Economics 812 Midterm Answer Key
Prof. Bryan Caplan
Spring, 2002

Part 1: True, False, and Explain
(10 points each - 3 for the right answer, and 7 for the explanation)
State whether each of the following nine propositions is true or false. Using 2-3 sentences AND/OR equations, explain your answer.

1. You and a friend both read the same article in the *AER* finding that the minimum wage does not increase unemployment. You both agree that P(article finds minimum wage raises unemployment | the minimum wage really does raise unemployment)=.75, and P(article finds minimum wage raises unemployment | the minimum wage really does not raise unemployment)=.25. But the two of you DISAGREE in your final estimates: your P(minimum wage raises unemployment| article's findings)=.9, while your friend sets the same probability at .45.

True, False, and Explain: Your prior probability that the minimum wage increases unemployment must be exactly double your friend's prior probability that the minimum wage increases unemployment.

FALSE. Let A be "minimum wage raises unemployment" and B be "AER article finds that minimum wage does not raise unemployment." We want to solve for P(A) knowing P(A|B), P(~B|A), and P(~B|~A). P(~B|A)=1-P(B|A), so using Bayes' Law, we can calculate P(A) for me and my friend:

For me: $.9 = \frac{.25P(A)}{.25P(A) + .75(1 - P(A))}$, implying my P(A)=.964

For my friend: $.45 = \frac{.25P(A)}{.25P(A) + .75(1 - P(A))}$, implying my friend's P(A)=.771

By inspection, .964<2*.771.

Most answers treated .75 as P(B|A) instead of P(~B|A). But the text gives you P(article finds minimum wage RAISES unemployment) conditional on various things, but the article in fact facts that the minimum wage does NOT raise unemployment! One sign that this answer is wrong is that it implies that we get *more* confident that the minimum wage causes unemployment after we see conflicting evidence!

Problems 2 and 3 refer to the following information.

60% of all agents in an economy have U=ln x + ln y, and the other 40% have U=2 ln x + ln y. All agents start with 1 unit of x and 1 unit of y.

2. True, False, and Explain: $\frac{p_x}{p_y} < 1.4$.

TRUE. Using the formula from the homework, and adjusting the ratios of agents from 50/50 to 60/40: $\frac{p_x}{p_y} = \frac{60*.5*1+40*2/3*1}{60*.5*1+40*1/3*1} = 1.31 < 1.4$.

3. True, False, and Explain: Agents of the first type will buy approximately .155 units of x.

FALSE. Each agent has total income of 1*1.31+1*1=2.31. Agents of type 1 spend half of their income on x. Their consumption of x therefore equals their total spending divided by the price: 2.31/2/1.31=.882.

4. There are two players in the "Big Brother/Little Brother" game. The players simultaneously decide whether to Read or Play Sports. Player 1 earns a payoff of 10 if he does the SAME thing Player 2 does, and 0 otherwise; Player 2 earns a payoff of 10 if he does the something DIFFERENT than what Player 1 does, and 0 otherwise.

True, False, and Explain: The following normal form accurately represents this game.

	Player 2		
Player 1		Read	Play Sports
	Read	10,0	0,10
	Play Sports	0,10	10,0

TRUE. The left payoff goes to Player 1, the right to Player 2. When they both Read or both Play Sports, the payoffs are therefore 10 to Player 1 and 0 to Player 2. In the two other boxes, the payoffs are reversed.

5. True, False, and Explain: In a game of complete and perfect information, every Nash equilibrium is subgame perfect, and MSNE can never exist.

FALSE. Kreps Figure 12.11(a) shows a game of complete and perfect information with two NE, only one of which is subgame perfect. Every game of complete and perfect information has a SGPNE, but that does NOT mean that every NE is SGP.

MSNE can exist in a game of complete and perfect information if there are tied payoffs.

6. Suppose the Ultimatum Game is played simultaneously rather than sequentially. One player writes down an offer, and the other player writes down

a minimum acceptable offer. Both notes are then opened; if Player 1's offer is greater than or equal to Player 2's minimum acceptable offer, they get Player 1's allocation. Otherwise both players get nothing.

<u>True, False, and Explain:</u> There is only one weakly dominant strategy in this game and one subgame perfection equilibrium, but (assuming players' offers do not have to be whole numbers) an infinity of Nash equilibria.

FALSE. It is indeed weakly dominant for Player 2 to write a minimum acceptable offer of 0, making it strictly dominant for Player 1 to offer 0.

Moreover, it is indeed that case that there are an infinity of NE. If Player 1's offer plus Player 2's minimum acceptable offer add up to the total payoff, you have a NE.

HOWEVER, in a simultaneous game, all of these infinite number of NE are subgame perfect! In a simultaneous move game, there is only one subgame, so all NE are SGP. Intuitively, in the simultaneous game, Player 2 is in just as strong a bargaining position as Player 1. Player 1 can threaten to give a low offer, but Player 2 can just as easily threaten to reject such an offer. In contrast, in the sequential game, Player 1 does not just *threaten* to give a low offer. He *makes* the offer irrevocably, which then leaves Player 2 with a definite choice between something and nothing.

7. Suppose two bargainers infinitely repeat the following game. Their strategy is to always play Soft as long as both players have always played Soft in the past. If one player ever plays Hard, both of them play the MSNE of the game forever afterwards.

		Player 2	
		Hard	Soft
Player 1	Hard	0,0	5,1
	Soft	1,5	4,4

<u>True, False, and Explain:</u> The smallest value of β able to sustain cooperation is .5.

FALSE. To answer this problem, we first need to solve for the MSNE. Let σ be P2's probability of playing Hard. Then P1 is indifferent if $0\sigma+5(1-\sigma)=1\sigma+4(1-\sigma)$, implying $\sigma=.5$. Since payoffs are symmetric, both players play Hard 50% of the time. Thus, players are equally likely to get the (Hard,Hard) payoff of 0, the (Hard,Soft) payoff of 5, the (Soft,Hard) payoff of 1, or the (Soft,Soft) payoff of 4. The expected payoff is thus .25*0+.25*5+.25*1+.25*4=2.5.

Once we know this, we simply solve for the critical β:

$\sum_{t=0}^{\infty} 4\beta^t \geq 5+\sum_{t=1}^{\infty} 2.5\beta^t$. Thus: $\frac{4}{1-\beta} \geq 5+\frac{2.5\beta}{1-\beta}$, implying that $\beta \geq .4$.

8. N firms are trying to form a stable cartel. One of them makes the following suggestion: "Let's set our cartel price somewhat *below* the monopoly level. That way, we'll make lower profits every turn, but the incentive to cheat will also be a lot smaller. Moderate collusion will be easier to sustain than full collusion."

True, False, and Explain: Assuming firms play trigger strategies, this reduces the critical value of β under both Bertrand and Cournot competition.

FALSE. Under Bertrand collusion, it makes no difference. If the cartel price and profits fall, a defecting Bertrand firm slightly undercuts the *reduced* cartel price and thereby steals only the *reduced* cartel profits. The cooperation condition becomes:

$\frac{1}{N}\sum_{t=0}^{\infty}\beta^t \Pi_r \geq \Pi_r$, so the profits still cancel out, leaving the requirement that $\beta \geq \frac{N-1}{N}$.

Under Cournot collusion, however, this strategy could work. If the cartel expands output, the market price falls, and the optimal defection quantity accordingly falls (and falls even more relative to the higher level of output the cartel allows). So defection profits fall relative to a 1/N share of cartel profits, making cooperation more sustainable.

9. Suppose there is costless entry and exit in the lobbying/rent-seeking "industry."

True, False, and Explain: Repeated interaction between lobbyists will neither increase nor reduce the total social cost of rent-seeking.

TRUE. Without entry and exit, repeated interaction could either increase or reduce the total social cost of rent-seeking. However, with costless entry and exit, the rate of return in the lobbying industry has to exactly equal the overall market rate of return. Thus, if lobbyists collude to raise the return to lobbying, they attract new entry until the return falls back to normal. Similarly, if lobbyists push returns below the normal level in an effort to build up a "tough" reputation, firms exist until the return rises back to normal.

Part 2: Short Answer
(20 points each)
In 4-6 sentences AND/OR equations, answer all three of the following questions.

1. Democratic governments are often lobbied to extend monopoly protection to various firms. Carefully analyze and diagram the full Kaldor-Hicks efficiency consequences (allocative, productive, lobbying) of this practice if (a) productive efficiency and lobbying ability are perfectly correlated (i.e., the lowest-cost firm always defeats higher-cost rivals in political battles if they spend the same amount), and (b) productive efficiency and lobbying abilities are imperfectly correlated.

In case (a), there will be allocative and lobbying inefficiency, but no productive inefficiency. That is because the most productively efficient firms wins every time. In contrast, in case (b), there is a probability of productive inefficiency in addition to allocative and lobbying inefficiency, because the higher-cost firm might win the lobbying contest. It is also worth noting that a more productively efficient firm will always be willing to pay more to get a monopoly privilege because the lower your costs, the greater the monopoly profits the privilege enables you to earn. With unequal costs, you will not necessarily see full rent dissipation, especially in case (a). There, the most productively efficient firm only needs to spend an amount greater than the monopoly profits the second most-efficient firm could earn if it won the privilege.

2. Why does Landsburg say that "prices are good"? Carefully explain Landsburg's position. What role do the Welfare Theorems and game theory play in his argument?

Landsburg explains that competition by itself could be good or bad. In general, there is no guarantee that competition leads to socially desirable outcomes. However, when you combine competition, rationality, and market prices, you do have a (limited) guarantee of social optimality. The First Welfare Theorem in particular shows that if rational agents compete subject to market prices, you normally get an efficient outcome. Landsburg uses some game theory examples to illustrate cases where competition and rationality lead to socially suboptimal outcomes.

3. In some graduate economics programs, like the University of Chicago's, the students rarely study cooperatively. In other programs, practically every student belongs to a study group. Some observers attribute this to Chicago's high failure rate and the conditionality of funding on passing first-year exams. Others attribute this to a Chicago "culture." Use game theory to model both of these competing hypotheses. To what extent do your two accounts rely on repeated game considerations?

To model the first hypothesis, I would suggest modeling study group participation as a repeated PD game. Because of the high failure rate, the probability that the game continues is smaller than at other schools. Moreover, because funding depends on passing exams, the temptation payoff if you defect at the last minute (taking your friends' notes right before the big exam and then refusing to share yours) is greater than in other programs. Both of these factors require greater patience to sustain cooperation.

The model the second hypothesis, I would suggest modeling study group participation as a coordination game. If other students join groups, you'd better too. But if no one else is joining, you look like an idiot if you go around trying to form one. Thus, equilibria with and without study groups both exist.

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Spring, 2003

Part 1: True, False, and Explain
(10 points each - 2 for the right answer, and 8 for the explanation)
State whether each of the following nine propositions is true or false. Using 2-3 sentences AND/OR equations, explain your answer.

Problems 1 and 2 refer to the following information.

1. Agents live for two periods. They are endowed with 1 unit of a consumption good in period 1 and 2 units in period 2. The period 1 good spoils if not consumed in period 1. There are two types of agents:

Type A: 25% of the agents have U=ln c_1.

Type B: The other 75% have U=ln c_1 + ln c_2

True, False, and Explain: The general equilibrium interest rate will exceed 200%.

TRUE. This is just the standard two-good general equilibrium model applied to intertemporal trade. Thus, we can use the equation from the notes: $\frac{p_x}{p_y} = \frac{\sum a_i \overline{y_i}}{\sum b_i \overline{x_i}}$. Specifically:

$\frac{p_1}{p_2} = \frac{25*1*2 + 75*.5*2}{25*0*1 + 75*.5*1} = 10/3$. In other words, if you want one more unit of consumption in period 1, you have to give up 10/3 of a unit in period 2. That means that the interest rate is 233%>200%.

2. True, False, and Explain: If the two types of agents did not interact (i.e., there is one island for all of the A's and a different island for all of the B's), the interest rate on A would be positive but the interest rate on B would be negative.

FALSE. The interest rate would be positive on both islands. You do not need to re-do the calculations to answer. The interest rate on A would obviously be infinite because the agents put zero value on period 2 consumption but have positive endowments in that period. But the interest rate on B would also be positive, because the B's value both goods equally but have bigger endowments in period 2. Therefore they would seek to borrow in period 1 until the interest rate got high enough to make them content to consume 1 unit in period 1 and 2 units in period 2.

3. True, False, and Explain: The Ultimatum Game can be solved using strict dominance.

FALSE. It can be solved using *weak* dominance. Always accepting is a weakly dominant strategy for the recipient. But it is not strictly dominant because accepting 0 and rejecting 0 yields the same outcome.

4. Two players play a Prisoners' Dilemma game followed by a Hawk-Dove game. Consider the following candidate equilibrium: Both players Cooperate in the first game. Then in the second game:

- If both players Cooperated in the first game, both play Dove.
- If one player Cooperated in game 1 and the other didn't, the Cooperator plays Hawk in game 2 and the other player plays Dove.
- If neither Cooperated in turn 1, both players play the MSNE in turn 2.

True, False, and Explain: You need to know the exact payoffs to determine whether this is a subgame perfect NE.

FALSE. It is definitely not a SGPNE. Why not? Both players playing Dove on turn 2 is not a NE. One player would want to switch to Hawk. This might however be a SGPNE if (Coop, Coop) in turn 1 led to the MSNE in turn 2. Then it would depend on the exact payoffs.

Questions 5 and 6 refer to the following information.

Suppose that a store decides whether to cheat or not cheat, and a consumer decides whether to investigate the store's reputation, buy without investigating, or not buy without investigating. Intuitively, if the customer investigates, he is never swindled, but always wastes some time. The cost of investigation is $a>0$.

	Investigate	Buy	Don't Buy
Cheat	0, -a	5,-5	0,0
Don't Cheat	3, 3-a	3,3	0,0

5. True, False, and Explain: If a MSNE does not exist, there are two PSNE.

FALSE. If a MSNE does not exist, there is only ONE PSNE: (Cheat, Don't Buy). A MSNE does not exist if Investigate is strictly dominated; i.e., if a>5. Once you are left with the two rightmost columns, it is clear that (Cheat, Buy) is not an equilibrium (the customer would switch to Don't Buy); (Don't Cheat, Buy) is not an equilibrium (the store would switch to Cheat); and (Don't Buy, Don't Cheat) is not an equilibrium (the customer would switch to Buy).

6. True, False, and Explain: If the game is infinitely repeated, the equilibrium (Don't Cheat, Buy) may be sustainable even if a>5.

TRUE. If a>5, it never pays to Investigate. But the customer can still find out about the store's honesty by buying without investigating and seeing what happens. He could then induce honest behavior with trigger strategies, for example. Trigger strategies would work as long as $3/(1-\beta)\geq 5$, where β is the store's discount factor.

7. True, False, and Explain: If firms have heterogeneous costs, the equilibrium in a one-shot Bertrand game will definitely be more allocatively efficient but may be less productively efficient than a one-shot Cournot game.

FALSE. The one-shot Bertrand game is always perfectly productively efficient, because the lowest-cost producer(s) take over the whole market. In Cournot, in contrast, productively inefficient firms may survive. Bertrand games have no allocative inefficiency if the two most efficient firms are equally efficient, but if there is a big gap in costs it is possible that allocative inefficiency will be more severe than in Cournot.

8. True, False, and Explain: Landsburg (*Fair Play*) argues that leaving childbearing decisions to individuals creates a special kind of Prisoners' Dilemma.

TRUE. But unlike anti-population thinkers, Landsburg argues that selfishness leads to too FEW children rather than too many. Families fail to consider the positive externalities their children will have on the world, and those positive externalities almost certainly outweigh any negative externalities.

9. True, False, and Explain: Repeated game theory provides a solid theoretical explanation for the widely-accepted view that collusion is more common than predation.

FALSE. Repeated game theory merely shows that in infinitely-repeated games, both collusion and predation MAY be sustainable. It gives no particular reason to think that one is more sustainable than the other. You need more details to understand why predation is less common than collusion.

Part 2: Short Answer
(20 points each)
In 4-6 sentences AND/OR equations, answer all three of the following questions.

1. "Journalists seem to think that the costs of foreign competition can be measured by the number of Americans who leave their jobs as a result. That's pretty much the opposite of the truth." (Landsburg, *Fair Play*)

Use cost-benefit analysis to defend the journalists' position.

