ANSWER OUTLINE

Midterm Exam (80 Points Total) **Leigh Tesfatsion**
DATE: Thursday, March 12, 11:00am **Econ 308, Spring 2009**

NOTE: Please answer **ALL FOUR** questions included on this test. In answering these questions, be sure to:

(a) Use this packet for all of your answers; use the reverse sides of pages if more space is necessary. 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:SHORT ANSWERS [10 Points Total (About 10 Minutes)]

Q1-Part A [6 Points]

- (1) [2 Points] Explain briefly but carefully what is meant by an *object* in object-oriented programming.
- (2) [2 Points] Explain briefly but carefully what is meant by an *agent* in agent-oriented programming (at least according to researchers such as Nick Jennings).
- (3) [2 Points] Some debate has arisen regarding whether "objects" can fully implement "agents" that are meant to represent people in social interaction settings. Indicate, briefly, at least one key issue in this debate.

Answer Outline for Q1-Part A:

(1) An object is a software entity that contains attributes (data,state information,...) plus methods (behaviors, functions, procedures...) which act on these attributes, and that controls access to these attributes and methods by having them designated as public, private, or protected. (2) According to Nick Jennings, an agent is an object capable of displaying structural reactivity (changes in internal structure in response to environmental changes), social ability (interaction with other agents through some form of language), pro-activity (goal-directed actions), and autonomy (some degree of control over its own actions – "self-activation." (3) Debate has arisen over a number of issues. For example, is the current way in which objects are permitted to control access to their attributes and methods flexible enough for the modeling of people in social settings? Is communication among objects through their public interfaces currently too rigid and stylized to capture key aspects of social communication? Do objects truly have enough "autonomy" to represent people in social settings? And so forth.

Q1-Part B [4 Points]: Explain briefly but carefully, in words, what is meant by an *experimental design*. Be sure to include a description of the key components constituting an experimental design.

Answer Outline for Part B: From on-line class notes, an *experimental design* consists of a careful description of how a particular hypothesis can be experimentally tested. This requires an explicit specification of the treatment factors to be tested, the specific range of values over which these treatment factors will be tested, the manner in which observations will be generated, recorded, and reported, and the criteria that will be used to evaluate whether the hypothesis is rejected or not on the basis of these observations.

		PRIV: A	PRIV: F
GOV	A	(40,40)	(0,30)
	F	(80,10)	(20,20)

QUESTION 2: [20 Points Total (About 20 Minutes)]

Consider an economy in which the Government (GOV) and the Private Sector (PRIV) each decide once and for all whether to adhere to the Rule of Law or not. For GOV, adherence to the Rule of Law means that all tax receipts collected from PRIV are used for socially productive investments (rather than trips to Bermuda), and for PRIV, adherence to the Rule of Law means that all taxable earned income is reported to GOV to be taxed.

Consequently, both GOV and PRIV can make one of two possible decisions: ADHERE (A) to the Rule of Law, or FAIL (F) to adhere to the Rule of Law. Moreover, GOV and PRIV must make their decisions simultaneously, without knowing each other's decision. The payoff matrix describing this *one shot* (i.e., once played) game for players GOV and PRIV is depicted above. In each cell of the payoff matrix, the first reported payoff is GOV's payoff, and the second reported payoff is PRIV's payoff.

Q2-PART A [4 Points] For any possible decision pair that GOV and PRIV might choose, define carefully **in words** what it would would mean to say that this decision pair:

(i) is a Nash equilibrium (NE);

(ii) is Pareto efficient (PE).

Answer Outline for Q2-PART A: (i) A feasible decision pair (DG,DP) for GOV and PRIV is a *Nash equilibrium (NE)* if, given DP, then GOV has no incentive to deviate from DG, and, given DG, then PRIV has no incentive to deviate from DP. (ii) A feasible decision pair (DG,DP) for GOV and PRIV is *Pareto efficient (PE)* if there exists no other feasible decision pair such that the resulting payoffs for GOV and PRIV are each at least as large as under the original decision pair and at least one of these payoffs is strictly larger than under the original decision pair.

