Econ 4545 Environmental Economics

Review Questions- Set 2

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Markets, Market Failure, Efficiency, Inefficiency, Corrections, Equity, etc.

To make these questions easier to digest I have grouped some of them by topic. Some questions will appear on multiple topics:
Questions relating to public commodities:
Questions relating to common-property resources:
Questions relating to excessive market power:
Questions specifically about efficiency:
The following questions have yet to be put in bins. In some cases this is because they do not fit into one of the above bins:

Questions relating to public commodities:

1. What is an externality? What is a private good? What is a public good? Explain, in words, why externalities and public goods cause market failure.
2. What is the difference between a scarce textbook common-property resource and a public commodity? (1) As part of your answer define both terms and explain how they are different. (2) Explain why there is a market failure if a resource is a scarce and common property. (3) Explain why there is a market failure if a commodity is a public commodity. (3) Give the reader an example of an environmental commodity that is public in nature, convincing her that it is predominately public in nature. Answer the questions in the order asked.

Answer: A common-property resource is a resource for which access is not controlled. That is, anyone can harvest units of the resource for only the cost of harvesting. Said another way, there is no gatekeeper that can keep one from harvesting.

A public commodity, as defined in class and in the notes, is a commodity that is noncongestible in consumption, and that has the property that consumption by one implies consumption by all. In explanation, a commodity is noncongestible (non-rivalrous) if one individual's consumption of a unit of the commodity does not preclude other individuals from consuming that same unit of that commodity. The second condition says that if x units of the commodity are produced everyone in society is forced to consume those x units.

Scare, common-property resources and public commodities are different beasts.
Scare, common-property resources are congestible. Public commodities are, by definition, non-

congestible. If everyone considers a public commodity a good, once produced, limiting access to it is inefficient.

The market fails in the allocation of scare, common-property resources because the private cost of harvesting an additional unit of the resource, by either an individual or a firm, is less than the cost to society of harvesting that last unit. This results because the private harvester is not required to pay or account for the full loss to society: because of their actions, there is less of the resource for others to harvest either now or in the future.

If access was controlled by a private profit-maximizing owner, the owner would require every harvester to pay this opportunity cost, if they want access. If access was controlled by the government, and the government behaved efficiently, they would either require harvesters to pay a harvest fee equivalent to the opportunity cost of the stock reduction, or allow no harvesting beyond the efficient amount.

The market will not produce public commodities in at efficient levels from society perspective. Efficiency dictates that society produce commodities (private or public) up to the point where the marginal cost to society of producing an additional unit is equal to the marginal benefit. For private commodities the marginal benefit to society is the simply the marginal benefit to the individual that consumes the unit, but for public commodities, the marginal benefit is the sum of the marginal benefits (positive and negative) to every member of society. The problem is that a private producer cannot get people to pay their marginal benefit from consumption because there is no way to exclude anyone from consumption once the commodity is produced. Everyone can "free ride" on the consumption of others. Public commodities that are goods for all will be under-produced by the market. A major reason for governments is their ability to produce public commodities in efficient amounts. They have the ability to tax, so can force everyone to pay.

An aside: imagine a public commodity that everyone really hates. The efficient amount from everyone's perspective is zero. If I were a private firm with the rights to produce this commodity, I might threaten to produce it and try and get people to pay up to get me not to do it. But as with public goods, some people will not contribute hoping to free ride on the contributions of others.

An example of an environmental commodity that has a strong component of public-ness: Remember no commodity is purely public or private in nature. I am thinking of environmental commodities that individuals can get benefits from without actually being in contact with or without consuming in the "using up" sense of the word. These types of benefits are called "non-use benefits". Such benefits are non-congestible – my enjoying the thought of it does not preclude you from thinking about it. Examples might include knowing that the Alaska wilderness is protected or that a species has been saved in that wilderness. I choose the Alaska wilderness example because most of us will never go there, so most of benefits and costs are non-use in nature. A more complicated example would be the re-introduction of wolves in Colorado. For most of us, most of the benefits or costs we will receive are of a non-use, non-congestible nature. However, there are other effects that are not public in nature. For example, if the wolves eat my cows, they are less likely to eat yours, and I suffer the consequences, not you.

