed that the only type of strategies that the workers can learn over time are of the form "choose Work with probability Prob and Shirk with probability [1-Prob]". Note that this does not permit the workers to learn strategies that can effectively "punish" or "reward" the actions of the other player in an immediate transparent way. For example, Worker2 cannot evolve a strategy such as Tit-for-Tat that immediately punishes the other player for a Shirk action. Rather, Roth-Erev RL applied to $\{Work, Shirk\}$ only permits the rather slow evolution of action choice probabilities for Work and Shirk that are conditioned on ALL past payoffs and not on the immediate past plays of a rival.

Notice, however, that Roth-Erev RL can actually be applied to ANY action domain as long as a probability distribution function (PDF) can be defined over the elements of this action domain. For instance, for the game at hand, Worker1 could have an action domain consisting of finitely many strategies (complete contingency plan) for repeatedly playing the above worker game an arbitrary number of times with Worker2. Examples of strategies that might be elements of this action domain include Tit-for-Tat, Tit-for-Two Tats, Trigger Strategy (Work until shirked against and thereafter Shirk), and AllD (always defect). The action choice probability distributions evolved under Roth-Erev RL for such an action domain would thus be *mixed strategies* dictating for each day D which strategy in the action domain is to be implemented with what probability.

QUESTION 3: CREATIVE MODELING [20 Points, About 20 Minutes]

Suppose you have a deposit account at the First National Bank. If you see other people hurrying to withdraw their money from the First National Bank because (for whatever reason) they fear the bank is going bankrupt, you might fear for your money and hurry to withdraw your deposit account funds.

If this "chain reaction" continues, lots of people will end up seeking to withdraw their funds from the First National Bank, all within a relatively short period of time, and the First National Bank will go bankrupt. That is, the bank will not have enough money on hand to meet its customers' demands for withdrawals. Such a situation is called a **bank panic**.

Suppose you wanted to model the possible emergence of a bank panic among a population of agents by means of a **two-dimensional cellular automaton (2D CA) model with von Neumann neighborhoods**. The state of any particular agent A (calm or panicked) depends on the state of the agents in agent A's neighborhood.

Using simple diagrams and verbal descriptions, outline a possible way that this 2D CA modeling of a bank panic might reasonably be done, keeping in mind the limited time you have to devote to this question (about 20 minutes).

Answer Outline for Q3:

Although many different forms of Q3 answers are acceptable, all Q3 answers will be evaluated on the following basis:

(a) [6 Points] demonstrated understanding of what is meant by a 2D CA with von Neumann neighborhoods (see Econ 308 Syllabus Section I, "Introduction to Cellular Automata");

(b) [10 Points] reasonableness and interest of the proposed 2D CA model of a bank panic;

(c) [4 Points] organization, logical clarity, and completeness of the model description.

Regarding (c), a complete model description for a *standard* 2D CA would include: a size for the 2D CA "board"; an explicit specification of the neighborhood of each cell (or of each agent residing at a cell), which here you are requested to specify as a von Neumann neighborhood; the possible states of each cell (or of each agent residing in a cell); the transition rule determining when a cell (or an agent residing in a cell) transits from one state to another as a function of the states of its neighbors; the initial board set-up; and the way the entire bank panic simulation is activated (e.g. by the random introduction of one or more panicked agents into an existing population of calm agents scattered randomly across the board). However, recognition is given in the grading that the more ORIGINAL the model envisioned, the harder it might be to write out the model in COMPLETE form.