Q2-PART B [8 Points]: Using the payoff matrix above, determine for **each** of the **four** possible decision pairs for GOV and PRIV:

(i) whether the decision pair is or is not a NE;

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

Note: *Be sure to provide a careful justification for your assertions in terms of the definitions you provided above in Q2:Part A.*

Answer Outline for Q2-PART B: There are four feasible decision pairs to consider. Each will be considered in turn.

(A,A): PE but NOT NE

> This is NOT a NE because, given (A,A), each agent has an incentive to switch to F. This IS PE, however, since at least one agent gets a lower payoff under each other feasible decision pair.

(A,F): NOT PE AND NOT NE

> This is NOT PE because each player gets a higher payoff under (A,A). This is NOT a NE because, given (A,F), GOV has an incentive to switch to F.

(F,A): PE but NOT NE

> This is NOT a NE because, given (F,A), PRIV has an incentive to switch to F. This IS PE because at least one agent gets a lower payoff under each other feasible decision pair.

(F,F): NE but NOT PE

> This IS a NE. Given (F,F), neither GOV nor PRIV has an incentive to switch to A. This is NOT PE since it is Pareto-dominated by (A,A).

Q2-PART C [4 Points]: Most game theorists would argue that there is a uniquely rational outcome for this game between GOV and PRIV. Explain in what sense this game might be said to have a uniquely rational outcome.

Answer Outline for Q2-PART C: Decision F is a *dominant strategy* for GOV in this one-shot game. That is, whatever PRIV chooses to do, it is always better for GOV to choose F. Being able to deduce the existence of a dominant strategy F for GOV from the payoff matrix, PRIV should presumably expect GOV to choose F. But, if GOV is going to choose

F, the best that PRIV can do is to also choose F. Game theorists therefore argue that the only "rational" outcome for this game is (F,F).

Q2-PART D [4 Points]:

- (1) [1 Point] Define, in words, what is meant by *coordination failure* in any game context.
- (2) [1 Point] Explain, specifically, how coordination failure could arise in the game at hand between GOV and PRIV.
- (3) [2 Points] Is this coordination failure due to agents failing to have expectations that are rational in some sense? Explain carefully.

Answer Outline for Q2-PART D: By definition, for any game, a set of strategies (one for each player) exhibits *coordination failure* if and only if it is a Pareto-dominated Nash equilibrium, i.e., it is a NE that is not PE. Consequently, for the game at hand, coordination failure would hold at (F,F) since (as determined in Part B) this is a NE that is not PE.

The economy at hand could get stuck at (F,F) because, once there, no individual agent has any incentive to deviate. However, if the actions of GOV and PRIV could somehow be coordinated in a credible way, they would both be better off choosing (A,A).

The danger of ending up in coordination failure at (F,F) is not due to any lack of information or to "irrational" expectations on the part of GOV or PRIV. Indeed, both agents have full information about every structural aspect of the game – namely, the payoff matrix and the rules of the game requiring both agents to choose their decisions simultaneously. Given this information, each agent can see that F is a dominant strategy for GOV. Given that F is a dominant strategy for GOV, it seems a reasonable expectation on the part of PRIV that GOV will choose F. In turn, realizing that PRIV will recognize GOV has F as a dominant strategy, it is reasonable for GOV to expect that PRIV will optimize against F and itself choose F.

QUESTION 3: [35 Points Total] (About 35 Minutes)]
Consider a market for bushels of apples consisting of three surplus-seeking sellers, S1, S2, and S3, plus two surplus-seeking buyers, B1 and B2. Table 1, below, presents the specific bushel reservation prices for sellers and buyers for each successive bushel of apples they sell and buy, respectively.