Some comments on answers: Non-congestible (non-rivalrous) is necc but not sufficient for a commodity to be a public commodity. Many of you incorrectly **defined** a public commodity as a commodity that is non-congestible.

Some commodities are non-congestible but not public commodities.

FM radio is an example. It is con-congestible but everyone does not have to listen to every song played on FM radio, you can exclude yourself. Another example is cable TV: Cable TV is non-congestible but it is not a public commodity because the supplier can exclude people.

A definition includes the necessary and sufficient conditions.

For example "a long neck" is not a definition of a giraffe

There are lots of things with long necks (e.g. some beer bottles) that are not giraffes.

3. What is a public commodity? Provide two examples of environmental resources that have a public commodity component. For one of them, explain why a competitive market system will not provide an efficient amount of this public commodity. As part of your answer, provide a graphical example that identifies the efficient provision of your environmental public commodity (for your graph assume society consists of only two or three individuals)
4. What would ice cream cones be like if they were public goods?
5. Identify an environmental commodity, resource or implemented policy whose existence does, or would have a substantial public commodity aspect. Identify one that has not been discussed in the lecture notes nor prior review questions. Explain why you example has a significant public commodity component. As part of your explanation explain what it means to say a commodity is public in nature. Note that this question has two part. Make sure you answer both parts of the question.

Comments:
"Not necc" Means "not necessarily" as in your statement might not be true.
Noncongestible and nonrivalrous are synonyms, so you should not be saying that a public commodity is noncongestible **and** nonrivalrous.
Noncongestible is necessary for a commodity to be a public commodity but it is not the definition of a public commodity.
A public commodity is a commodity such that every time a unit of the commodity is made available to one member of society every member of society consumes that unit of that commodity.
That requires that it is congestible, non-excludable, and that one cannot exclude oneself from consuming it once the commodity is made available.

My inclination is not to say that a policy is, or is not, a public commodity. But a policy can affect the level of a public commodity.

For example, it was U.S. policy to attack Iraq and because of this policy we attacked Iraq, and a war resulted. I would say that the existence of the war was (is) a public commodity from the perspective of U.S. citizens in that we all were forced to accept that we were a nation at war with a country in the Middle East. (Of course some of aspects of the war are not public in nature. For example, if Sargent Joe gets shot it does not imply we all take the bullet.)

The standard textbook example of a public commodity is national defense. If the U.S. protects one of us from foreign attack is protects all of us, or so the abstract argument goes.

Consider a policy to save flying dingbats from extinction. If the policy is successfully implemented, flying dingbats are preserved (saved from extinction). This outcome is public in nature in the sense that if they are saved for one of us they are saved for all of us, independent of whether we like or hate them. The stock of them exists and will continue to exist. (That, however, does not mean that every encounter an individual might have with a dingbat is public in nature. For example, if a dingbat breaks its neck flying into my deck window, breaking the window, this does not imply a dingbat flies into everyone's deck window.)

Please read the review questions and answers on how public commodities and common-property resources are not the same thing.

Some student examples that were either not on point or questionable included:

Sunlight: some aspects are some are not, so one has to be clear about what aspects of sunlight are public in nature. The heat (energy) from the sun is public in nature but not the light from the sun.

You can easily exclude yourself from it by going in a closet.

A regulation to restrict water consumption in California: This example confused me. It is the case that since it is the "law of the land" we all have to live with it, but what is the public commodity that was produced by this policy? A better legal example might be the Supreme Court ruling on marriage, the ruling that says any human can marry any other human. I would be inclined to say what is public is the knowledge that it is legal for anyone to marry. And what makes it a decent example is that it is something many people feel strongly about—this knowledge changes the utility levels of many of us.

One group said: a policy to reduce CFCs is public in nature because "One person's ability to reduce CFC's doesn't affect another's ability to do the same." I am confused by this explanation. Substituting words, I could say, "One person's ability to reduce their consumption of ice-cream cones does not affect another's ability to do the same." But while a correct statement, this fact does not make ice-cream cones a public commodity. We need to really think about what is the commodity that we are attributing a public aspect to.