The most obvious possibility Landsburg overlooks is that labor markets don't clear due to downwardly rigid wages. If so, workers may be randomly rationed out of their jobs, and unable to find new ones. The workers who stay will be worse off than those who switch to a new job, but better off than the laid-off.

The journalists might also appeal to positive externalities of work, most obviously those created by the safety net.

2. Explain why the free-entry equilibrium with fixed costs is inefficient in a Cournot game. Is this a realistic prediction? Why or why not? Explain how you would try to break out of this equilibrium if you ran one of the firms.

Take the simplest case where there is a fixed cost and zero MC. Then obviously the cheapest way to make a quantity Q is to have one firm make it all. The social cost is K, versus N*K for the free-entry equilibrium. Assuming a homogenous good, however, this prediction is highly unrealistic. One firm could loudly announce that it is selling for one penny below the price reached by the Cournot auctioneer and steal the whole market. Cournot oligopoly would then break down into contestable monopoly.

3. In any long-term friendship, there are *multiple equilibria, of which only a small fraction are ever played*. Give a good example to illustrate this principle. Building on Kreps' discussion of "Why Might There Be an Obvious Way to Play a Game?" analyze what makes the observed equilibria "special."

There are many ways that friends could pay for joint restaurant meals: even split, Dutch treat, alternating full payment, {you pay for one meal, then I pay for two, then you pay for three...}, and so on ad infinitum. If your friends expected you to go along with any of these practices, you probably would. But in practice, the even split and the Dutch treat are far more common than any other technique. What makes these equilibria "special"? Kreps talks about preplay negotiation, convention, learned behavior, and focal points. Friends rarely negotiate their bill-splitting system in advance. But convention, learned behavior, and focal points all probably play a role. I would guess that focal points are the most crucial: If I ate lunch with a member of an unfamiliar culture, I would still expect him to expect that we would either split the bill or each pay our own ways.

Economics 812 Midterm
Prof. Bryan Caplan
Spring, 2004

Part 1: True, False, and Explain
(10 points each - 2 for the right answer, and 8 for the explanation)
State whether each of the following nine propositions is true or false. Using 2-3 sentences AND/OR equations, explain your answer.

1. Suppose a million new immigrants enter the U.S., driving down the wages of low-skilled Americans by $1/hour.

True, False, and Explain: **According to Landsburg (*Fair Play*), this change usually increases Kaldor-Hicks efficiency, because the positive effect of population growth on innovation tends to outweigh the negative externality of falling wages.**

FALSE. While Landsburg does discuss the R&D externalities of population growth, he explains that falling wages are not an externality at all. It is at worst a transfer from workers to employers, and if there is any demand elasticity the fall leads to additional surplus.

Several students also mentioned that immigration does not necessarily increase world R&D because one country's population must fall for another's to rise. These answers received a couple extra points.

2. Two types of agents consume guns (g) and butter (b). The Type A agents have U=.5 ln g + .5 ln b, and initially own 1 unit of guns and 1 unit of butter. The Type B agents have U=.3 ln g + .7 ln b, and initially own .5 units of guns and .5 units of butter. 10% of the agents are Type A; the other 90% are Type B.

True, False, and Explain: **The price of guns will not equal the price of butter.**

Plugging into the formula $\frac{p_x}{p_y} = \frac{\sum a_i \overline{y_i}}{\sum b_i \overline{x_i}}$ from the notes:

$$\frac{p_x}{p_y} = \frac{10*.5*1+90*.3*.5}{10*.5*1+90*.7*.5} = 18.5/36.5 = .507 \neq 1.$$

3. True, False, and Explain: **If everyone has lexicographic preferences for x over y, the conclusion of the First Welfare Theorem holds even though its assumptions do not.**

TRUE. With lexicographic preferences, no equilibrium price vector exists, since if $p_y>0$ everyone will want to sell all they have, and if $p_y=0$, everyone will want an infinite amount. However, any

distribution of resources will be Pareto efficient, because reallocating y or x between people always leaves one person better off and another person worse off.

4. Consider the following 2-player game:

	Up	Down
Left	0,0	0,0
Right	0,0	0,0

True, False, and Explain: **This game has 4 PSNE but no MSNE.**

FALSE. There are 4 PSNE, but there is also an infinite number of MSNE. Any probability mix leaves your opponent indifferent. (Several students said that there was no reason to randomize, but that misses the whole point of MSNE. If neither play can do strictly do better by changing, you have an equilibrium).

Questions 5 and 6 refer to the following information.

Suppose that two players repeatedly play the following game.

	Hawk	Dove
Hawk	-10,-10	5,0
Dove	0,5	3,3

5. True, False, and Explain: **If the game is repeated infinitely, trigger strategies can sustain the socially optimal outcome as long as β>.6**

FALSE. The socially optimal outcome (social payoffs are maximized) occurs at Dove, Dove. The trigger strategy would be: If you ever play Hawk, I will play Hawk forever afterwards to punish you, and you will play Dove. It is therefore in a player's interest to play Dove if:

$\frac{3}{1-\beta} \geq 5$, which holds as long as $\beta \geq .4$.

Many students assumed that the cheater would lose 10 every turn, but that would require the cheater to play Hawk, which he would definitely not do if he expected his opponent to play Hawk. (Remember – hold all other player's behavior fixed and see if you can do better solely by changing your own behavior!) Student who correctly reasoned from this assumption got 6 points.

A few other students assumed that the MSNE would be the trigger strategy, but punishing by playing Hawk forever is obviously a tougher punishment. If you worked through this approach correctly, you also got 6 points.

6. True, False, and Explain: **If the game is repeated twice, β=1, and players get to flip a coin after turn 1, there is no NE where players play (Dove, Dove) in turn 1.**

FALSE. I propose the following NE. We both play Dove in turn 1. If we keep this agreement, then in turn 2 we play (Dove, Hawk) if the coin said Heads, and (Hawk, Dove) if the coin said Tails. But if player 1 plays Hawk in turn 1, then in turn 2 we play (Dove, Hawk) regardless of the coin toss, and if player 2 plays Hawk in turn 1, then in turn 2 we play (Hawk, Dove) regardless of the coin toss. The payoff from playing this strategy is 3+.5*5=5.5, which exceeds the payoff from cheating, which would be 5+0=5.

Incidentally, you could sustain cooperation even without a coin flip. Just do the MSNE in turn two if both players played Dove in turn 1. But if player 1 plays Hawk in turn 1, then in turn 2 we play (Dove, Hawk), and if player 2 plays Hawk in turn 1, then in turn 2 we play (Hawk, Dove). Since both players play Hawk with p=1/6 in the MSNE, the expected MSNE payoff is once again:

1/36*-10+5/36*5+5/36*0+25/36*3=2.5.

7. Suppose there is a Cournot industry with the demand function Q=a-bP, 8 firms, 0 MC, and no fixed cost.

True, False, and Explain: **A firm would want to split into two firms because it would earn 62% more profit as a result.**

TRUE. From the hw, we know that profits as a function of N equals $\frac{a^2}{(N+1)^2 b}$. So profits for one firm in a industry with 8 firms are $\frac{a^2}{81b}$, while profits for two firms in a industry with 9 firms are $2\frac{a^2}{100b}$. The latter is 62% greater than the former.

8. True, False, and Explain: **Kreps argues that in the "noisy" real world, trigger strategies are not a practical way to sustain collusion. Instead, colluding firms would only punish if prices were significantly below the agreed level.**

FALSE. Kreps specifically states that "you cannot go too far in lessening the severity of punishment, making it of shorter duration, say, or only triggering punishment when prices fall very far. This would encourage each side to chisel somewhat..." (p.526) Intuition: If no small deviations get punished, then everyone will always engage in a small deviation.

9. Suppose firms in an industry have fixed costs and increasing marginal costs. The industry demand curve lies strictly above firms' AC curves.

True, False, and Explain: **Bertrand competition will allow only one firm to survive in this market, implying no productive inefficiency but some allocative inefficiency.**

FALSE. With increasing MC, the AC curve eventually turns up – it will have a U-shape. So if demand is high, multiple firms can definitely survive. Ignoring divisibility problems, it is possible for multiple firms to survive in such an industry, setting P=AC=MC.

Part 2: Short Answer
(20 points each)
In 4-6 sentences AND/OR equations, answer all three of the following questions.

1. "The assumptions of the Arrow-Debreu model are sufficient but not necessary conditions for the efficiency of laissez-faire."

Discuss this statement, using two specific examples from game theory to illustrate your point.

Arrow-Debreu assumes that firms have no control over prices. But in the Bertrand oligopoly game, firms set prices, but can still reach the first-best outcome where P=MC. Similarly, in the Ultimatum game, there are no enforceable trades at all, and yet the game theoretic prediction ($.01 for you, rest for me) is perfectly efficient. In both cases, then, laissez-faire is fully efficient even though the A-D assumptions do not hold.

Other good examples some students used: repeated play (including reputation), coordination games.

2. Use Tullock's insights on rent-seeking to analyze students' allocation of effort between studying and cheating. What changes if students can bribe professors for better grades?

Tullock would predict that students would keep cheating until the rate of return from studying equals the rate of return from cheating. In equilibrium, both methods of earning grades would have to be equally effective. If students can bribe professors, this leads students to cut back on both studying and cheating in favor of cash bribes. On the surface, this seems clearly more efficient. But there is an externality on the value of the diploma. More interestingly, if professors can extract bribes from their students, this will lead to additional competition for academic jobs (like getting a second Ph.D.), presumably with little social benefit.

3. Suppose you have a 2-player version of the voluntary donation game from the notes, with one difference: Each agent cares somewhat about the other, so player one maximizes $U_1=c_1D+.5*c_2D$, and player two maximizes $U_2=c_2D+.5*c_1D$. Carefully set up each player's maximization problem. Then solve for the symmetric Nash equilibrium.

Note that $D=d_1+d_2=2-c_1-c_2$. So player 1 maximizes:

$$U_1=c_1(2-c_1-c_2)+.5*c_2(2-c_1-c_2)=2c_1-c_1^2-1.5c_1c_2+c_2-.5c_2^2$$

And player 2 maximizes: $U_2= 2c_2-c_2^2-1.5c_1c_2+c_1-.5c_1^2$

Differentiating U_1 wrt c_1: $2-2c_1-1.5c_2=0$

Differentiating U_2 wrt c_2: $2-2c_2-1.5c_1=0$

Solving 2 equations in two unknowns implies $c_1=c_2=4/7$. Each player keeps 4/7 for himself and donates 3/7 to the common fund, whereas in the simple model without altruism, each agent keeps 2/3 for himself and donates only 1/3. Altruism partially solves the public goods problem.

Economics 812 Midterm
Prof. Bryan Caplan
Spring, 2005

Part 1: True, False, and Explain
(10 points each - 2 for the right answer, and 8 for the explanation)
State whether each of the following nine propositions is true or false. Using 2-3 sentences AND/OR equations, explain your answer.

1. A special medical test always detects the presence of a disease if a person has it; however, 5% of perfectly healthy people will test positive as well (there is a 5% "false positive" rate). Suppose that .1% of people actually have the disease, and that members of the population are tested *at random*.

True, False, and Explain: The approximate conditional probability of having the disease given the fact that you test positive is 95%. (**Hint:** Remember Bayes Rule!)

FALSE. Applying Bayes' Rule, the P(have disease| you tested positive)=

$$\frac{1*.001}{1*.001+.05*.999}=1.96\%.$$

2. Two types of agents consume guns (g) and butter (b). The Type A agents have U=.5 g + .5 b. The Type B agents have U=.3 g + .7 b. All agents initially own 1 unit of guns and 1 unit of butter. 50% of the agents are type A; 50% are type B.

True, False, and Explain: **General equilibrium does not exist because the agents' demand functions are discontinuous in price.**

FALSE. Since these are linear utility functions, they DO generate demand functions that are discontinuous in price. (E.g., the Type A agents want only guns if $p_g<p_b$, and only butter if $p_b<p_g$). However, this continuity is not a *necessary* condition for GE to exist (rather it is one item on a list of sufficient conditions). In fact, GE exists in this economy if $p_g=p_b$. Then the type Bs sell all of their guns, and the type As are not unwilling to sell all of their butter. In equilibrium, then, the Type As have all the guns and the Type Bs have all of the butter.

Many students used the price formula ratio from the notes, but that only works for log utility!

3. True, False, and Explain: **In a Coordination game, Pareto-inferior equilibria are not subgame perfect.**

FALSE. In the simultaneous Coordination game that we analyzed in class, there is only one subgame, so both of the equilibria are subgame perfect.

It is however true that in a *sequential* version of the Coordination game, the Pareto-inferior equilibria are not subgame perfect. I gave partial credit for students who answered TRUE on this ground.

4. True, False, and Explain: **Landsburg's "Indifference Principle" (*The Armchair Economist*) is inconsistent with the concept of the MSNE.**

FALSE. MSNE is actually a special case of Landsburg's Indifference Principle. The Indifference Principle states that in equilibrium, people will be indifferent between all of their choices. If one were better than the other, everyone would do it. And this is precisely what happens in a MSNE: ever agent is indifferent between every choice.

5. Consider the following 2-player game:

	Up	Down
Left	10,0	10,0
Right	0,10	0,10

True, False, and Explain: **This game has no PSNE and one MSNE.**

FALSE. Since Left is strictly dominant for Player 1, and Up and Down have equal payoffs for Player 2, there are two PSNE: (Left, Up), and (Left, Down). But there are also infinitely many MSNE, where Player 1 plays L with p=1, and Player 2 plays Up with *any* probability.

Questions 6 and 7 refer to the following information.

Suppose that two players play an Ultimatum game where Player 1 divides a payoff of 10 between himself and Player 2. Then the players play the following Hawk-Dove game ONCE. Players do not discount the future (β=1).

	Hawk	Dove
Hawk	-10,-10	5,0
Dove	0,5	3,3

6. True, False, and Explain: **An even split (5/5) in the Ultimatum game is a focal point but cannot be a SGPNE.**

FALSE. It would be a SGPNE given the following strategies: If Player 1 offers an even split or better in turn 1, then in turn 2 they play (Hawk, Dove); otherwise, they play (Dove, Hawk). If Player 1 follows this strategy, he gets 5+5=10. If he deviates and keeps all 10, then he still is not strictly better off, because he gets 0 in turn 2. Player 2 would not want to deviate either; refusing his offer in the Ultimatum game obviously makes him worse off, and deviating from his proposed strategy in turn 2 – holding constant Player 1's action – also makes him worse off. If he plays Dove when he's expected to play Hawk, he loses 2; if he plays Hawk when he's expected to play Dove, he loses 10!

How is this possible? It is possible because the last game (Hawk-Dove) has two equilibria. So you can punish deviation in turn 1 in a self-enforcing way even in the last turn.

7. True, False, and Explain: **If the players play the Hawk-Dove game first, and the Ultimatum game second, exactly two SGPPSNE exist.**

TRUE. In the last turn, it is only subgame perfect for Player 1 to offer 0 and keep 10 for himself, and Player 2 to accept. But there are two PSNE in the first turn: (Dove, Hawk) and (Hawk, Dove). So for the whole game, there are two SGPPSNE: (Dove, Hawk, 0, Accept) and (Hawk, Dove, 0, Accept).

8. True, False, and Explain: **According to Kreps, game theory rules out the possibility that "cheap-talk" can affect games' outcomes.**

FALSE. While Kreps says that "[I]t is typical in the analysis of non-cooperative games to omit such communication from formal models," he immediately adds that "This doesn't mean that these possibilities won't affect the outcome of games; they do so in some important ways in various situations." Most obviously: in Coordination games with Pareto-inferior equilibria.

9. Suppose the demand curve for a contestable monopoly crosses the AC curve at more than one point.

True, False, and Explain: **There are multiple equilibria.**

FALSE. Under contestable monopoly, P=AC, but only the higher quantity/lower price intersection is an equilibrium. At the higher intersection, even a monopolist that DID NOT face potential competition would want to cut price somewhat to earn additional profits. If you do face potential competition, you would have to cut your price all the way down to the lowest intersection of demand and AC to prevent entry.

Part 2: Short Answer
(20 points each)
In 4-6 sentences AND/OR equations, answer all three of the following questions.