Table 1: Apple Market: True Bushel Reservation Prices for Sellers and Buyers

Bushels	S1	S2	S3	B1	B2
1	\$10.00	\$10.00	\$50.00	\$80.00	\$80.00
2	\$50.00	\$60.00	\$70.00	\$60.00	\$80.00
3	\$80.00	∞	\$70.00	\$20.00	\$60.00
4	∞	∞	0	0	\$60.00
5	∞	∞	0	0	\$20.00
7	∞	∞	0	0	0
8	∞	∞	0	0	0

IMPORTANT NOTE:

> The **Blank Graphs** provided for Q3:Part A through Q3:Part E, below, should be used to provide the requested graphical answers for these parts in a clear and carefully labeled form. If you wish, you can superimpose some or all of your graphical answers for Q3:Part A through Q3:Part D on top of each other instead of graphing each one separately as long as the resulting graph(s) clearly depict all required graphical answers for Q3:Part A through Q3:Part D. However, please provide *separate* graphs to support your findings for Q3:Part E.

Q3:Part A (3 Points) Using the information in Table 1, graphically depict below the **True Total Supply Schedule** for this market with bushel quantities on the horizontal axis and the bushel prices on the vertical axis. *Be sure to show which plotted quantity-price combinations correspond to which traders.*

Q3:Part B (3 Points) Using the information in Table 1, graphically depict below the **True Total Demand Schedule** for this market with bushel quantities on the horizontal axis and the bushel prices on the vertical axis. *Be sure to show which plotted quantity-price combinations correspond to which traders.*

Q3:Part C (1 Points) Using your findings in parts Q3:Part A and Q3:Part B, explicitly describe and graphically depict all possible **Competitive Market Clearing (CMC) Points** for this market.

Q3:Part D: (3 Points) Using your findings in parts Q3:Part A through Q3:Part C, separately calculate and report the amount of **Net Seller Surplus** and **Net Buyer Surplus** at any CMC point (indicate which one), and graphically depict these amounts below.

Q3:Part E (25 Points) Suppose the apple market in Table 1 is conducted through an auctioneer, as follows:

- The surplus-seeking sellers and buyers express (i.e., report) individual supply and demand schedules to the auctioneer;
- The auctioneer then sets the market price at what he believes to be a CMC price level *based on these expressed individual supply and demand schedules*;
- If multiple possible CMC price levels are perceived by the auctioneer to exist, the auctioneer sets the market price at the *midpoint* of the range of perceived possible CMC price levels;
- The maximum possible number of quantity units are then sold at the market price set by the auctioneer.

INSTRUCTIONS FOR PART E: For each part E(1)-E(5) below, justify your assertions carefully. If for any of these parts you assert that there IS an incentive to behave strategically by reporting something other than true reservation prices), provide a **graphical depiction** below that demonstrates how the trader(s) in question obtain(s) greater surplus by this strategic behavior.

Part E(1):(5 Points) Does **SELLER 1** have an incentive to report a 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?*

Part E(2):(5 Points) Does **SELLER 2** have an incentive to report a 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?*

Part E(3):(5 Points) Does **SELLER 3** have an incentive to report a 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?*

Part E(4):(5 Points) Do the **THREE SELLERS S1, S2, and S3 TOGETHER** have an incentive to *collude* in the reporting of supply schedules to the auctioneer that *deviate* from their true supply schedules, *given that **all buyers** report their true demand schedules to the auctioneer?*

Part E(5):(5 Points) Given that one or more sellers has an incentive to report a supply schedule to the auction in the first round of trade that deviates from their true supply schedule, what incentive (if any) do **BUYER 1 AND BUYER 2 TOGETHER** have in the second round of trade to collude on the reporting of demand schedules to the auctioneer that *deviate* from their true demand schedules?

ANSWER OUTLINES FOR Q3:PARTS A-E See attached slides.

QUESTION 4: CREATIVE MODELING [15 Points Total (About 15 Minutes)]

Consider a *Hash-and-Beans (H&B) Market Economy* computationally modeled as a "virtual world" that runs over time periods T=1, 2, ..., ∞. Suppose this economy consists of:

- I hash-producing firms H1,...,HI (hash=fried potatoes!);
- J bean-producing firms B1,...,BJ;
- K consumers C1,...,CK.