A road congestion tax is designed to reduce congestion on congestible roads. It does not increase or decrease the amount of a public commodity? The road congestion tax in the U.K. was not implemented to reduce air pollution.

6.

Questions and answers relating to externalities:

1. What is an externality? What is a private good? What is a public good? Explain, in words, why externalities and public goods cause market failure.
2. Define what is meant by the term "market failure" (Don't define market failure by example). Now define one specific type of market failure that plagues the natural resource/environmental sector of the economy. (Your definition of a specific type of market failure should also be example free). Now explain, as if to another individual in this class, the impact this specific type of market failure will have on the allocation of resources. Now give an example of this type of market failure in the natural resource/environmental sector. Now discuss two ways the government might correct your example of market failure. (Your discussion of corrections should consider their distributional implications and their political feasibility.) Note that this question has five parts.

Answer: It is important to distinguish between a definition and an example. A market failure is something inherent to the market system that causes the market equilibrium allocation of resources to be inefficient. An important distinction is the distinction between market and nonmarket failures. Consider a world of no market failures (externalities, etc), but where the market equilibrium allocation of resources is inefficient, because of a government price control. In this case, the allocation of resources is inefficient, but it is not a failure of the market. If left to its own devices, the market allocation might have been efficient. The inefficiency was imposed on the market by an outside agent (the government), so the market cannot be blamed. This is a nonmarket failure. A lot of people feel the government is the author of many nonmarket failures.

Further note that the market has not failed if the equilibrium allocation is efficient but not fair. Markets did not evolve to achieve fairness. They cannot be deemed failures for failing to achieve something not in their job description.

Market failures include: ill-defined property rights (including, but not limited to common property), lack of complete markets (including, but not limited to the lack of futures markets) externalities, excess market power (monopoly and oligopoly power), public goods, and distortions in the capital markets.

I chose externalities as the type of market failure that I will discuss.

Externalities: There is an externality if an economic agent(s) does something that directly influences (not indirectly through market prices) some other economic agent(s) and there is the potential to make one of the parties better off without making some of the others involved worse off. Or, equivalently, there is an externality if an external effect is produced at an inefficient level.

Examples of externality-type environmental market failures abound.

Ceteris paribus, an externality is external effect produced at an inefficient level. If an economic agent’s actions produce a positive or negative effect on others but the agent producing the effect

does not have an incentive to fully take the effect into account, the agent will not produce the effect up to the point where the marginal benefit to society from the last unit produced equals the marginal cost to society.

Individual agents produce thing up to the point where the marginal benefit to the agent equal the marginal cost (this maximizes the agent's net benefits from the action). If marginal private benefits equal marginal social benefits and marginal private costs equal marginal social costs, the agent will produce the efficient amount from society's perspective, even though the agent is pursuing only his or her own interests.

When the agent's actions involve an external benefit or costs that he or she is not internalizing, a wedge is driven between marginal private and social benefits and/or marginal private and social costs. In this case, there is a divergence between what is best for the individual and what is best for society.

It is important that you show that the market allocation will be inefficient in the presence of the externality type you specified. To do this, you need to show that at the market equilibrium allocation, social benefits are not maximized. One could accomplish this by demonstrating that at the market equilibrium, marginal social costs of production (or consumption) do not equal marginal social benefits, implying the commodity is either overproduced (too much consumed) or under-produced (too little consumed).

Unregulated and untaxed smokestack emissions are an example of a negative externality.

Note that the presence of pollution does not imply the presence of an externality. There is no externality if the pollution (the external effect) is at its efficient level.

One could tax the emissions at the rate which causes the polluter to emit the efficient amount. The tax will be the amount that eliminates, at the efficient amount of emissions, the wedge between the private and social costs of pollution. The tax will internalize the external cost imposed on society by the emitter's actions.

Others actions include requiring the polluter to produce the efficient amount of pollution - no more no less. That is, a regulation that requires the firm to pollute a certain amount.