1. Suppose:

- 40% of all agents (the Type As) in an economy have U=ln x + ln y, and the other 60% (the Type Bs) have U=3 ln x + ln y.
- All agents start with one unit of x and one unit of y.

How will redistribution of x from As to Bs affect the general equilibrium $\frac{p_x}{p_y}$?

Write down the formula for $\frac{p_x}{p_y}$, using $\bar{x}$ to indicate the quantity of x you let the Type As keep. (**Hint:** Remember hw#2, problem 4!)

In hw#2, problem 4, $\frac{p_x}{p_y} = \frac{50*.5*1+50*2/3*1}{50*.5*\bar{x}+50*1/3*\left(2-\bar{x}\right)} = \frac{7}{\bar{x}+4}$.

The current problem is different in a few ways:

1. The utility function of the Type Bs normalizes to U=.75 ln x + .25 ln y, not U=2/3 ln x + 1/3 ln y.

2. There are 40% As and 60% Bs, not 50/50.

3. As a corollary of 2, taking 1 unit of x from each A does NOT give 1 unit of x to each B! Instead, if the As have $\bar{x}$ each, then the Bs have $(100-40\bar{x})/60 = (5-2\bar{x})/3$ each. Five points off if you did not figure this out.

So the correct formula for $\frac{p_x}{p_y} = \frac{40*.5*1+60*.75*1}{40*.5*\bar{x}+60*.25*\left(5-2\bar{x}\right)/3} = \frac{13}{2\bar{x}+5}$.

2. What kind of a bargainer are you? Why? Explain your typical strategies in game theoretic terms. Are there any focal points that you frequently rely on?

I am usually a soft bargainer, probably because I have greater disutility of conflict than most people. I value my tranquility. But it depends greatly on the bargaining partner. I am an extremely soft bargainer with my kids, because I put a lot of weight on their welfare. I am a hard bargainer with my parents, because I know they put a lot of weight on my welfare. I generally am a hard bargainer with students, in part to maintain a reputation that discourages rent-seeking. One focal point that I often rely on is accepting the other party's FIRST offer without negotiation as long as it's "reasonable." This cuts down on transactions costs, and if people expect me to follow it, they make their first offer a reasonable one.

3. Suppose an Incumbent infinitely repeats the following entry deterrence game. Suppose that in order to have a reputation for Fighting, an Incumbent must be *willing* to accept the (In, Fight) result for **one** turn. (After that turn, he earns the (Out, Fight) payoff forever). Write down the inequality the Incumbent must satisfy to have this reputation. Then solve for the critical value of β.

The Incumbent can have this reputation as long as:

$$-5+\sum_{t=1}^{\infty}10\beta^t \geq \sum_{t=0}^{\infty}4\beta^t$$

$$-5+\frac{10\beta}{1-\beta} \geq \frac{4}{1-\beta}$$

$$\beta \geq .6$$

Economics 812 Midterm Answer Key
Prof. Bryan Caplan
Spring, 2006

Part 1: True, False, and Explain
(10 points each - 2 for the right answer, and 8 for the explanation)
State whether each of the following nine propositions is true or false. Using 2-3 sentences AND/OR equations, explain your answer.

1. Situation A is a Kaldor-Hicks improvement over Situation B. Situation A is Pareto efficient.

True, False, and Explain: **Situation A must also be Kaldor-Hicks efficient.**

FALSE. Just because A is a Kaldor-Hicks improvement over B does not imply that there isn't another situation that would be a Kaldor-Hicks improvement over A. The additional information that A is Pareto efficient is irrelevant, because virtually all situations are Pareto efficient.

2. Suppose 50% of all agents are certain (p=1) that occupation of Iraq will reduce terrorism, and 50% of all agents are certain (p=1) that occupation of Iraq will increase terrorism. A betting market exists where agents can bet on their beliefs.

True, False, and Explain: **A general equilibrium can only exist if the prices of the two bets are equal.**

FALSE. Assuming agents cannot sell short, the price ratio will depend upon the *amount that people are willing to bet*, which in turn depends upon wealth. If the people who believe that the invasion will reduce terrorism are willing on average to bet twice as much as the people who believe the opposite, for example, the betting market will clear when the "reduce" bet pays half as much as the "increase" bet.

In agents can sell short (or, equivalently, just issue notes offering to pay $1 if X happens), there is no equilibrium. Due to their certainty, both sides would happily offer offer an infinite amount of notes that pay off if the other side turns out to be right, so the price ratio would be undefined.

3. True, False, and Explain: **According to Kreps, economic experiments confirm that general equilibrium analysis has little predictive value.**

FALSE. On p.198, Kreps says exactly the opposite: "The results obtained are usually striking in their support of Walrasian equilibrium."

Questions 4 and 5 refer to the following game:

	Left	Right
Left	2,1	0,0
Right	0,0	1,2

4. **This game has a MSNE with expected payoffs equal to (1.5, 1.5).**

FALSE. To make Player 2 indifferent, Player 1 plays L with probability σ:

1σ+0=0+2(1-σ), so σ=2/3

To make Player 1 indifferent, Player 2 plays L with probability φ:

2φ + 0=0 + (1-φ), so φ=1/3

To find expected pay-offs, simply plug the probabilities back into the above equalities: the expected payoffs in equilibrium are (2/3, 2/3). Alternately, you could note that (L,L) happens 2/9 of the time, (R,R) happens 2/9 of the time, and something else happens 5/9 of the time, so expected payoffs for Player 1 are 2/9*2+2/9*1+5/9*0=2/3, and expected payoffs for Player 2 are 2/9*1+2/9*2+5/9*0=2/3.

5. True, False, and Explain: **Played simultaneously, this game has two SGPPSNE. Played sequentially (with Player 1 moving first), this game has two PSNE, but only one is SGP.**

TRUE. The simultaneous game only has one subgame, so both (L,L) and (R,R) are SGPNE. The sequential game still has two PSNE: Player 1 will play L if he believes Player 2 will play L, and R if he believes Player 2 will play R. However, once Player 1 plays L, Player 2 would definitely want to play L too, so by backwards induction, only (L,L) is SGP.

6. Suppose there are two firms able to produce a good. Firm #1 has TC=$1000 + $0Q; Firm #2 has TC=$0 + $10Q.

True, False, and Explain: **If demand goes up high enough, Firm #1 will drop out of the market and Firm #2 will set its price just below Firm #1's AC.**

FALSE. The opposite holds: Firm #2 has lower AC at low quantities, but Firm #1 has lower AC at high quantities. If quantity>100, Firm #1 can charge just below $10 and take the whole market at a profit.

7. True, False, and Explain: **If firms set prices (as opposed to quantities), firms would never want to split into additional firms, even if the game were infinitely repeated and β=1.**

FALSE. If β=1, Bertrand collusion is definitely sustainable, and if each firm gets an equal share of the monopoly profit, then splitting could increase your profits from a 1/N share of the monopoly profit to a 2/(N+1) share, which is greater for N>1.

Firms might also want to split if there are diseconomies of scale, though I gave less credit for this answer since it didn't use the information about repeated play and the discount rate.

8. N players are deciding whether to contribute to a public good. The public good is discrete: it is produced at the optimal level so long as 1 person contributes. Contributing costs the individual who contributes C, and 0 otherwise. If the public good is produced, everyone gets a benefit of B; otherwise they get a benefit of 0. B>C.

True, False, and Explain: **There are two PSNE, only one of which is Kaldor-Hicks efficient.**

FALSE. There are N PSNE, and all of them are Kaldor-Hicks efficient. If no one is contributing, then any one player would want to deviate to contribute; if more than one player is contributing, then any one player would want to deviate to not contribute. The only stable equilibria are those where exactly one player contributes. Since B>C, but 1 contribution is all that is necessary, each of these equilibria is Kaldor-Hicks efficient.

9. In *Leviathan*, Hobbes argues that, in the absence of government, individuals always prefer war to peace, leading to a "war of all against all" equilibrium.

True, False, and Explain: **This precisely what the Hawk/Dove game predicts.**

FALSE. For PSNE, the Hawk-Dove game predicts that you will *never* see universal war; instead, you'll see one aggressor and one appeaser. In the MSNE of the Hawk-Dove game, (War, War) can occur, but it is an unlucky coincidence, not a typical result.

Part 2: Short Answer
(20 points each)

In 4-6 sentences AND/OR equations, answer all three of the following questions.

1. Give an example of lexicographic preferences. How can lexicographic preferences preclude the existence of a general equilibrium? Is it possible for a general equilibrium to exist given the existence of lexicographic preferences? Explain.

I lexicographically preference my sons' lives to money – I wouldn't part with them for any amount of money. Lexicographic preferences can preclude the existence of general equilibrium because if everyone shares the same preferences, they won't sell the lexicographically preferred good to buy more of other goods at any p>0 – but if the price of other goods falls to 0, they want more of these other goods than exist. There are many ways that general equilibrium could co-exist with lexicographic preferences: (1) Some people have these preferences, others don't, and the former buy all of the lexicographically preferred good from the latter; (2) People have different lexicographic preferences; (3) People only have lexicographic preferences up to a certain quantity (e.g. everyone might have a lexicographic preference for one kidney, but not two).

2. Coordination equilibria are often persistent, but they also change. Give a real-world example. Then use game theory to explain how this change happened, paying particularly close attention to the incentives of the "first-movers."

My example: It used to be almost impossible to publish survey research in economics, and as long as no one would publish it, no economist wanted to do it. This is no longer true. The reason is probably that there were some economists who were *burning* to do survey research, so they worked on it even when the chance of publication was low. But once they published some work, this raised the payoff. This led slightly less enthusiastic economists to try survey research, which raised the chance of publication, which led to more survey research... Heterogeneous preferences were the lever that got the survey research ball rolling.

Another class of good answer focused on the importance of market leaders. A market leader thinks that other people will change if he changes too, so he feels safer doing something different. Continuing with my example, many of the economists who started doing survey research – like Alan Blinder – were already famous for other accomplishments. So they could expect people to take them seriously even if they "broke the rules," which helped change the rules.

3. Landsburg (*The Armchair Economist*) argues that laws restricting cosmetic surgery are an inefficient restriction on competition. Using the game theory you have learned so far, present and defend what you see as the strongest possible *counter-argument* to Landsburg's claim. (You don't have to agree with your argument; just present it as forcefully as possible).

You can't just say that cosmetic surgery is a "Prisoners' Dilemma" for women, because efficiency calculations require us to count the value to both women AND men. (Analogously, you can't just say that price supports are efficient because they benefit sellers; you have to show that the gain to sellers outweighs the gain to buyers). Similarly, you can't just say that more cosmetic surgery reduces the supply of non-cosmetic surgery: That's true for all goods. Better answers:

Maybe men value relative beauty, not absolute beauty; they want to marry a woman who is *better*-looking than other women, but don't particularly care how good-looking she is in absolute terms. If so, cosmetic surgery burns up resources without making the average woman OR the average man better off.

Maybe people *directly* disvalue the average level of cosmetic surgery in their society, on the grounds that it "commodifies" or "cheapens" life. But since the average level of cosmetic surgery is non-excludable, no one factors it into his/her decisions, leading to too much cosmetic surgery. This is a common objection to e.g. human cloning.

Economics 812 Midterm
Prof. Bryan Caplan
Spring, 2007

Part 1: True, False, and Explain
(10 points each - 2 for the right answer, and 8 for the explanation)
State whether each of the following nine propositions is true or false. Using 2-3 sentences AND/OR equations, explain your answer.

1. True, False, and Explain: **One *benefit* of the war on drugs that Landsburg's efficiency analysis overlooks is the salaries paid to the extra government employees required to enforce these laws.**

FALSE. The salaries paid are actually a social *cost*, because the government employees could have done something else instead with their time. If the employees' opportunity cost equals their current wage, then their entire salaries are a social cost; if they are paid more than their opportunity cost, then the *difference* between their actual wage and their alternative wage is a transfer, and the remainder is a social cost.

Students who answered false on the grounds that the salaries are a transfer got a little credit, but not much.

2. True, False, and Explain: **Contestable monopoly leads to "second-best" efficient outcomes, whereas Bertrand competition leads to "first-best" efficient outcomes.**

FALSE. If there are zero fixed costs and the most efficient firm faces an equally efficient competitor, *both* yield the first-best efficient outcome of P=MC. If there are fixed costs and the most efficient firm faces an equally efficient competitor, *both* yield the second-best efficient outcome of P=AC. If the most efficient firm does not face an equally efficient competitor, then price can exceed both MC and AC.

3. There are two islands with equal numbers of agents. All agents live for two periods and are endowed with 1 unit of a consumption good in period 1 and 1 unit in period 2. The period 1 good spoils if not consumed in period 1. On the Island #1, agents have $U=\ln c_1$; on Island #2, agents have $U=\ln c_1 + \ln c_2$.

True, False, and Explain: **If trade between islands is possible, the interest rate will exceed 50%. If trade between islands is not possible, the interest rate on Island #1 will exceed the interest rate on Island #2 by less than 100 percentage-points.**

FALSE. With trade, the interest rate will indeed exceed 50%. Using the GE formula:

$\frac{p_{c1}}{p_{c2}} = \frac{1*1+.5*1}{0*1+.5*1} = 3$, an interest rate of 200%. However, with isolated islands, Island #1 will have an infinite interest rate (since no one values c_2), and Island #2 will have a 0% interest rate (since the two goods are equally abundant and equally valued). Thus, Island #1's interest rate infinitely exceeds Island #2's.

Questions 4 and 5 refer to the following game:

	Trust	Doubt
Truth	2,2	0,0
Lie	4,-2	-2,0

4. **This game has two PSNE, plus a MSNE where players play (Truth, Trust) with probabilities (.5,.5).**

FALSE. There are zero PSNE, but the MSNE given is correct. For the PSNE, notice that at (Trust, Truth), Player 1 wants to switch; at (Truth, Doubt) Player 2 wants to switch; at (Trust, Lie) Player 2 wants to switch; and at (Lie, Doubt) Player 1 wants to switch. For the MSNE, similarly:

Player 1 is indifferent when:

$2\sigma+0(1-\sigma)=4\sigma-2(1-\sigma)$, implying $\sigma=.5$.

Player 2 is indifferent when:

$2\varphi-2(1-\varphi)=0$, implying $\varphi=.5$.

5. Suppose both players have a discount rate, $\beta=1$, and play this game twice.

True, False, and Explain: **There is a NE where players play (Truth, Trust) in the first turn, and the MSNE of the one-shot game in the second turn.**

FALSE. Since this is a finitely-repeated game, and there is only one equilibrium in the second game, the only equilibrium is to play the MSNE each turn. After all, if Player 1 switches to Lie in turn 1, how is Player 2 going to punish him?

6. Two players play an Ultimatum game, followed by a Coordination game.

True, False, and Explain: **There are an infinite number of SGPPSNE, some of which have a 50/50 split in the first turn.**

TRUE. As long as one Coordination game has lower payoffs for Player 1, there is a viable threat. Suppose, for example, that:

- $\beta=1$
- in turn 1, the players are splitting 2

- in turn 2 (Left, Left) yields a payoff of (5,5) and (Right, Right) yields a payoff of (3,3) (and of course (Left, Right) and (Right, Left) yield (0,0)).

Then the following is an equilibrium: in turn 1, a 50/50 split; in turn 2, (Left, Left) if Player 1 offered at least 50/50 in turn 1, and (Right, Right) otherwise. If player 1 offers 100/0 instead of 50/50, he gains 1 in turn 1, but loses 2 in turn 2.

Now notice that since payoffs are continuous, this is just one out of an infinite number of equilibria. The above approach could also sustain 50.01/49.99, 50.02/49.98, etc.

7. Suppose there are two firms able to produce a good. Firm #1 has TC=$50 + $0Q; Firm #2 has TC=$0 + $10Q. The demand curve is given by Q=20-P.

True, False, and Explain: **Firm #1 will drop out of the market and Firm #2 will charge the monopoly price.**

FALSE. By producing 10.01 units and charging $9.99, Firm #1 can make a profit of 10.01*$9.99-$50, or approximately $50. But Firm #2 loses money at this price, so it will drop out of the market. Intuitively, since Firm #1 has fixed costs but no marginal costs, and Firm #2 has marginal costs but no fixed costs, the thing to check is whether Firm #1 remains profitable at a price just below Firm #2's MC.