In the initial period T=1, each hash and bean firm has a particular wealth level (in dollars). These initial wealth levels are private firm attributes. Also, each consumer in each period T receives a money endowment (in dollars) from an external (unmodeled) source that can be saved or spent. These money endowments are private consumer attributes.

At the beginning of each period T, each hash firm produces a supply of hash at a constant marginal cost and publicly posts a unit price for hash, and each bean firm produces a supply of beans at a constant marginal cost and publicly posts a unit price for beans. The objective of each firm is to attain the highest possible average per-period profits (revenues minus costs) over time.

At the beginning of each period T, after firms post their prices, each consumer engages in a search among firms to purchase hash and beans. The objective of each consumer is to attain the highest possible average per-period utility of consumption over time, subject to the constraint in each period T that its expenditures on hash and beans do not exceed its available money holdings (endowment plus savings).

Task for Question 4:

Suppose you are a consultant to a specific hash firm H1 in the H&B Market Economy, tasked with helping H1 to decide on its production and price level in each successive trading period T = 1, 2,....

In particular, suppose hash firm H1 asks you to develop an agent-based "test bed" (computational model) that H1 can use to experimentally test the profitability of different possible combinations of production and pricing decisions for himself over time. The goal of H1 is to survive (not go broke) and, if possible, to prosper (attain as high an accumulated amount of profits as possible over time).

Using simple flow diagrams and verbal descriptions, briefly outline how you would approach this modeling task.

Your outline will be evaluated on the basis of the following four characteristics: (1) extent to which your proposed approach is consistent with the objective of developing an agent-based test bed for the consulting assignment at hand; (2) originality of thought; (3) plausibility, correctness, and interest of assertions; and (4) clarity of exposition.

Answer Outline for Q4:

Obviously many different types of answers could be submitted for Q4. Given this is a xx-point question, only the outline of a possible approach can be expected.

It is of interest to consider what kinds of considerations would presumably have to go into the development of such a test bed were this an actual real-world consultant project. Key development steps are indicated below.

Clearly, however, each development step would have to be guided and supported by appropriate empirical data in order to achieve a test bed with sufficient operational validity that it can generate useful scenario-conditioned predictions.

Key Development Steps:

- **Specify Basic Model Structure:** Identify the types of agents to be modeled in the test bed and their logical relationships.

  Given the stated purpose for which the test bed is desired, these modeled agents should include (at a minimum): hash firms; bean firms; and consumers. Moreover, the test bed should permit H1 to act under a variety of different production and pricing strategies, and perhaps even to have a variety of different learning methods for selection of these strategies. Also, presumably some (or all) of the remaining firms and the consumers should have at least some intelligence (e.g., like ZI-C traders) so that they avoid engaging in systematically stupid behaviors. Otherwise, it will not be a very useful test bed for H1's purposes!

  Additional types of supporting agents might include:
  - a "world" agent, e.g., for setting clock time, instigating the initial creation and configuration of its constituent agents, and determining "world protocols" (social norms and/or legal rules) for handling things such as bankruptcy of firms and consumers and breaking of contracts;
  - a "market" agent (specifying the basic market form and the specific trade protocols for market participation);
  - "location" agents, such as cells constituting a grid (if a spatial model is to be used with firms and consumers having definite locations at any given time point).

- **Specify Logical Flow of Agent Activities Over Time:** Identify the basic types of agent actions and interactions to be modeled.

For example, different types of market forms (e.g., centralized auction vs. bilateral trading), market protocols (e.g., pricing rules), and learning methods for firms and/or consumers will potentially result in different types of trading interactions (who trades with whom, and how regularly) as well as different patterns of demand bids and supply offers among firms and consumers.

- **Implement Test Bed:**

  Agents that represent institutional and structural features (e.g., world agent, market agent, spatial agent) are passive (non-cognitive) entities. Their attributes will presumbly be either fixed or changing for reasons external to the agent per se (e.g., number of consumers occupying each location).

  However, for the cognitive agents (firms and consumers), at least some of their attributes are going to have to be "state variables" that change over time due to their own actions (e.g., money holdings, memories of past outcomes). Moreover, behavioral methods will be needed to determine demands and supplies under alternative conditions, perhaps with some kind of learning capabilities permitting the agents to change what actions they choose to take in any given situation based on past experiences.

  What makes this test bed seemingly *require* some kind of computer implementation is the complex interactions (feedbacks) that would realistically be expected among the following three types of behaviors of the cognitive entitites over time:

  - the supply offers of firms and the demand bids of consumers in each period T, which collectively results in money outcomes that might render some firms or consumers insolvent and hence unable to participate in any future trades;
  - the particular search methods that consumers use to find suitable firms, and/or the suitable search methods that firms use to find suitable consumers;
  - the production/pricing strategies of the firms, and possibly also their location decisions.

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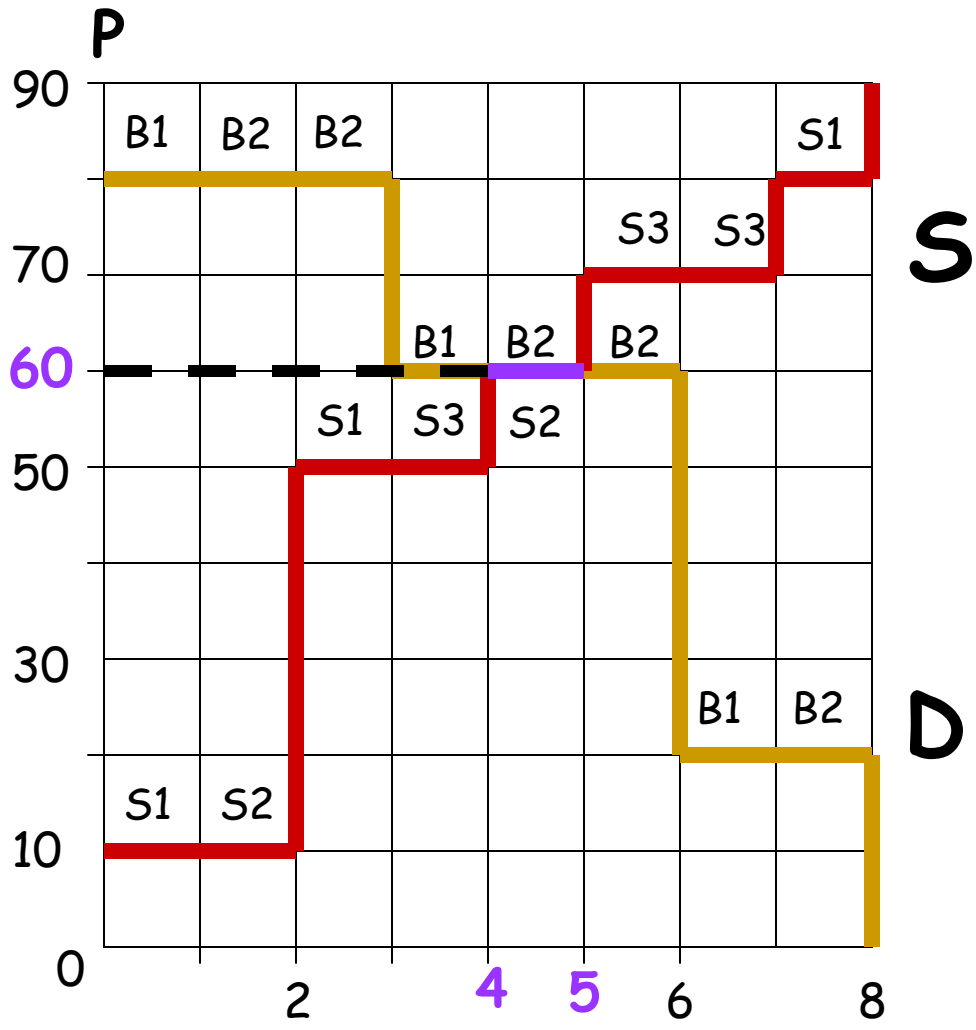
D,S,CMC Points, and Total Net Surplus (A-D)