8. Suppose two Bertrand competitors collude in an infinitely-repeated game, but the first firm insists on getting the "lion's share" of the profits. The first firm gets 90% of the monopoly profits. The second firm gets the remaining 10%.

True, False, and Explain: **This is a NE as long as β≥.1 for both firms.**

FALSE. The first firm will not defect as long as $\sum_{t=0}^{\infty}.9\beta^t\Pi_m \geq \Pi_m$, so its β≥.1. But the second firm will defect unless: $\sum_{t=0}^{\infty}.1\beta^t\Pi_m \geq \Pi_m$, so its β≥.9.

9. Satellite television has enormous fixed costs, but near-zero marginal costs. Suppose the current market structure, where two firms (Dish Network and Direct TV) supply satellite television, was the outcome of Cournot competition with free entry. Suppose further that no *additional* entry is legally allowed.

True, False, and Explain: **A merger to monopoly will increase productive efficiency, hurt allocative efficiency, and decrease overall efficiency.**

FALSE. The merger will increase productive efficiency by halving fixed costs. (Students who explicitly claimed that all costs were sunk got full credit, though that's got to be incorrect – there are lots of alternative uses for satellites, and they eventually have to be replaced). And in the Cournot model, going from 2 firms to 1 reduces allocative efficiency. However, the *net* efficiency effect is ambiguous, because we do not know the relative sizes of the two effects.

<u>Part 2:</u> Short Answer
(20 points each)
In 4-6 sentences AND/OR equations, answer all three of the following questions.

1. "As with other fundamentals of action, doubts about probability are self-refuting." (Caplan, "Probability, Common Sense, and Realism.") Carefully explain Caplan's argument. Is he right?

Caplan claims that arguing against probability is self-refuting because (a) people argue against it in order to change others' minds, even though (b) they know that arguing against probability does not always work. As he states in his article:

> One cannot even argue against probability theory without implicitly holding some belief about the probability that doing so will change listeners' minds. Few Misesians would be naive enough to imagine that attacking probability theory *has* to reduce its number of adherents. Rather, they attack probability theory because, given their beliefs about the probability of changing people's minds, they see it as the most valuable way to use their time. Any attack on probability presupposes it.

The best objection a student offered is that people might argue just for the fun of it, even though they don't believe that they have any chance of persuading anyone. I would reply that, even in this case, they must assign some probability to the view "Arguing against probability will be fun."

2. N players are deciding whether to contribute to a public good. The public good is discrete: it is produced at the optimal level so long as one person contributes. If the public good is produced, everyone gets a benefit of 3 if they didn't contribute, and 2 if they did. If no one contributes, everyone gets 0. Find the MSNE. When is the MSNE Kaldor-Hicks efficient?

(<u>Hint:</u> If *p* is the probability that one player contributes, the probability that *no other player* contributes equals $(1-p)^{N-1}$, and the probability that *at least one other player* contributes is $1-(1-p)^{N-1}$).

If you contribute, then you get (3-1)=2 for sure. If you don't contribute, you get 3 if at least one other player contributed, and 0 otherwise. Therefore, by symmetry, each player is indifferent if:

$2=0*(1-p)^{N-1}+3*(1-(1-p)^{N-1})$

This implies indifference when $(1-p)^{N-1}=1/3$, implying that $p=1-\sqrt[N-1]{1/3}$.

The MSNE is efficient in all cases where one and only one player contributes.

Students who correctly solved the 2-player version got substantial partial credit.

3. Throughout history, the usual system has been for heads of state (such as kings) to serve for life. In modern times, however, heads of state often leave office voluntarily long before their deaths. Using all of the game theory you have learned, provide the best possible explanation for *both* of these patterns. Why has there been a transition from one pattern to the other?

Here is one possible answer:

Historically and today, the system of government succession is a Coordination game with culturally determined focal points. When people expect leaders to serve for life, remaining in office provokes little negative reaction. Stepping down, in contrast, signals weakness and confusion - which invite attack. However, when people *expect* leaders to step down after their term expires, a leader who refuses to leave office seems power-hungry or crazy, which typically provokes negative responses from other leaders and the population. In contrast, stepping down when people expect it is not a sign of weakness or confusion, so leaders aren't scared to do so. The bottom line is that it is usual safest for leaders to do what people expect, and dangerous to do the opposite.

Why did this transition occur? My short answer is that revolutions and elite ideological change in favor of democracy gradually changed cultural expectations. If you built a skyscraper in NYC that was twice the size of the Empire State Building, the focal meeting place in NYC might change. Similarly, after a democratic revolution, or after decades intellectual activism for democracy, the focal political system in a society might change.

Economics 812 Midterm
Prof. Bryan Caplan
Spring, 2008

Part 1: True, False, and Explain
(10 points each - 2 for the right answer, and 8 for the explanation)
State whether each of the following nine propositions is true or false. Using 2-3 sentences AND/OR equations, explain your answer.

1. Suppose your P(more abortions cause less crime)=.4, P(Levitt's research results | more abortions cause less crime)=.6, and P(more abortions cause less crime | Levitt's research results)=.8.

True, False, and Explain: **If you satisfy Bayes' Rule, your P(Levitt's research results | more abortions *don't* cause less crime) must be .1.**

TRUE. Let A=more abortions cause less crime, and B=Levitt's research results, then apply Bayes' Rule and solve for P(B|~A):

.8=.6*.4/(.6*.4+P(B|~A)*.6)

.8=.24/(.24+P(B|~A)*.6)

so P(B|~A)=.1.

2. True, False, and Explain: **If a state of affairs is Pareto efficient, then deadweight costs must be zero.**

FALSE. If a state of affairs is K-H efficient, then deadweight costs must be zero. But Pareto efficiency does not imply K-H efficiency; in fact, most Pareto efficient situations are *not* K-H efficient. Monopoly is a classic example: There are deadweight costs, but there is no feasible way to get rid of the deadweight costs without making the monopolist worse off.

3. Suppose you have a betting market where half the participants are certain that Clinton will win the Democratic nomination, and the other half are certain that Obama will win.

True, False, and Explain: **A general equilibrium will not exist.**

TRUE. If both sides are certain, they are willing to bet an infinite amount, and put zero value on claims that pay off if the other side is right. (This is basically a problem of lexicographic preferences). *However*, if short sales are not allowed, then the most each side can bet is their total assets. If so, a general equilibrium will exist equal to the ratio of the amount each side bets. (I gave full credit for FALSE if they discussed both possibilities).

4. Suppose a pirate robs ten people and puts all of their money inside a treasure chest. When the police recover the chest (and before the pirate can spend a penny), they ask each of the ten victims to state how much money he lost. To discourage lying, the police announce that if the total losses claimed by the victims exceeds the total amount of money in the chest, none of the victims will get any money back.

True, False, and Explain: **There is a unique NE in which every victim says the truth.**

FALSE. Truth-telling is *one* NE, and probably a focal NE. But there are infinitely many NE: Any set of claims that sums to the total amount of money qualifies.

5. Suppose that two players play this PD game, followed by this Coordination game.

	Don't	Defect
Don't	3,3	0,4
Defect	4,0	2,2

	L	R
L	5,5	0,0
R	0,0	5,5

True, False, and Explain: **If ß=.5, the only SGPNE are (Defect, Defect), (L,L) and (Defect, Defect), (R, R).**

FALSE. Since both (L,L) and (R,R) pay the same, it might seem like punishment is impossible in turn 2. However, this ignores the MSNE, which has an expected payoffs of (2.5, 2.5). If players threaten to play the MSNE in turn 2 if someone plays Defect in turn 1, we have a NE as long as:

$3+5\beta \geq 4+2.5\beta$. So if $\beta=.5$, we have $5.5 \geq 5.25$, implying a NE.

6. "If your rival(s) suspect that you are not rational, or even if they suspect that you suspect that they suspect that you aren't rational, then the 'rational' actions for you can be quite different than if you ignore this possibility." (Kreps, *A Course in Microeconomic Theory*)

True, False, and Explain: **This point explains why threatening to fail students for leaving early does not work in the real world.**

FALSE. Kreps' point explains why threatening to fail students *could* work! If everyone knows everyone is fully rational, there is no point threatening to fail students because no one believes you will do it. But if you suspect that someone is irrational, or suspect that someone suspects that you are irrational, a "crazy" threat just might work.

7. Suppose that two firms flip a coin, then play a contestable monopoly game with *sunk* costs.

True, False, and Explain: **The coin flip allows the firms to raise their expected profits, even though the set of equilibria in the contestable monopoly game does not change.**

TRUE. With or without the coin flip, this game has a MSNE where expected profits are zero, and two PSNE where one firm earns monopoly profits and the other earns nothing. However, if firms play simultaneously, neither of the PSNE is focal. Flipping the coin creates a focal point: If the coin says heads, then firm 1 plays In and firm 2 plays out; if the coin says tails, the reverse happens. This doesn't change the set of equilibria, but it does make it easier for firms to reach the profitable equilibria.

8. True, False, and Explain: **In a market with perfectly selfish consumers and producers, the existence of a public good implies both allocative and productive inefficiency.**

FALSE. A public good implies that market output is roughly zero, so there will be no productive inefficiency. However, there will be massive allocative efficiency – all the area between the SB curve and the cost curve disappears. When a good is not produced at all, the effective price is infinite, so P>>MC.

9. Suppose that two firms compete in a market with linear demand and zero costs.

True, False, and Explain: **Collusion is easier to sustain in the Cournot model than it is in the Bertrand model.**

FALSE. From the notes, Bertrand collusion is feasible as long as $\beta \geq .5$, but Cournot collusion is feasible as long as $\beta \geq .53$. This means that greater patience is necessary to sustain Cournot collusion.

<u>Part 2:</u> Short Answer
(20 points each)
In 4-6 sentences AND/OR equations, answer all three of the following questions.

1. Suppose country A has 1000 skilled workers and 1000 unskilled workers, and country B has 0 skilled workers and 10,000 unskilled workers. Both countries initially prohibit all immigration. Build on the Second Welfare Theorem to propose a Pareto-improving policy reform.

The K-H efficient outcome requires free migration, so skilled workers can move to country B, and unskilled workers can move to country A. However, unskilled workers in country A are likely to suffer massive wage declines as a result of this move. Fortunately, this is a very simply economy, so it is not difficult to create Pareto improvements using redistribution as the Second Welfare Theorem suggests. The simplest solution would be to charge unskilled workers from B an entry fee and skilled workers from A an exit fee, and give the revenue to unskilled workers from A.

2. Why does popcorn cost more at movies – and how is this possible in a market with free entry? If you give an answer that Landsburg rejects, you must explain why he is wrong to reject your answer.

Landsburg ignores a simple possibility: Popcorn prices are high due to price discrimination, which is entirely possible because the market for movie theaters – like most retail! – is *imperfectly* competitive. There are only a few movie theaters in a given area, and even these are imperfect substitutes. They can charge P>MC and/or price discriminate because – due to fixed costs – existing firms are just breaking even, and new entrants are likely to actually lose money.

3. Suppose two strangers meet on a desert island. Is mutual warfare a NE? A likely NE? A unique NE? Use all of the game theory you have learned – and common sense – to answer the question.

Since the question says "common sense," I'm going to tell you what I think is really going on – not just repeat a model from class. Here goes: Unless there are big differences in fighting ability between the two people, or only enough food for one person, mutual *peace* is probably the unique NE. If both people play peace, they probably more than double their total output, and gain a friend as well. If either person plays war, both lose these benefits, and risk severe injury even if they win the fight. Realistically, if one person is stuck on an island, and another washes up on shore, the first person doesn't start sharpening his spear. Instead, he rushes to help out the new arrival, because he reasonably expects him to become a great ally.

Economics 812 Midterm
Prof. Bryan Caplan
Spring, 2009

Part 1: True, False, and Explain
(10 points each - 2 for the right answer, and 8 for the explanation)
State whether each of the following nine propositions is true or false. Using 2-3 sentences AND/OR equations, explain your answer.

1. True, False, and Explain: **In practice, *ex ante* Pareto efficiency is equivalent to Kaldor-Hicks efficiency, because in the long-run, the benefits of allowing uncompensated Kaldor-Hicks improvements more than cancel out the losses.**

FALSE. While many, perhaps most, people will be ex ante better off if you allow uncompensated K-H improvements, in the real world it is still extremely unlikely that *everyone* will be better off. As I said in the notes, "someone somewhere is sure to slip through the cracks." As a result, the ex ante Pareto efficiency standard, unlike the Kaldor-Hicks efficiency standard, ends up approving of every status quo.

Problems 2 and 3 refer to the following information.

2. Agents live for two periods. They are endowed with 1 unit of a consumption good in period 1 and 2 units in period 2. The period 1 good spoils if not consumed in period 1. There are two types of agents:

Type A: 10% of the agents have $U=\ln c_2$.

Type B: The other 90% have $U=\ln c_1 + \ln c_2$

True, False, and Explain: **The general equilibrium interest rate will exceed 200%.**

FALSE. Normalize the two utility functions, then apply the formula from the notes to get
$\frac{p_x}{p_y} = \frac{\sum a_i \overline{y_i}}{\sum b_i \overline{x_i}} = \frac{10*0*2+90*.5*2}{10*1*1+90*.5*1} = 90/55 = 1.64$, implying a 64% interest rate.

3. True, False, and Explain: **If the two types of agents do not interact (i.e., there is one island for all of the A's and a different island for all of the B's), the interest rate on A will be positive but the interest rate on B will be negative.**

FALSE. Applying the formula from the notes, we see that on the type A's island:

$\frac{p_x}{p_y} = \frac{\sum a_i \overline{y_i}}{\sum b_i \overline{x_i}} = \frac{0*2}{1*1} = 0$, implying a -100% interest rate (not, as many people said, negative infinity!). Intuitively, on the island where no one values consumption in period 1, lending in period 1 consumption buys you nothing in period 2.

Similarly, on the type B's island:

$\frac{p_x}{p_y} = \frac{\sum a_i \overline{y_i}}{\sum b_i \overline{x_i}} = \frac{.5*2}{.5*1} = 2$, implying a 100% interest rate. Intuitively, the type B's value both kinds of consumption equally, but have a larger endowment in period 2, so they try to borrow against their higher future earnings.

4. Consider the following normal form:

	Left	Right
Left	2,2	0,0
Right	0,0	0,0

True, False, and Explain: **This game has one PSNE and one MSNE, but it can be solved through weak dominance.**

FALSE. The game has two PSNE: (Left, Left), and (Right, Right). It has no MSNE – if you try to solve for one, you just get "play Right" with 100% probability for both players. The game can however be solved through weak dominance: Left is sometimes better the Right, and never worse.

Problems 5 and 6 refer to the following information.

Kreps imagines a monopolist's monologue:

> Out there are many people who would enter this industry and take away my profits if they thought they that they could themselves make a profit... My choice of an output level of 5 may look silly in the short run, but if it keeps you (and other potential entrants) out of my market, it is a good strategy to employ.

5. True, False, and Explain: **Kreps' monopolist engages in "limit pricing."**

FALSE. The notes explain that "limit pricing" is when the lowest-cost firm sets its price just below the costs of the second-lowest-cost firm. In Kreps' example, in contrast, firms have equal costs. What Kreps' monopolist is trying to do is take advantage of its *first-mover advantage* to make output so high that an entrant would be unable to cover its costs.

6. Kreps adds, "Now rather a lot is wrong with the story just told..."

True, False, and Explain: **The monopolist's story might be OK in a repeated game IF there are also sunk costs.**

FALSE. The monopolist's story can work with repeated play OR sunk costs; either one is enough. With repeated play, a monopolist might endure losses in the hope of deterring future entry. With sunk costs, the monopolist's first-mover advantage would be stronger – once it locks in its quantity, the entrant would know for sure that it would lose money (rather than convincing the monopolist to reduce its output to accommodate the entrant).

7. Suppose two players play the following normal form *N* times. *N* is finite and known by both players.

	Left	Right
Left	5,1	0,0
Right	0,0	1,5

True, False, and Explain: **Alternating back and forth between (L,L) and (R,R) is an equilibrium as long as *N* is <u>even</u> and β≥5/6.**

FALSE. This is an equilibrium for all *N* and all β. Whenever a firm defects from it, it gets 0 instead of 1 or 5, so there's never any point in deviating.