CMC Point:
P*=$60, 4 ≤Q* ≤5

Total Net Surplus:

S1: [60–10] + [60-50] = 60
S2: [60-10] + [60-60] = 50
S3: [60-50] = 10

B1: [80-60]+[60-60] = 20
B2: [80-60]+[80-60]+[60-60] = 40

Total Net Surplus: $180

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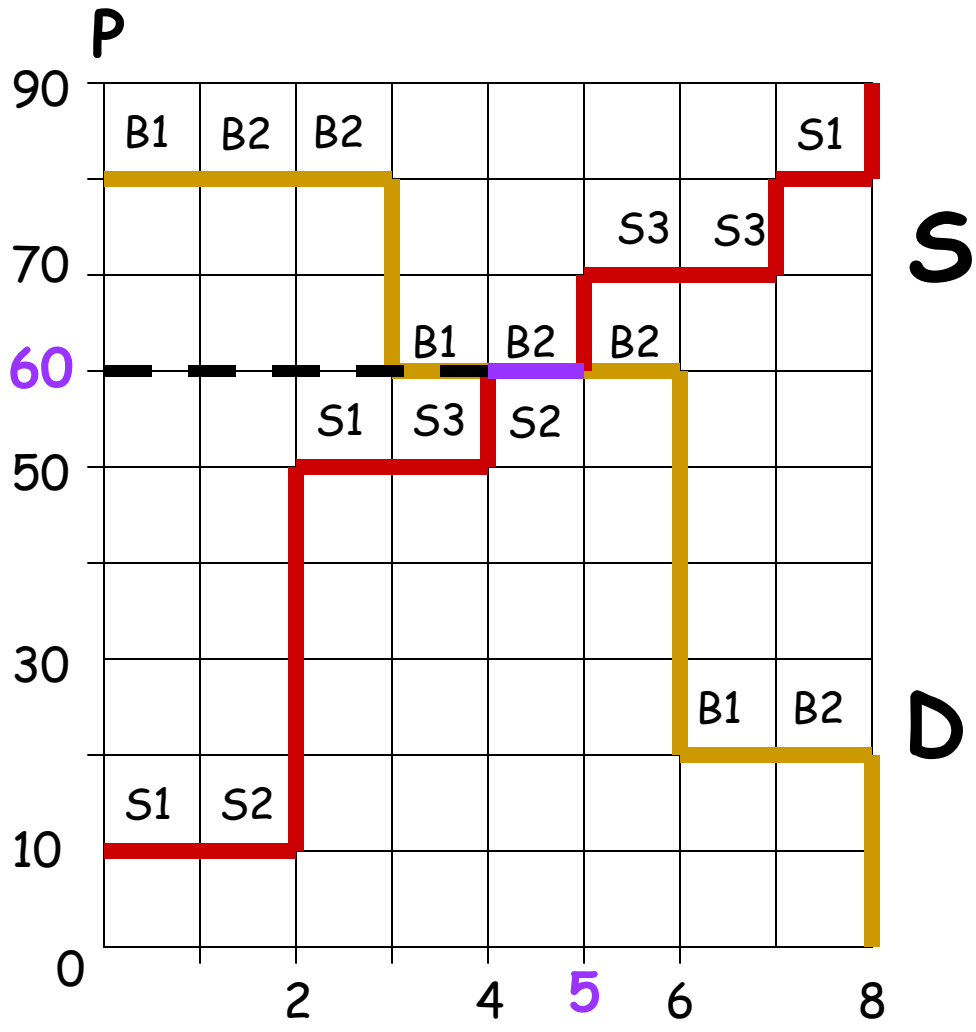
Part E: Strategic Sellers & Market Power