8. Consider a Cournot model with two firms. P=10-Q, and MC=0.

True, False, and Explain: **If one firm moves first, the unique SGPNE has a higher Q than it does with simultaneous play.**

TRUE. Applying subgame perfection, let's start with the second mover. It maximizes:

$Pq_2 = (10 - q_1 - q_2)q_2$, implying:

$10 - q_1 - 2q_2 = 0$, so $q_2 = \frac{10 - q_1}{2}$

In a SGPNE, the first mover takes the second-mover's reaction function into account. This means that it substitute's firm 2's reaction function into it's own profit function *before* taking the derivative:

$Pq_1 = (10 - q_1 - \left[\frac{10 - q_1}{2}\right])q_1$. This simplifies to:

$(\frac{10 - q_1}{2})q_1$. Maximizing wrt q_1 gives us:

$5 - q_1 = 0$, so $q_1 = 5$. Now plug into firm 2's reaction function to get: $q_2 = \frac{10 - 5}{2} = 5/2$.

$Q = q_1 + q_2 = 7.5$. Since Cournot output is: $Q = \frac{aN}{b(N+1)} = 20/3 < 7.5$, output rises.

BTW, you may already be familiar with this problem as the "Stackelberg model."

9. True, False, and Explain: **The War/Peace game confirms the view that the invention of atomic weapons reduced the risks of war and human extinction.**

FALSE. In the MSNE, the probability of playing War falls as the (War, War) payoff gets more negative; and since the probability that (War, War) happens is that $[P(War)]^2$, the risk of war goes down. However, the probability of human extinction still probably goes up – nukes make war less likely, but much more devastating if it does happen.

Part 2: Short Answer
(20 points each)

In 4-6 sentences AND/OR equations, answer all three of the following questions.

1. People occasionally argue that Western consumers are virtually "satiated" – before long, they will have everything they want. Assume this claim is correct, and that labor productivity continues to improve. Describe the general equilibrium consequences for output, employment, wages, and real interest rates. Carefully explain your reasoning.

What happens:

Output: Output continues to rise *slightly* as labor productivity keeps going up, approaching but never reaching the satiation level. If output hit satiation, people would stop working; but otherwise the tendency of greater productivity to raise output remains.

Employment and wages: Increasing labor productivity raises labor demand, and as workers approach satiation, their labor supply curve starts to bend backwards. The result: Wages go up, but employment declines as satiated high-wage workers switch from labor to leisure.

Real Interest Rates: As the intertemporal GE consumption model at the end of the Week 2 notes explains, positive time preference ($\beta<1$) and growing income ($g>0$) guarantee a positive real interest rate. Since the question says, "Labor productivity *continues* to improve," there is no reason to say that real interest rates rise; all we can say is that they remain positive.

Note: The question says "*virtually* satiated," not "completely satiated"; furthermore, nothing in the question suggests that consumers would remain satiated if there were a drastic fall in output. It is incorrect, then, to claim that output and employment would fall to zero. Even if this were so, though, wages would still go up, because in GE workers earn their marginal product.

Furthermore, no matter what happens to output, there's no reason to think that real interest rates would *fall*. If labor productivity is rising, workers who feel almost satiated today should expect to feel *even more* satiated next year, so interest rates would still be positive!

2. People (including economists) often think that monopolies are productively inefficient. Why, on reflection, would this be strange? What additional assumptions do you need to make the "inefficient monopolies" story internally consistent?

It would be strange for monopolies to be productively inefficient because *regardless of how little competition a firm faces*, higher costs imply lower profits. Even a monopoly totally protected by the government should still want to minimize costs; otherwise it's just leaving money on the table. (Many students mentioned potential competition, but that misses this much more fundamental point).

Two good stories about productively inefficient monopoly:

a. Firms have a range of levels of productive efficiency, and the government decides to legally protect a firm that is NOT the most efficient. This could be because the firm best at lobbying the government for help is not the best at actually producing the product.

b. The firm is a monopoly with regulated profits. This gives it an incentive to eliminate the "excess" profits by letting costs rise, rather than cutting prices. Remember the "gold-plating effect"?

3. If Landsburg's "People Wanted," (*Fair Play*) is correct, does Kaldor-Hicks efficiency require the long-run *maximization* of population? Carefully explain your answer, staying as close as possible to Landsburg's descriptive claims about the economic consequences of population growth.

Kaldor-Hicks efficiency does NOT require population maximization. Landsburg points to important positive externalities of child creation. However, positive externalities of X do not imply the efficiency of maximizing X! (By analogy, the negative externalities of pollution do not imply the efficiency of a total ban).

In the *absence of natalist subsidies*, Landsburg thinks that every child is more than worth its social cost (except, he notes, for criminals, welfare recipients, etc.) In his view:

Benefit to Society > Benefit to the Family $\geq$ Cost to the Family $\approx$ Cost to Society

As you pile on the subsidies, though, the marginal cost to families of caring for more children go up. Eventually you reach the point where the cost to the family of creating another person exceed the benefit to society. There's no reason to think this point is equivalent to "long-run maximum population."

You could also argue that eventually population has negative externalities – not "resource depletion" (as Landsburg explains, that's doesn't count), but on e.g. air pollution, congestion, or other uncharged impositions upon your fellow man.

The conclusion that K-H efficiency does not imply population maximization is clearly true if you don't count unconceived people's "willingness to pay to be conceived." Even if you did, though, K-H still might not imply population maximization. Consider: If you already felt completely exhausted taking care of 9 kids, the 10th kid might have to pay you more than his discounted lifetime earnings to induce you to have him, so the cost of his conception exceeds the benefit.

Economics 812 Midterm
Prof. Bryan Caplan
Spring, 2010

Part 1: True, False, and Explain
(10 points each - 2 for the right answer, and 8 for the explanation)
State whether each of the following nine propositions is true or false. Using 2-3 sentences AND/OR equations, explain your answer.

1. True, False, and Explain: **Landsburg's Indifference Principle undermines the standard efficiency rationale for taxing negative externalities.**

FALSE. The Indifference Principle implies that taxes on e.g. air pollution raise rents, leaving tenants no better off. However, the owners of fixed resources *are* better off by an amount equal to the increase in rent! In other words, the Indifference Principle has implications for *who* benefits from taxes on negative externalities, not *whether* these taxes have benefits.

2. Two types of agents consume guns (g) and butter (b). The Type A agents have U=.5 ln g + .5 ln b, and initially own 10 units of guns and 10 units of butter. The Type B agents have U=.3 ln g + .7 ln b, and initially own *nothing*. 10% of the agents are Type A; the other 90% are Type B.

True, False, and Explain: **The equilibrium price of guns will equal the equilibrium price of butter.**

Using the formula from the notes:

$$\frac{p_g}{p_b} = \frac{10*.5*10 + 90*.3*0}{10*.5*10 + 90*.7*0} = 1.$$

But there's no need to use the formula. Since the Type B agents have nothing to sell, they're irrelevant to the market. And since the Type A agents have equal endowments of both goods and value both goods equally, the price ratio has to be 1:1. (To get full credit, you had to note these facts).

3. True, False, and Explain: **In an Ultimatum game, a 50/50 split is the only SGPPSNE; in a Dictator game, a 100/0 split is the only SGPPSNE.**

FALSE. In an Ultimatum game, a 100-ε/ε split is the only SGPPSNE; as long as the giver offers more than 0, the receiver has an incentive to accept, so the giver offers as little as possible. (There are an infinite number of PSNE, but only one is SGP). In the Dictator game, a 100/0 split is the only SGPPSNE, because there's no reason for the giver to share anything.

4. Landsburg says that the "obvious" explanation for why popcorn costs more at movies is wrong.

True, False, and Explain: **The problem with "obvious" explanation, according to Landsburg, is that even the simplest monopoly problem has multiple NE.**

FALSE. The "obvious" explanation, according to Landsburg, is monopoly. But under normal assumptions, a monopolist would want to charge a high ticket price, then sell *everything else* (popcorn, bathroom privileges, etc.) at MC.

5. Suppose you have the following Hawk/Dove game. Players do not discount the future. In the one shot game, the two players flip a coin to decide who plays Hawk and who plays Dove.

		Player 2	
		Hawk	Dove
Player 1	Hawk	-100,-100	5,1
	Dove	1,5	4,4

True, False, and Explain: **If they play this game *twice*, the players <u>can</u> both on average earn more per turn than they would in the one-shot game.**

TRUE. The players could agree to play Dove, Dove on turn 1. Then, if either played Hawk in turn 1, the *other* player would play Hawk in turn 2. If both cooperate (or both defect) in turn 1, they would flip a coin to decide who plays Hawk and who plays Dove in turn 2. The result: Players get [4+(.5*5+.5*1)]/2=3.5 per turn instead of 2*(.5*5+.5*1)/2=3 per turn.

6. Suppose the government gives one car manufacturer a monopoly privilege. The lobbying process leads to full rent dissipation. Each firm has the same constant marginal cost of production, and demand is linear.

True, False, and Explain: **Deadweight costs fall when demand falls or firms' costs increase.**

TRUE. Under these assumptions, deadweight costs equal the usual Harberger triangle plus the Tullock rectangle – and output equals half the competitive level. (There's no productive inefficiency because firms have the same costs, and the shift involves an increase in *firms'* costs). If demand falls, both the triangle and rectangle shrink. The same happens if costs rise.

Part 2: Short Answer
(20 points each)
In 4-6 sentences AND/OR equations, answer all three of the following questions.

1. Consider a Cournot model with two firms. P=10-Q, and **Total** Cost=K for each firm. In equilibrium, all firms that produce must be profitable, and all firms that can profitably produce do so. Graph market price as a function of K. Explain your reasoning.

Key fact to remember: In the Cournot model, each firm's revenue is given by: $\Pi_c = \frac{a^2}{b(N+1)^2}$.

So if two firms remain in the market, each earns 100/9 – K, and if only one firm remains, it earns 25-K.

From this we can immediately deduce that if K>25, zero firms will remain in the market, and the effective price of the good will be infinite (since it's no longer available at any price).

If K≤100/9, similarly, both firms stay in the market, and we get the Cournot duopoly result: q=10/3, Q=20/3, P=10/3.

What if 100/9>K>25? Then there's only one firm, and it charges the monopoly price – unless it foresees that this will provoke entry. The monopoly price is 5, and the monopoly quantity is 5 as well. Will charging the monopoly price ever provoke entry? No. If the incumbent firm produces 5, an entrant would maximize:

$\Pi_e = (10-5-q_e)q_e - K$, which reaches a maximum at q_e=2.5, which is only profitable for K≤25/4, which is less than 100/9.

Bottom line: For low K, there are two firms and the Cournot duopoly result. For medium K, there is one firm and the monopoly result. For high K, there are no firms at all.

2. In the real world, why don't reputational incentives eliminate all fraud?

Some of the obvious reasons: In the real world, time preference, number of turns, and utility functions all vary widely – and none of them are knowable with certainty. So in the real world, it is often hard to tell whether or not reputational incentives will work – and people often decide it's better to just take their chances. Another key problem: In the real world, honest mistakes happen, so trigger strategies just aren't practical. But even setting all of these problems aside, there's a more fundamental reason why fraud will never disappear completely: As the rate of fraud falls, so does the optimal level of effort to *prevent* fraud. But as anti-fraud effort falls, the incentive for fraud increases. Think about this as a game where sellers can be Honest or Dishonest, and buyers can either be Trusting or Cautious. In the MSNE, 100% Honesty will never be an equilibrium, because if 100% of sellers were Honest, 100% of buyers would be Trusting, which means that Dishonesty pays.

3. "Free market economists typically express confidence in the ability of markets to produce public goods... At the same time, free market economists tend to be pessimistic about the stability of cartels in an unregulated market. If markets successfully produce local public goods, however, why are stable cartels not more prevalent?" (Cowen and Sutter 1999)

Explain Cowen and Sutter's argument using basic game theory. Does it make sense in the real world? Why or why not?

Their argument is that producing public goods and maintaining cartels are both Prisoners' Dilemmas. (In fact, you could say that "maintaining the cartel" *is* a public good from the point of view of the participating firms). While is in the collective interest of members to cooperate, it is in their individual interests to defect.

The argument makes *some* sense in the real world. Private production of public goods and stable, voluntary cartels are both rare. However, there are some important differences. Many people get a "warm glow" from contributing to public goods production – showing a little altruism makes them feel like better people. It's a lot harder for cartels to appeal to members' altruism. Unions are a good exception – and it's interesting to note that unions often enroll a few percent of the workforce even without government help. Another point worth mentioning: The short-run gains from undercutting a cartel are much larger than the short-run gains of refusing to contribute to a public good. The firm that cheats on a cartel can steal the whole market; the donor who cheats on a voluntary public good just saves his donation.

Economics 812 Midterm
Prof. Bryan Caplan
Spring, 2011

Part 1: True, False, and Explain
(10 points each - 2 for the right answer, and 8 for the explanation)
State whether each of the following six propositions is true or false. Using 2-3 sentences AND/OR equations, explain your answer.

1. Two types of agents live for two periods. In each period, they receive an endowment of *perishable* consumption goods – storage over time is not possible. Type A agents have U=ln c_1 + ß ln c_2; Type B agents have U= ln c_1 + ρ ln c_2. Both types of agents are equally numerous and have endowments of 1 in each period.

True, False, and Explain: **The equilibrium interest rate r equals 2/(ß+ρ).**

FALSE. (1+r) equals the price ratio of period 1 consumption to period 2 consumption. So just normalize the utility functions to be:

$$U = \frac{1}{1+\beta}\ln c_1 + \frac{\beta}{1+\beta}\ln c_2 \text{ and } U = \frac{1}{1+\rho}\ln c_1 + \frac{\rho}{1+\rho}\ln c_2$$

Then apply the 2-good GE formula from lecture:

$$\frac{p_1}{p_2} = \frac{\frac{1}{1+\beta}*1 + \frac{1}{1+\rho}*1}{\frac{\beta}{1+\beta}*1 + \frac{\rho}{1+\rho}*1} = \frac{2+\rho+\beta}{\beta+2\beta\rho+\rho}$$. Since this is equal to (1+r), r= $\frac{2+\rho+\beta}{\beta+2\beta\rho+\rho}$ -1, which does not equal 2/(ß+ρ).

2. Consider the following normal form:

	Left	Right
Left	1,1	0,0
Right	0,0	2,2

True, False, and Explain: **If two players play this game *sequentially*, there are three NE but only one SGPNE.**

FALSE. Played sequentially, there are only TWO NE (L,L) and (R,R). The MSNE from the simultaneous version of the game does not exist, because if player 1 randomizes, player 2 gets to see whatever he played, and will therefore copy whatever he did with certainty. Out of the two NE, only (R,R) is SGP. You can show this with backwards induction: since player 1 knows that player 2 will match him in the second turn, he always wants to play R.

Questions 3 and 4 refer to the following information:

An Incumbent and an Entrant infinitely repeat the following game.

	Enter	Don't Enter
Predate	-10,-10	10,0
Don't Predate	2,2	10,0

Consider the candidate equilibrium where the Incumbent always plays Don't Predate, and the Entrant plays Enter until the Incumbent plays Predate once. After the Incumbent plays Predate, the Entrant never plays Enter again.

3. True, False, and Explain: **This is not a NE unless the Incumbent's discount factor is less than .6.**

FALSE (but see below). Playing the candidate equilibrium is Nash if:

$\sum_{t=0}^{\infty} 2\beta^t \geq -10 + \sum_{t=1}^{\infty} 10\beta^t$. This simplifies to:

$\frac{2}{1-\beta} \geq -10 + \frac{10\beta}{1-\beta}$, so $\beta \leq .6$. Since deviating has a short-run *cost* and a long-run *benefit*, low discount rates are required to sustain the equilibrium.

If you answered TRUE and said the above, I gave you full credit. Technically, though, since the question says "less than .6" rather than "less than **or equal to** .6," the correct answer is FALSE.

4. Suppose that every turn, there is a p>0 that the entire industry disappears due to exogenous technological innovation.