CMC Point for Part E:
P*=$60, Q* = 5

Total Net Surplus:

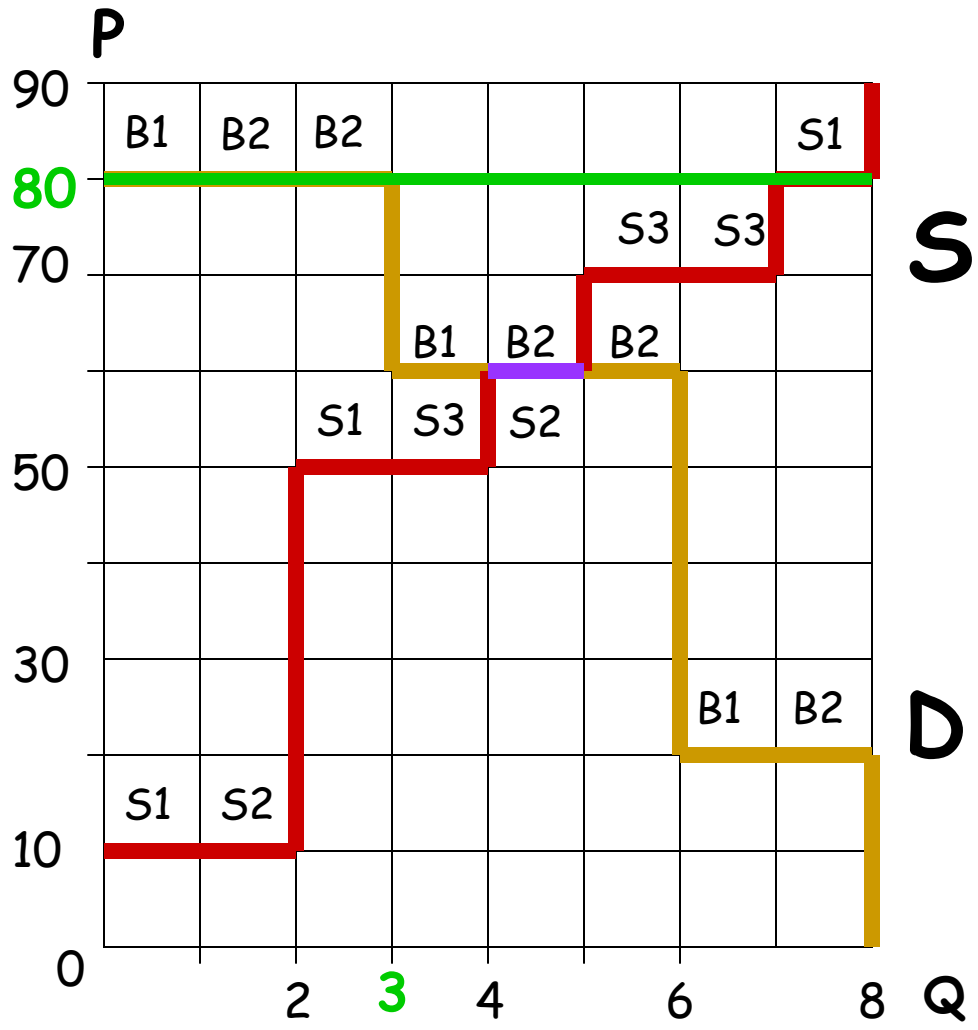
S1: [60–10] + [60-50] = 60
S2: [60-10] + [60-60] = 50
S3: [60-50] = 10

B1: [80-60]+[60-60] = 20
B2: [80-60]+[80-60]+[60-60] = 40

Total Net Surplus: $180

No INDIVIDUAL seller can profit by UNILATERALLY deviating from his true supply schedule.

Suppose all three sellers S1, S2, & S3 collude on $80 (all units)



"CMC" Point: P* = $80, Q* = 3

Total Net Surplus:

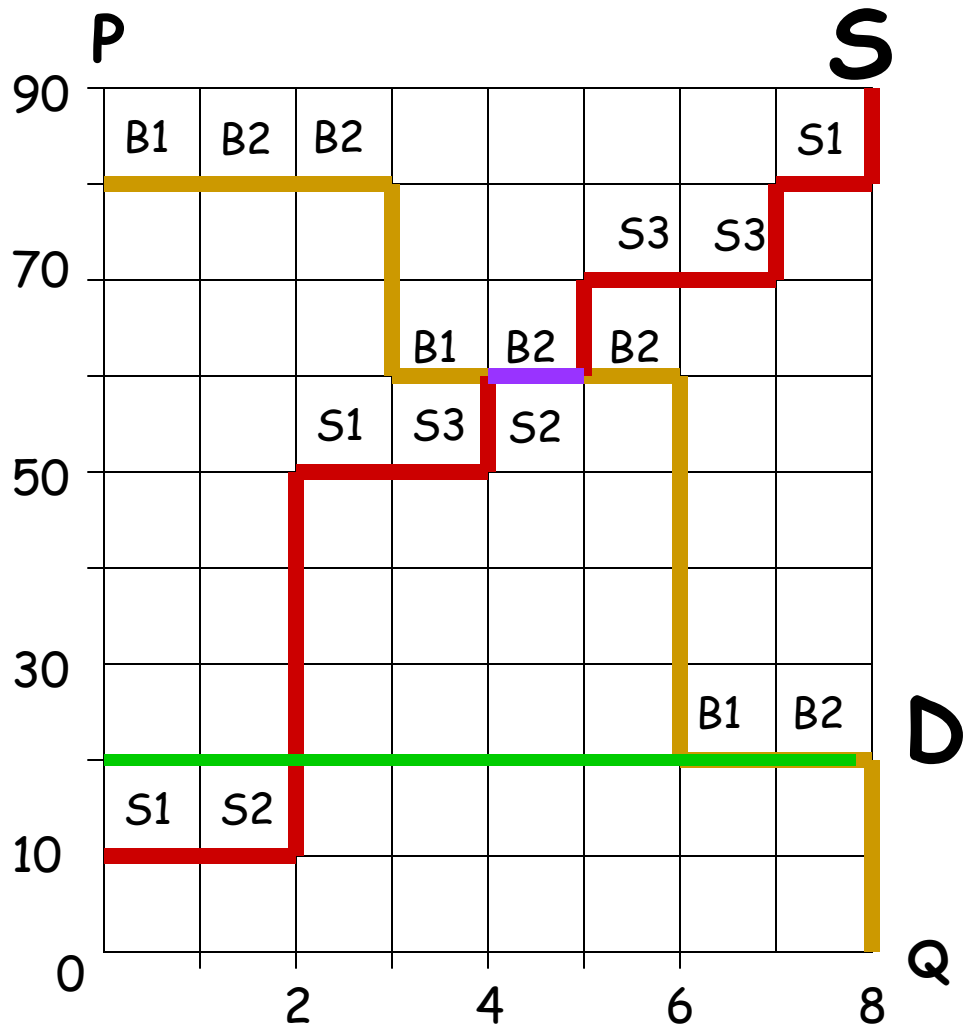
S1: [80–10] + [80-50] = 100
S2: [80-10] = 70
S3: 0 = 0

S3 needs to receive at least 10+ in compensation from S1 and S2, which is feasible and incentive compatible (all sellers better off).

B1: [80-80] = 0
B2: [80-80]+[80-80] = 0

Total Net Surplus: $170

Buyer Retaliation Next Period?



B1,B2 could bid $20 on all of their units.

If Sellers remain firm, they get nothing (no trade). If S1 and S2 "defect" and accept the deal, they get 10 each (and S3 has no power to do anything about it).

If S1 and S2 "defect" and accept, 2 units are sold at $20:

B1: [80-20] = 60
B2: [80-20] = 60

This is better than CMC outcome for both B1 and B2.