True, False, and Explain: **Predation may still be sustainable.**

TRUE. You could interpret β as a continuation probability (1-p) rather than a discount factor and just use the math for Question 3. Or you just revise the inequality, flip the sign, and solve. Predation is sustainable as long as:

$-10 + \sum_{t=1}^{\infty} 10(1-p)^t \beta^t \geq \sum_{t=0}^{\infty} 2(1-p)^t \beta^t$, implying:

$\beta(1-p) \geq .6$.

5. True, False, and Explain: **Bertrand competition between identical firms with fixed costs yields a second-best efficient outcome.**

TRUE. The first-best outcome is when one firm produces at MC, avoiding any allocative inefficiency from P>MC (the Harberger triangle). But in Bertrand competition with fixed costs, competition leads *one* firm to drop out, and the other to set P=AC – a standard second-best result. At lower prices, firms would lose money and exit. Bertrand competition will NOT lead to wasteful duplication of fixed costs; if it did, either firm could profit by slightly cutting its price and stealing all its competitors' customers.

6. Consider the following one-shot game:

	Attack	Submit	Defend
Attack	-10,-10	5,-3	-20,-5
Submit	-3,5	0,0	0,-1
Defend	-5,-20	-1,0	-1,-1

True, False, and Explain: **There is a MSNE, but no PSNE.**

FALSE. Defend is strictly dominated by Submit for both players, so this game simplifies to a standard Hawk/Dove game with the four upper-left cells. In such games, there are two PSNE – (Attack, Submit) and (Submit, Attack) in this case, plus a MSNE.

<u>Part 2:</u> Short Answer
(20 points each)
In 4-6 sentences AND/OR equations, answer all three of the following questions.

1. "People may be unable to articulate, for example, that 'I would be willing to pay $200 per month in additional rent to live in a safer neighborhood.' They might even nonsensically assert that 'You can't put a price on safety.' But in acting, they implicitly make such trade-offs." (Caplan, "Probability, Common Sense, and Realism")

What objection to probability theory is Caplan trying to answer? Does he succeed?

Caplan is answering the objection that probability theory is *unrealistic* because normal people rarely explicitly calculate probabilities. He argues that probability is no more unrealistic than the standard assumption that people have a willingness to pay. Normal people rarely explicitly state their willingness to pay, but their behavior reveals that they still *have* a willingness to pay. Similarly, normal people rarely explicitly state their probabilities, but their behavior shows that they *have* probabilities. As Caplan writes, "In short, just as demand theory does not commit us to the view that the typical person explicitly ponders, 'How much Gouda cheese would I buy if the price were a penny per pound? probability theory does not commit us to the view that the typical person explicitly ponders, 'What is the probability that I have an evil twin?'"

2. Modify the Hawk/Dove game to explain why in the real world – unlike Thomas Hobbes' *Leviathan* – two shipwrecked people are unlikely to try to murder each other. Carefully explain why your model is a good description of the choices and payoffs that human beings would **actually** face in this situation.

The simplest way to modify the Hawk/Dove game is to change the payoffs. In the real world, (Dove, Dove) is usually more profitable for both parties than (Hawk, Dove) or (Dove, Hawk). Unilateral aggression could easily lead to the breakdown of trust and cooperation, and require frequent, costly monitoring. And depending on how "dovish" Dove is, unilateral aggression might even result in some costly injuries for the aggressor as well as the victim. As a result, Dove becomes a strictly dominant strategy.

You could simply keep the usual Hawk/Dove payoffs and model the situation as a repeated game, but then you'd have to explain why repeated play seems likely to lead to cooperation rather than a struggle for dominance. Focal points, perhaps?

3. With full rent dissipation, roughly what would U.S. rent-seeking as a percentage of GDP be? Is this a reasonable estimate of actual U.S. rent-seeking as a percentage of GDP? If not, what is the best explanation for the discrepancy?

With full rent dissipation, you'd expect U.S. rent-seeking would equal government spending as a percent of GDP, roughly 40%. This is an unrealistically high estimate; nothing like 40% of GDP is spent on lobbying, however broadly defined. The best explanation for the discrepancy is that most government spending is NOT up for grabs. Politicians largely have to satisfy voters to keep their jobs, and voters want money for the elderly, defense, etc., not whoever lobbies the most. You could also observe that even with full rent dissipation, 40% is an overstatement unless lobbyists are allowed to simply keep their money without offering any costly goods and services in exchange.

Economics 812 Midterm Answer Key
Prof. Bryan Caplan
Spring, 2012

Part 1: True, False, and Explain
(10 points each - 2 for the right answer, and 8 for the explanation)
State whether each of the following six propositions is true or false. Using 2-3 sentences AND/OR equations, explain your answer.

1. Let "CK"="the results of the Card-Krueger minimum wage study." Suppose the p(econometrics is reliable)=.8, p(CK|econometrics is reliable)=.3, and p(~CK|econometrics is reliable)=.7.

True, False, and Explain: **P(econometrics is reliable|CK)>70%.**

FALSE. Using Bayes' Rule:

$$P(reliable \mid CK) = \frac{P(CK \mid reliable) * P(reliable)}{P(CK \mid reliable) * P(reliable) + P(CK \mid \sim reliable) * P(\sim reliable)} = \frac{.3 * .8}{.3 * .8 + P(CK \mid \sim reliable) * .2}$$

We do not know P(CK|~reliable). But $\frac{.24}{.24 + P(CK \mid \sim reliable) * .2} > .7$

only if P(CK|~reliable)<.514.

Questions 2 and 3 refer to the following information:

Bryan, Tyler, and John play a game with three possible strategies: Comics, Chess, and Opera. Their payoffs are:

	Bryan	Tyler	John
Everyone Plays Comics	10	1	2
Everyone Plays Chess	1	5	5
Everyone Plays Opera	4	4	4
All Other Cases	0	0	0

2. True, False, and Explain: **This game has one PSNE if the players play sequentially, but three PSNE if the players play simultaneously.**

FALSE. For the simultaneous game, (Comics, Comics, Comics), (Chess, Chess, Chess), and (Opera, Opera, Opera) are all PSNE equilibria. But so is every situation where each players plays a *different* strategy: e.g. (Comics, Chess, Opera). This gives everyone zero payoffs, but no individual can increase his payoff by switching. For the sequential game, there is only one *subgame perfect* PSNE, where the first mover picks the strategy that he most prefers everyone to play – Comics for Bryan, Chess for Tyler or John. But every PSNE in the simultaneous game remains a PSNE in the sequential game.

3. A MSNE also exists.

True, False, and Explain: **In this MSNE, Tyler is indifferent when:**
P(Bryan plays Comics)*P(John plays Comics)=P(Bryan plays Chess)*P(John plays Chess)= P(Bryan plays Opera)*P(John plays Opera)

FALSE. This would only be true if all the payoffs for Tyler were equal, which they are not. Tyler is actually indifferent when:

1*P(Bryan plays Comics)*P(John plays Comics)=5*P(Bryan plays Chess)*P(John plays Chess)= 4*P(Bryan plays Opera)*P(John plays Opera)

4. Consider a simple contestable monopoly model where an incumbent faces an equally productively efficient potential entrant. Both have constant marginal costs and zero fixed costs of production. Both firms know that there is a probability p that – if the incumbent remains in business – the government will prosecute the incumbent for antitrust violations. If this occurs, the incumbent loses a fixed cost K. The entrant never faces antitrust prosecution.

True, False, and Explain: **Equilibrium quantity is decreasing in both p and K.**

TRUE. pK is effectively a fixed cost. Since only the incumbent faces this cost, the entrant will inevitably drive him from the market. The entrant chooses the highest price consistent with driving the incumbent from the market, an epsilon below the point where the incumbent's AC curve intersects the demand curve. The higher p and K, the higher the incumbent's AC, and the higher the price the entrant can safety charge.

5. True, False, and Explain: **With zero costs of production, Kreps (*A Course in Microeconomic Theory*) shows that consumers are better off in a Stackelberg equilibrium than a Cournot equilibrium.**

TRUE. Kreps shows that under Cournot, total output equals 2(A-k)/3, while under Stackelberg, total output equals 3(A-k)/4. With zero costs of production, k=0, so Cournot output equals 2A/3, while Stackelberg output equals 3A/4.

6. Consider the following one-shot game:

	Attack	Submit
Attack	-1, -1000	100,1
Submit	1,100	50,50

True, False, and Explain: **There are two PSNE and one MSNE, but only (Attack, Submit) is focal.**

TRUE. This is just the Hawk-Dove game, so (Attack, Submit) and (Submit, Attack) are the two PSNE, and there is also a MSNE. But given the fact that (Attack, Attack) is *extremely* bad for player 2, (Attack, Submit) is a strong focal point: Both players will look at it and think "Player 2 won't want to risk attacking."

Part 2: Short Answer
(20 points each)

In 4-6 sentences AND/OR equations, answer all three of the following questions.

1. Are *any* of the main assumptions of general equilibrium theory true in the real world? Carefully explain your answer.

The assumptions that there are *I* consumers, *K* commodities, non-negative consumption, and endowments are all trivially true; even an endowment vector of all zeros is still an endowment. But none of the other assumptions are empirically true:

a. Utility is not increasing in all commodities, because some people actually dislike some goods and/or reach satiation points.

b. The market price vector is not continuous, because the penny is the smallest unit.

c. Given a price vector, people are sometimes indifferent between different consumption bundles (e.g. blue shirts vs. green shirts), so $U_i(p)$ does not have a unique solution for everyone.

d. There are some goods (e.g. air) where people satiate at price=0, so total demand does not always exceed total endowment for a low enough price.

e. There are lumpy goods and discrete reactions, so the total demand function is not continuous in p_k.

2. Why does popcorn cost more at movies? You should either (a) offer an answer Landsburg fails to consider in *The Armchair Economist*, or (b) argue that Landsburg prematurely rejects the right answer.

I think Landsburg prematurely rejects the price discrimination story. Yes, there are many theaters, but they are hardly perfect substitutes for each other. Theaters are at best monopolistically competitive. Every theater has a least a mild geographic monopoly; people won't want to drive an extra 15 minutes to cut the cost of popcorn by a $1. Why price discriminate on popcorn, but not the restrooms? Probably because of fairness norms: Theater goers would be very resentful if they had to pay extra to use the restroom, leading to less repeat business.

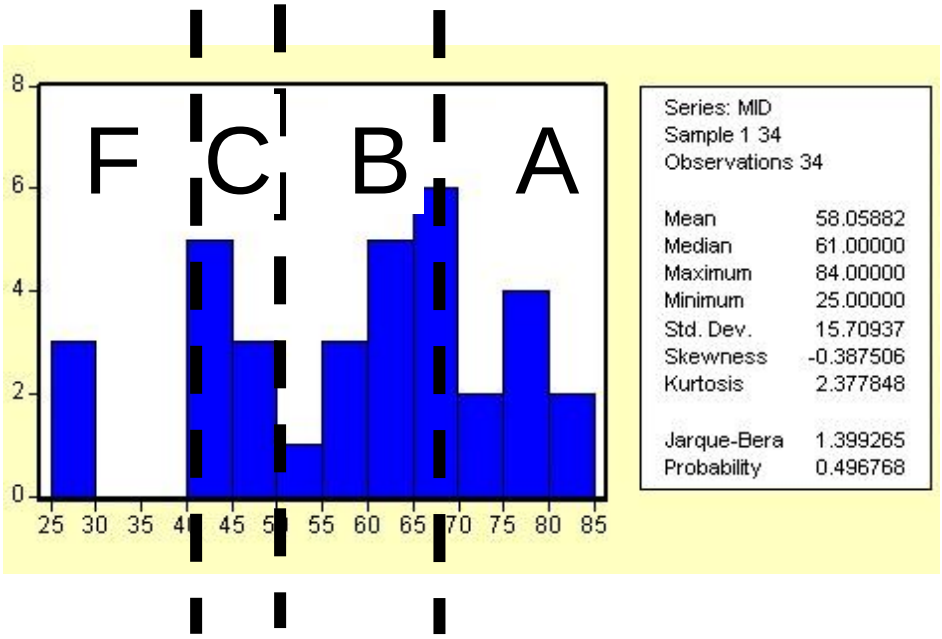
3. Compare the maximum deadweight costs of a government grant of monopoly to the deadweight costs of outright prohibition of a product. How would your answer change for a product with negative externalities? Use graphs to clarify your answer.

The worst-case scenario for a government grant of monopoly is when (a) the government gives the grant to a productively inefficient firm, and (b) there is full rent dissipation during the struggle to get the grant. The only social benefit is the triangle of consumer's surplus under the demand curve and above the monopoly price.

The worst-case scenario for Prohibition is even worse: If the ban is strictly enforced, all the surplus in the market is destroyed.

With negative externalities, however, a grant of monopoly or outright prohibition might actually be the most efficient policy. It depends on the severity of the externalities: You have to compare socially optimal output to output under perfect competition, monopoly, and prohibition. The larger the externality, the more likely monopoly (or even prohibition) will be welfare-enhancing. For small externalities, however, it may be more efficient to have overproduction due to competition than underproduction due to monopoly.

Economics 812 Midterm Answer Key
Prof. Bryan Caplan
Spring, 2013



Approximate Grades

67-120	A
50-66	B
40-49	C
0-39	F

Part 1: True, False, and Explain
(10 points each - 2 for the right answer, and 8 for the explanation)
State whether each of the following six propositions is true or false. Using 2-3 sentences AND/OR equations, explain your answer.

1. True, False, and Explain: **As population increases, finding real-world Pareto improvements becomes more difficult.**

TRUE. A change is only a Pareto improvement if absolutely *no one* is better off. As population grows, you increase the chance of hurting at least one person, especially since you increase the chance of the existence of a person with misanthropic or otherwise "weird" preferences. Furthermore, as population increases, the cost of identifying and compensating 100% of all losers goes up.

2. Suppose all agents have lexicographic preferences for either X or Y. At least one agent has lexicographic preferences for X over Y, and at least one agent has lexicographic preferences for Y over X. All agents start with X>0 and Y>0.

True, False, and Explain: **A unique general equilibrium exists.**

TRUE. As long as $0<(p_X/p_Y)<\infty$, everyone with a lexicographic preference for X will want to sell ALL his Y, and everyone with a lexicographic preference for Y will want to sell ALL his X. But to clear the market, the market value of all the X on the market must equal the market value of all the Y on the market. This happens when p_X*(total X endowments of Y-preferrers)=p_Y*(total Y endowments of X-preferrers); in other words, when

p_X/p_Y=(total Y endowments of X-preferrers)/(total X endowments of Y-preferrers), the unique general equilibrium. For example, if the X-preferrers start with a total of 200 Y, and the Y-preferrers start with a total of 100 X, the unique GE is p_X/p_Y=200/100=2.

3. Consider the following variant on the Ultimatum Game:

		Player 2	
Player 1		Accept	Reject
	t	(10-*t*),*t*	0, Z

Z=0 if *t*≥5, but Z=1 if t<5.

True, False, and Explain: **There are an infinite number of PSNE, but only one SGPNE.**

TRUE. This is just like the Ultimatum Game in the notes, except that the unique SGPNE is now for Player 1 to offer 1 (I also accepted 1.01 and 1+ε), because Player 2 strictly prefers to Reject offers less than 1. As in the Ultimatum Game in the notes, there are an infinite number of PSNE, because IF Player 1 expects Player 2 to Reject any offer less than X, Player 1's optimal response is to offer X. In this variant, X can be any number from 1-10.

4. "But once you're in the theater, the owner has a *lot* of monopolies." (Landsburg, *The Armchair Economist*)

True, False, and Explain: **Landsburg's point is that when monopolies sell a product with multiple features, they tend to reduce quality on all margins - to charge a monopoly price for each and every product feature.**

FALSE. Precisely the opposite is true. Landsburg's point is that monopolists normally want to charge a *competitive* price on each and every product feature, then charge a monopoly price for the PACKAGE. Otherwise, theater owners would want to charge high prices for the bathrooms and every other amenity in the theater. Landsburg's conclusion is that monopoly by itself cannot explain high popcorn pricing. A better explanation is price discrimination: If willingness to pay for popcorn positively correlates with willingness to pay for admission, but willingness to pay for bathrooms does not correlates with willingness to pay for admission, then charging more than MC for popcorn makes sense.

5. Consider an infinitely repeated Bertrand game with N equally productively efficient firms with constant MC and 0 fixed cost. The firms want to collude. Their system: each period, the cartel *randomly* picks one firm (1/N chance per firm) to charge the monopoly price. All the other firms charge the monopoly price + \$0.01. The firms enforce this agreement with trigger strategies.

True, False, and Explain: **Since all firms expect a 1/Nth share of the monopoly, this equilibrium is sustainable as long as** $\beta \geq \frac{N-1}{N}$.

FALSE. In any period, a firm that is NOT supposed to charge the monopoly price earns 0 if it sticks to the plan, but earns Π_m if it deviates by charging \$.01 less than the monopoly price. The expected value of future profits for subsequent periods are $\sum_{t=1}^{\infty} \frac{\beta^t \Pi_m}{N}$, because each firm has a 1-in-N chance of getting to charge the monopoly price and reaping the monopoly profits in each period. To sustain collusion, then, we need:

$\sum_{t=1}^{\infty} \frac{\beta^t \Pi_m}{N} \geq \Pi_m$. This simplifies to: $\frac{1}{N} \frac{\beta}{1-\beta} \geq 1$, implying $\beta \geq \frac{N}{N+1}$.

Collusion is harder to sustain in this scenario than when colluding firms evenly divide the monopoly profits every period.

6. True, False, and Explain: **Kreps argues that in the "noisy" real world, trigger strategies are not a practical way to sustain collusion. Instead, colluding firms would only punish if prices were significantly below the agreed level.**

FALSE. Kreps specifically states that "you cannot go too far in lessening the severity of punishment, making it of shorter duration, say, or only triggering punishment when prices fall very far. This would encourage each side to chisel somewhat..." (p.526) Intuition: If no small deviations get punished, then everyone will always engage in a small deviation.

Part 2: Short Answer
(20 points each)
In 4-6 sentences AND/OR equations, answer all three of the following questions.

1. Caplan (1999, 2001) defends the unrestricted use of subjective probability theory in economics. What is the best objection to his position? State your case as forcefully as possible.

There were several good answers to this question. One was that most people assign discrete probability categories (certain, highly likely, somewhat likely, 50/50, somewhat unlikely, highly unlikely, impossible) rather than 0-1 numbers, and that these categories predict their behavior better than a continuous model. Another was that most people don't know Bayes' Rule, and therefore frequently violate subjective probability theory on a very deep level.

2. Suppose artificial intelligence researchers produce and patent a perfect substitute for human labor at zero MC. Use general equilibrium theory to predict the overall economic effects on human welfare before AND after the Artificial Intelligence software patent expires.

While the patent lasts, the patent-holder will produce a monopoly quantity of AIs. As a result, the effective labor supply increases, and wages for human beings fall – but *not* to 0 because the patent-holder keeps P>MC. The overall effect on human welfare, however, is still positive! Since the AIs produce more stuff, and only humans get to consume, GDP per human goes up. How is this possible if wages fall? Simple: Earnings for NON-labor assets (land, capital, patents, etc.) must go up. Humans who *only* own labor are worse off, but anyone who owns a home, stocks, etc. experiences offsetting gains.

When the patent expires, this effect becomes even more extreme. With 0 fixed costs, wages fall to MC=0, but total output – and GDP per human – skyrockets. Human owners of land, capital, and other non-labor assets capture 100% of all output. Humans who only have labor to sell, however, will starve without tax-funded redistribution or charity.

3. Suppose you play a 5-turn Centipede Game with (a) a random American, and (b) a random Ph.D. Micro student at GMU. How would you personally play in each of these cases? What percentage of the theoretical maximum payoff would you receive in each case? Explain your answer.

If I played a random American, I would definitely NOT expect him to do backwards induction. I would however expect the random American to cheat on his last turn, so I would cheat one before that. (If I liked the person, or if I were playing a child, I would probably just cooperate the whole way through... depending on the sum at stake).

If I played a random Ph.D. Micro student at GMU, my strategy would heavily depend on anonymity. If the student and I knew or expected to discover each others' identities, then I would cooperate the whole way through... unless there was a *lot* of money at stake. If we were anonymous, however, I would expect my opponent to cheat on the round right before my last turn, so I would cheat one round before *that*. With a 5-turn game, that basically means I would cheat at the first opportunity – but if the game were longer, I would definitely try cooperating until the last five turns or so.

Economics 812 Midterm
Prof. Bryan Caplan
Spring, 2014

Part 1: True, False, and Explain
(10 points each - 2 for the right answer, and 8 for the explanation)
State whether each of the following six propositions is true or false. Using 2-3 sentences AND/OR equations, explain your answer.

1. Suppose the government imposes a tax on air pollution.

True, False, and Explain: **While this tax doesn't have to be a Kaldor-Hicks improvement, it remains theoretically possible for it to be a Pareto improvement.**

TRUE. The tax doesn't *have* to be a Kaldor-Hicks improvement; imposing a very high tax on something with a mild negative externality could easily make total social surplus lower. (Picture a $1000/day tax for skipping a shower). Nevertheless, a tax on air pollution can, as a matter of pure theory, be a Pareto improvement. Each individual could conceivably value the improved air quality more than the tax.

[Many students said FALSE, on the grounds that if a change is not a Kaldor-Hicks improvement, it cannot be a Pareto improvement. But the question said that the change *might* not be a Kaldor-Hicks improvement. This merely implies that the change might not be a Pareto improvement, which of course is perfectly compatible with the theoretical possibility that the change *is* a Pareto improvement.]

2. Suppose that two players play this PD game, followed by this Coordination game.

	Defect	Don't
Defect	3,3	4,0
Don't	0,4	2,2

	L	R
L	5,5	0,0
R	0,0	5,5

True, False, and Explain: **If ß=.9, the only SGPNE are (Defect, Defect), (L,L) and (Defect, Defect), (R, R).**

[I accepted either of the following responses.]

[Response #1: The literal answer.]

FALSE. The first game isn't really a PD, because the socially optimal result (Defect, Defect) is strictly dominant. Both (Defect, Defect), (L,L) and (Defect, Defect), (R,R) are equilibria for ALL values of β. But there is a third equilibrium: (Defect, Defect) followed by the mixed strategy equilibrium of playing L 50% of the time and R 50% of the time. Furthermore, this MSNE allows for a strange equilibrium: (Don't, Don't), followed by either (L,L) or (R,R) if both players played

(Don't, Don't) in the first round, or the MSNE if either player played Defect in the first round. This is an equilibrium as long as:

$2 + 5\beta \geq 4 + 2.5\beta$, implying a critical $\beta=.8$.

[Response #2: The answer assuming the first game really was a PD, with (Defect, Defect) payoffs of (2,2) and (Don't, Don't) payoffs of (3,3)].

FALSE. Both (Defect, Defect), (L,L) and (Defect, Defect), (R,R) are equilibrium for ALL values of β. But there is another obvious equilibrium: (Defect, Defect) followed by the mixed strategy equilibrium of playing L 50% of the time and R 50% of the time. This is an equilibrium as long as:

$3 + 5\beta \geq 4 + 2.5\beta$, implying a critical $\beta=.4$.

3. True, False, and Explain: **In an Ultimatum game, a 50/50 split is the only SGPPSNE; in a Dictator game, a 100/0 split is the only SGPPSNE.**

FALSE. In experiments, 50/50 splits are common for both games. Theoretically, however, the SGPPSNE of the Ultimatum game is $(100-\varepsilon,\varepsilon)$, where ε is the smallest amount the giver can give. The giver has no reason to give more because the receiver will always accept anything more than 0. In the Dictator game, similarly, the SGPPSNE is (100,0) because the Dictator has no incentive to share even a penny.

4. "Suppose that a manufacturer does hold an unbreakable patent on a particular product." (Kreps, *A Course in Microeconomic Theory*)

True, False, and Explain: **Kreps says that firms may engage in entry deterrence even if they have a legal monopoly (such as a patent).**

TRUE. Even firms with a legal monopoly have to worry about competition by *similar* products, giving them an incentive to reduce their prices to discourage entry. As Kreps explains on p.304, "The scope of patent protection does not always extend to protection against close substitutes for the patented product... Then the monopoly may act in a way to impede the entry of producers of these substitute goods."

5. Suppose firms in an industry have the same cost function, including a *sunk cost*. Product demand falls, leading to a halving of potential monopoly profits. Two firms play mixed strategies to decide whether to enter.

True, False, and Explain: **The probability that both firms enter and lose money falls by a factor of four.**

FALSE. From the homework, we know that the probability that ONE firm plays enter is $\frac{\Pi^m}{\Pi^m + a}$, so the probability that BOTH firms do so is $\left(\frac{\Pi^m}{\Pi^m + a}\right)^2$. Halving monopoly profits reduces the entry probability to $\frac{.5\Pi^m}{.5\Pi^m + a} = \frac{\Pi^m}{\Pi^m + 2a}$. This clearly reduces the probability of entry, but by LESS than half. (To halve the probability, the entire denominator, not just part of it, would have to double). Since the probability that one firm enters falls by less than half, the probability that two firms enter, $\left(\frac{\Pi^m}{\Pi^m + 2a}\right)^2$, falls by LESS than a factor of four.

6. Suppose N equally efficient firms lobby the government for a monopoly privilege. The firms never collude.

True, False, and Explain: **Bertrand-style lobbying will lead to a larger Tullock rectangle than Cournot-style lobbying would.**

TRUE. Note that the question specifies Bertrand- or Cournot-style LOBBYING. The natural interpretation is that with Bertrand-style lobbying, whichever firms lobbies the MOST wins the monopoly for sure, whereas with Cournot-style lobbying, your chance of winning the privilege depends on your lobbying as a fraction of TOTAL lobbying. By the usual logic, Bertrand lobbying leads one firm to set its lobbying equal to the total value of the monopoly, and all rivals to give up. Cournot lobbying, in contrast, leads all firms to lobby somewhat, but not enough to wipe out all the profits (i.e., to get full rent dissipation).

Part 2: Short Answer
(20 points each)

In 4-6 sentences AND/OR equations, answer all three of the following questions.

1. Why doesn't the First Welfare Theorem imply that market outcomes are Pareto efficient even in the presence of externalities? Why does Caplan claim that, the First Welfare Theorem notwithstanding, real-world market outcomes *are* Pareto efficient in the presence of externalities?

The no-externalities assumption is implicit in the assumption that Utility $U_i(x)$ solely depends on all K commodities in YOUR consumption bundle. This means that no consumers' consumption affects any OTHER consumer's utility. With externalities, this assumption is false, so the FWT need not hold.

Caplan claims that real-world outcomes are Pareto efficient because (a) any change is almost certain to make SOMEONE worse off, and (b) there is no feasible way to compensate 100% of the losers for any realistic change. As a result, there is no actual way to make one person better off without making someone else worse off. As a result, the world is Pareto efficient with or without externalities.

2. Suppose you had to play a 100-turn Hawk/Dove game with one other student in this class. Before the game starts, you are allowed to send your partner a one-paragraph essay on the theme, "You should cooperate with me because..." What would your essay say if you wanted to maximize your payoff? Be as persuasive as possible.

Here's what I propose we do: We play Dove for turns 1-99. If either of us plays Hawk, we revert to the MSNE for the rest of the game. On the last turn, we flip a coin: Heads I play Hawk and you play Dove, Tails I play Dove and you play Hawk.

You're probably a fair and honorable person. If so, I think you'll agree that my proposal is both fair and honorable, and happily play along.

But on the off-chance that you're not a fair and honorable person, you should *still* adhere to my proposal. This isn't a PD game, so playing Hawk can easily backfire for you even on the turn you play it. More importantly, my plan has credible punishments. Once we expect the MSNE, the MSNE is going to happen. You heard the same lecture I did. Finally, my proposal elegantly handles the end-game problem. If we've cooperated for turns 1-99, the coin flip maintains cooperation on turn 100. And you won't want to betray me on turn 99, because then on turn 100 you'll get the MSNE payoff instead of a 50% chance of the (Hawk, Dove) payoff and a 50% of the (Dove, Hawk) payoff.

In short, decency and self-interest both point in the same direction. Let's play!

3. Landsburg ("Why Prices Are Good: Smith versus Darwin") states that, "In biology there is no equivalent of the Invisible Hand." Would Landsburg expect there to be an Invisible Hand for *culture*? Explain what you think Landsburg would say, then argue that he's wrong. (Hint: Remember that cultural practices are often coordination games).

Landsburg would almost definitely NOT expect the Invisible Hand to apply. As he explains in *The Armchair Economist*, markets achieve a desirable SOCIAL outcome – efficiency – by channeling competition through PRICES. Competition alone gets you the bloodbath that is natural selection. Coordination, similarly, can lock-in all sorts of inefficient outcomes.

You could argue, however, that cultures compete with each other, mimicking the usual market mechanism. People who aren't happy with Amish culture, for example, are free to switch to non-Amish culture. New entry is possible, too – so if the current menu of cultural choices is unsatisfactory, you can start your own culture. Cultures, like firms, must pass the market test.

Economics 812 Midterm
Prof. Bryan Caplan
Spring, 2015

Part 1: True, False, and Explain
(10 points each - 2 for the right answer, and 8 for the explanation)
State whether each of the following six propositions is true or false. Using 2-3 sentences AND/OR equations, explain your answer.

1. True, False, and Explain: **In the real world, taxes on goods with negative externalities are always the least inefficient way for governments to raise a given amount of revenue.**

FALSE. Taxes on negative externalities have one clear advantage over lump-sum taxes: Lump-sum taxes don't hurt efficiency, but taxes on negative externalities CAN actually *increase* efficiency by discouraging socially harmful behavior. But this beneficial side effect of taxes on negative externalities reverses as soon as the tax starts to push market quantity below the intersection of supply and Social Benefits. So if revenue the government wants is large or the negative externality is minor, taxes on negative externalities might be less efficient than, say, lump-sum taxation.

Problems 2 and 3 refer to the following information.

Agents live for two periods. They are endowed with 1 unit of a consumption good in period 1 and 1 unit in period 2. The period 1 good spoils if not consumed in period 1. There are two types of agents:

Type A: 50% of the agents have $U=\ln c_2$.

Type B: The other 50% have $U=\ln c_1 + \ln c_2$

2. True, False, and Explain: **The general equilibrium interest rate will be less than 3%.**

TRUE. Normalizing the utility function for the Type B's, then applying the standard two-good GE result, yields: $\frac{p_x}{p_y} = \frac{.5*0*1+.5*.5*1}{.5*1*1+.5*5*1} = \frac{1}{3}$. This implies an interest rate of -67%, which is definitely less than 3%.

3. True, False, and Explain: **If the two types of agents do not interact (i.e., there is one island for all of the A's and a different island for all of the B's), the interest rate will be negative for A's but zero for B's.**

TRUE. On the island of the A's, the interest rate is $\frac{p_x}{p_y} = \frac{1*0*1}{1*1*1} = \frac{0}{1}$, or -100%.

On the island of the B's, the interest rate is: $\frac{p_x}{p_y} = \frac{1*.5*1}{1*5*1} = \frac{1}{1}$, or 0%. Intuitively, the A's place no value on period-1 consumption, so it's free; and the B's place equal weight on period-1 and period-2 consumption, and have equal amounts of both goods, so their prices are equal in equilibrium.

4. "In biology, there is no equivalent of the Invisible Hand." (Landsburg, *The Armchair Economist*)

True, False, and Explain: **Landsburg's discussion implies that in game theory, there *is* an equivalent of the Invisible Hand.**

FALSE. Landsburg identifies the Invisible Hand with the First Welfare Theorem. He explains that according to this theorem, rationality and individual utility maximization are insufficient to ensure efficiency. You also need competitive prices. Furthermore, game theory is specifically designed to analyze situations where the perfectly competitive model does *not* apply. Indeed, Landsburg's uses both biological and game theory-type examples (such as educational signaling) to expose *in*efficient equilibria.

5. Suppose two players play the following normal form *N* times. *N* is finite and known by both players.

	Left	Right
Left	5,1	0,0
Right	0,0	1,5

True, False, and Explain: **Alternating back and forth between (L,L) and (R,R) is a SGPPSNE equilibrium for all *N* and all β>0.**

TRUE. Even though this is a finite game, there is no incentive to deviate in the last turn, because deviation reduces your payment (of 1 or 5) to 0. Since there is no incentive to deviate in the last turn, the game never "unravels," and playing the equilibrium strategies is fully credible. The discount rate is a red herring – even if both players attach ZERO weight to future outcomes, playing the equilibrium is selfishly optimal.

Note: A few students said FALSE because this is also an equilibrium for β=0. But if something is true for β≥0, it is automatically true for β>0, too.

6. Suppose Cournot firms have TC=2 (i.e., fixed cost of 2 with MC=0). The demand curve is P=10-Q.

True, False, and Explain: **With free entry, the equilibrium number of firms is 5, with a deadweight cost of 8.**

FALSE. From the notes, the equilibrium number of firms is given by the integer immediately below:

$N = \frac{10}{\sqrt{K}} - 1 = 6.07$, so N=6, not 5. Since one firm could produce the entire output at the same cost as more firms, this implies a deadweight cost of 2 per additional firm, for a total of 10.

Note: A few students correctly observed that there would be additional deadweight loss caused by equilibrium prices exceeding MC=0. Although I gave full credit for saying that the deadweight cost is 10, I also gave full credit for saying it was 10 + the allocative inefficiency of P>MC.

Part 2: Short Answer

(20 points each)

In 4-6 sentences AND/OR equations, answer all three of the following questions.

1. "Mises is correct to point out that beliefs about the efficacy of action are implicit in action. But he at best misspeaks when he characterizes this necessary feature of action as knowledge of 'causality.' Instead, the necessary belief component of action is weaker; we don't need to know—or even believe we know—any exceptionless causal laws. We merely require beliefs about conditional probabilities." (Caplan, "Probability, Common Sense, and Realism")

Use Caplan's analysis of the connection between beliefs and actions to explain why you showed up for this evening's exam.

[I'm now pretending I'm a student.] According to Mises, I showed up at the exam because I believe that showing up will *cause* me to succeed in the program. Caplan's point is that Mises overstates. I could easily attend even though I realize that I *might* get in a car accident en route, or enter the classroom and discover that the exam's been cancelled. I might attend even though I believe I'm likely to fail the exam, just as Caplan submits articles to the *AER* expecting rejection. Being here only shows that, in Caplan's words, I think being here leads to a "better distribution of outcomes than any alternative plan." Nothing more – and nothing less.

2. "Schelling points explain why countries rarely fight wars, but fail to explain why countries often fight wars over seemingly minor events." Discuss, providing at least two real-world examples.

One of the most common way to avoid the War, War equilibrium of the Hawk/Dove game is territoriality: Fight on your own territory, Run away on other territory. But how is this "territory" defined? Schelling points provide an obvious explanation: Once two nations recognize each other's national borders, each can avoid war by carefully keeping its military on its side of the border. This helps maintain peace, but also shows that the preceding quotation is wrong. Using national borders to reach the peaceful equilibrium creates the possibility of war over a minor territorial transgression (or alleged transgression): Once national borders become a Schelling point, one country's decision to grab one square mile of another country could provoke a massive response from the country that claims that square mile. Two real-world examples: The Falkland Island crisis, where the United Kingdom fought against Argentina for seizing some sparsely-inhabited islands in the south Pacific; and the current Crimean crisis, which began when Russia unexpectedly occupied and annexed ethnically Russian territory in the Ukraine.

3. Suppose a society is in a very low-trust equilibrium: People don't trust others because others aren't trustworthy, and no one bothers to be trustworthy because no one will trust them. If you personally wanted to *break out* of this low-trust equilibrium – to become a widely trusted "honest broker" – what would you do? Carefully describe your strategy, step-by-step.

My steps: (1) Make some highly visible investments with large SUNK costs to show that I plan to be in business for a long time. (2) Create a tight-knit team of employees I know well personally, starting with friends and family. (3) Give NEW customers my products for free – and make sure I

maintain quality. (4) Gradually increase prices for older customers – providing large discounts for customers who refer their friends and family members.

If this doesn't work, I'd seek a "franchise" or other certification from a reputable outsider, such as a multi-national corporation.

Economics 812 Midterm Answer Key
Prof. Bryan Caplan
Spring, 2016

Part 1: True, False, and Explain
(10 points each - 2 for the right answer, and 8 for the explanation)
State whether each of the following six propositions is true or false. Using 2-3 sentences AND/OR equations, explain your answer.

1. Suppose all the assumptions of the First Welfare Theorem are true.

True, False, and Explain: **Markets are Pareto and Kaldor-Hicks efficient.**

TRUE. The First Welfare Theorem assumes no externalities, perfect information, and an exogenous price vector, and proves markets are Pareto efficient. Given these assumptions, moreover, people sell ANYTHING they possess that ANYONE else values more highly than they do, so markets maximize total surplus and are therefore K-H efficient.

Most students answered FALSE, citing the notes on the fact that Pareto efficiency does not imply K-H efficiency. This is true in the real world, but the assumptions of the First Welfare Theorem are so unrealistic that both Pareto and K-H efficiency follow!

2. Suppose 45% of all agents in an economy have U=ln x + ln y, and the other 55% have U=.75 ln x + .25 ln y. All agents start with one unit of x and two units of y.

True, False, and Explain: **In general equilibrium, exactly 55% of the agents consume more y than x.**

FALSE. 100% of agents consume more y than x. To see this, first calculate the equilibrium price vector:

$$\frac{p_x}{p_y} = \frac{.45 * .5 * 2 + .55 * .75 * 2}{.45 * .5 * 1 + .55 * .25 * 1} = 3.52$$

This implies all agents have income of 1*3.52+2*1=5.52. Type 1 agents spend 50% of this income on x, 50% on y, so they consume 5.52*.5/3.52=.784 x and 5.52*.5/1=2.76 y, so y>x for them. Type 2 agents spend 75% of their income on x, 25% on y, so they consume 5.52*.75/3.52=1.18 x and 5.52*.25/1=1.38 y, so y>x for them too.

3. Suppose that two players play the following three games in order: Coordination game, Prisoners' Dilemma, Ultimatum game.

True, False, and Explain: **Standard game theory predicts that this game will completely "unravel."**

TRUE. "Unraveling" means players play each stage of the game as if it were not repeated. The last stage – the Ultimatum game – has only one SGPNE, where Player 1 offers $.01 and keeps the rest for himself, and Player 2 accepts. As a result, standard game theory says players cannot use punishments to avoid the standard (Defect, Defect) outcome in the PD stage. This in turn implies that players treat the first stage – the Coordination game – as if it were a one-shot game. Hence, complete unraveling.

4. "But once you're in the theater, the owner has a *lot* of monopolies. He is the only supplier of rest rooms, for example. Why doesn't he charge you a monopoly price to use them? (Landsburg, *The Armchair Economist*)

True, False, and Explain: **Landsburg concludes that customer diversity, not supplier monopoly, explains why popcorn costs more at movies.**

FALSE. Landsburg concludes you need BOTH diversity AND some degree of monopoly (i.e., imperfect competition): "Price discrimination can only work when the seller has a monopoly of the appropriate kind." Monopoly without diversity leads to high ticket prices and MC pricing for popcorn and other extras. Diversity without monopoly leads to MC pricing for everything.

5. Suppose two players play the following normal form *N* times. *N* is finite and known by both players.

	Left	Right
Left	5,1	0,0
Right	0,0	1,5

True, False, and Explain: **Alternating back and forth between (L,L) and (R,R) is an equilibrium as long as *N* is even and β<1.**

FALSE. Alternating back and forth is ALWAYS an equilibrium. Defecting reduces your payoff from 5 or 1 to 0, so there is no temptation to "cheat" regardless of number of turns or discount rate.

6. Consider a Cournot model with two firms. P=20-Q, and MC=0.

True, False, and Explain: **If one firm moves first, the unique SGPNE has a higher Q than it does with simultaneous play.**

TRUE. With simultaneous play, the Cournot notes tell us market output is 2/3*20=13.3. With sequential play, player 2 sets q2=(20-q1)/2, so player 1 maximizes Pq1=(20-q1-(20-q1)/2)q1. Differentiating implies 10-q1=0, so q1=10, and q2=(20-10)/2=5. So q1+q2=15<13.3.

<u>Part 2:</u> Short Answer
(20 points each)
In 4-6 sentences AND/OR equations, answer all three of the following questions.

1. Construct a "second-best" efficiency defense of ONE existing policy you consider highly inefficient in a "first-best" sense. Be as convincing as possible.

Under current U.S. law, extremely rare, highly unpopular religions like Satanism are legal. This seems highly inefficient in a first-best sense: the total willingness of religious people to pay to ban Satanism probably vastly exceeds the totally willingness of Satanists to pay to keep their religion legal. However, politically drawing the line between religions like Satanism and moderately unpopular religions like Scientology is extremely contentious, and risks banning religions that DO pass the cost-benefit test because their followers love them and they only mildly annoy the majority. These costs and risks make across-the-board religious toleration a second-best optimum: While we have to tolerate a few inefficient religions, we avoid religious conflict and "false positives."

2. "[I]t seems that the basic textbook commentary on bilateral monopoly and bargaining had it right." (Kreps, *A Course in Microeconomic Theory*) Carefully explain (a) what Kreps is claiming here, and (b) why he claims it. Does a MSNE view of bargaining lead to a different conclusion?

Kreps is claiming that, according to standard textbook treatments, "bargaining outcomes depend on individual's expectations as to what the outcomes should be"; furthermore, such expectations can be "manipulated." He claims this because experiments show precisely this: Playing bargaining games with computers that demand 20% of the surplus subsequently leads human beings to bargain harder with other humans than playing bargaining games with computers that demand 50% of the surplus. The MSNE view leads to a somewhat different conclusion: While expectations do matter, some expectations are not *stable*. In particular, if people expect too much, lowering your expectations leads to higher payoffs – and if people expect too little, raising expectations leads to higher payoffs.

3. What is the *most* empirically relevant model our class has studied so far? The *least* empirically relevant model? Justify both answers.

The reputation model is the most empirically relevant. Reputation makes the business world go round, especially in the internet age of ubiquitous product reviews and ratings. Businesses can almost always raise their SHORT-RUN profits by cutting corners today, but refrain from doing so because this destroys their LONG-RUN profits.

The ultimatum game model is the least empirically relevant. It clearly predicts something that essentially NEVER occurs: offering people in disadvantageous bargaining positions an amount vanishingly close to zero. Instead, human beings in such situations gravitate toward even splits.

Economics 812 Midterm
Prof. Bryan Caplan
Spring, 2017

Part 1: True, False, and Explain
(10 points each - 2 for the right answer, and 8 for the explanation)
State whether each of the following six propositions is true or false. Using 2-3 sentences AND/OR equations, explain your answer.

1. Suppose a million new immigrants enter the U.S., driving down the wages of low-skilled Americans by $1/hour.

True, False, and Explain: **According to Landsburg (*Fair Play*), this change usually increases Kaldor-Hicks efficiency, because the positive externalities of population growth hugely outweigh the negative externality of falling wages for natives.**

FALSE. Landsburg says that falling wages are not a negative externality at all; instead, they're a TRANSFER to capitalists. As long as there is any demand elasticity, moreover, total surplus expands at the lower wage, so Kaldor-Hicks efficiency automatically increases. Landsburg discuses the positive externalities of population growth elsewhere, but they're not relevant here.

2. Two types of agents consume guns (g) and butter (b). The Type A agents have U=.7 ln g + .3 ln b, and initially own 1 unit of guns and 1 unit of butter. The Type B agents have U=.3 ln g + .7 ln b, and initially own .5 units of guns and .5 units of butter. 50% of the agents are Type A; the other 50% are Type B.

True, False, and Explain: **In GE, the price of guns will not equal the price of butter.**

TRUE. In GE, PriceG/PriceB=(.5*.7*1+.5*.3*.5)/(.5*.3*1+.5*.7*.5)=.425/.325=1.31>0.

3. Consider the following 2-player game:

	Up	Down
Left	0,0	0,0
Right	0,0	0,0

True, False, and Explain: **This game has 4 PSNE but no MSNE.**

FALSE. The game has 4 PSNE, but also an infinite number of MSNE. Since all payoffs are zero, EVERY combination of probabilities leaves everyone indifferent, so they're all MSNEs.

4. Suppose two players play the following normal form *N* times. *N* is finite and known by both players.

	Left	Right
Left	5,0	0,0
Right	0,0	0,5

True, False, and Explain: **Alternating back and forth between (L,L) and (R,R) is always an equilibrium as long as *N* is even.**

FALSE. Alternating back and forth is always an equilibrium for ALL N. There is no incentive to cheat in the last turn, since defection automatically yields a payoff of 0. This is particularly clear because (L,L) and (R,R) are both equilibria off the stage game, and repeatedly playing stage game equilibria is always an equilibrium.

5. Suppose each firm in an industry has TC= q_i^2 ; i.e., zero fixed costs with increasing marginal costs. Industry demand is given by P=1/Q, where Q= $\sum_{\forall i} q_i$.

True, False, and Explain: **Bertrand competition will allow an infinite number of firms to survive in this market, implying no productive or allocative inefficiency.**

TRUE. All firms have the same cost structure of TC= q_i^2 , so MC= $2q_i$ and AC= q_i . Due to this symmetric cost structure, Bertrand equilibrium implies that P=MC=minimum AC=0. When does P=0? Since P=1/Q, this only occurs when total output is infinite, requiring an infinite number of firms, each producing an infinitesimal quantity of output. There is no allocative inefficiency, since P=MC, and no productive inefficiency, because all output is produced at the minimum AC of 0.

6. True, False, and Explain: **The War/Peace game confirms the view that the invention of atomic weapons reduced the risks of war and human extinction.**

FALSE. The PSNE of the War/Peace game remains (Peace, War) and (War, Peace) no matter how bad the (War, War) payoffs become. But for the MSNE, the frequency of playing War falls as the (War, War) payoffs fall, and the frequency of the (War, War) result falls quadratically. However, the risk of actual war only declines because atomic weapons make actual war so terrible IF it occurs! With more primitive weapons, it is unclear if human extinction was even a possible outcome of war. Now, it may be.

Part 2: Short Answer
(20 points each)
In 4-6 sentences AND/OR equations, answer all three of the following questions.

1. People (including economists) often think that monopolies are productively inefficient. Why, on reflection, would this be strange? What additional assumptions do you need to make the "inefficient monopolies" story internally consistent?

Productively inefficient monopoly is strange because – for ALL market structures – higher costs imply lower profits. Even if a firm's monopoly is guaranteed by the government, why not maximize profits by minimizing costs? The two simplest ways to make this story internally consistent: (1) The monopolist could have lobbied to legally exclude more productively efficient competitors from the industry. (2) The monopolist's profits might be capped by the government, giving the monopolist an incentive to stealthily take its profits in the form of higher costs (the "gold-plating effect").

2. Suppose artificial intelligence researchers competitively produce a zero MC perfect substitute for ALL human labor (but not other inputs). Use general equilibrium theory to predict the effects on output, wages, profit, and overall human welfare.

This innovation effectively makes one input – labor – free. Wages therefore fall to 0 – why pay humans a positive wage when an AI will do an equally good job for free? Since infinite labor is now available for no cost, output soars. Profits, however, remain zero in equilibrium; with competition, all the benefits get passed on to the remaining scarce resources of capital and land. Since all production is consumed by humans, overall human welfare rises, though workers who own very little capital and land will be worse off.

3. Use an insight from Kreps we did NOT discuss in class to analyze something economically interesting in the real world. Clearly explain how a specific statement from Kreps helps explain specific individual or firm behavior.

On p,198, Kreps discusses experimental tests of Walrasian equilibrium. (He doesn't mention Vernon Smith by name, but Smith was a key figure here). Result: "except for a few special cases, those experiments that have been run are consistent with the notion of Walrasian equilibrium." What's striking is that *sharply* deviating from *many* extreme assumptions of supply-and-demand doesn't seem to matter much for market outcomes. So even though the Walrasian model seems to poorly describe the real world, the model still correctly predicts market outcomes; subjects act "as if" they're perfect competitors even when they're not. This suggests that industries economists usually describe as "oligopolistic" may actually be just as "competitive" as atomistic industries. And when I look around at the world, this seems plausible: As a rule, number of firms seems like a poor predictor of how well firms treat consumers.