One could also achieve efficiency with tradable emission permits. Firms would be required to have a permit for each unit of emissions. The government would issue the number of permits that would achieve the efficient amount of pollution. Firms that could reduce pollution on the margin at a lower cost than some other firms would do so and then sell their excess permits to the higher cost firms. An important equity issue is how the government should initially distribute the permits. Options include selling them to the highest bidder, giving them to the firms, giving them to environmental organizations, etc.

Other Comments:

Market failure is not the same thing as inefficiency. That is, market failure implies inefficiency, but inefficiency does not imply market failure. Said differently, market failure is sufficient, but not necessary for inefficiency.

Necessary vs. sufficient, and definitions

Efficiency is not the same thing as optimality. Optimality implies efficiency, but efficiency does not imply optimality

Optimality (efficiency and equity)

As I noted earlier, lack of equity in a market allocation of resources is not a market failure. The market is not designed to achieve an equitable allocation.

3. Make an argument that criminal law can be used to internalize negative externalities.

Answer: Simply put, negative externalities exist because the private marginal cost of producing the negative external effect is less than the social marginal cost, and the externality can be internalized by increasing the private marginal cost so that it equal the social marginal cost at the efficient level of the external effect. There are many ways to do this. One is with a tax, another is with criminal law. The efficiency justification for criminal law is that it increases the private cost of producing negative external effects; I might go to jail, or worse. When I take this into account, I reduce the amount of the effect I produce. For example, I assault fewer people because I worry about getting caught and going to jail. "Don't do the crime unless you can do the time." The difficulties, as with a pollution tax, include monitoring the level of the external effect you produce, and setting the tax/penalty at just the right level.

Keep in mind that criminal law, to achieve efficiency, has to increase the private cost of producing the negative external effect by **just the right amount**: not too much and not too little. The fact that there is a criminal sanction does not mean it was set at the correct level. The correct level is a function of the penalty and the probability of getting caught. The same is true of pollution taxes. The fact that there is a pollution tax does not imply that it is set at the correct level. If it is set at an incorrect level, there will still be an inefficient amount of pollution (still too much, or now, possibly too little if the tax is set too high)

4. Discuss criminal and civil law as a mechanism for internalizing a negative externality such as the illegal dumping or storage of toxic wastes.

1. Consider our example of a firm-firm externality where a widget factory, which is located on a river, discharges its wastes into the river and causes damage to the down-river resort. Was the externality caused by a common property problem? Explain.

2. Consider our example of a firm-firm externality where the widget factory located on a river discharges its wastes into the common property river and causes damage to the down-river resort. In theory, could the inefficiency be eliminated by a merger of the two firms? Explain. How likely is this to happen in practice?
3. Consider our example of a firm-firm externality where a widget factory, which is located on a river, discharges its wastes into the common-property river and causes damage to the down-river resort. We concluded that the inefficiency from the externality could be eliminated by some appropriate per-unit tax rate on the waste dumped into the river. Explain why such a tax would eliminate the externality. Use a graph to support your written explanation. Under what conditions would a tax on widgets, rather than a tax on the waste, also work? When would it not work?

Answer: Consider two different situations: (1) there is a fixed relationship between widget production and pollution (no abatement is possible) and (2) without abatement, pollution increases as widget production increases, but for any level of widget production the firm can reduce pollution by allocating labor and capital to pollution abatement.

For either case, one can eliminate the inefficiency by an appropriate per-unit tax on the pollution. The inefficiency results because by the marginal social cost of polluting is greater than the marginal private cost of polluting. The inefficiency can be eliminated by setting the pollution tax so that at the efficient level of pollution, the marginal private cost of polluting (marginal private cost before tax plus the tax) equals the marginal social cost of polluting. In which case, the tax will cause the private firm to fully take into account the social costs of its pollution when it decides how much to pollute; that is, the tax forces the firm to pay the full marginal cost of its pollution.

Insert first graph

Note that the tax will give the firm some incentive to allocate labor and capital to the abatement of pollution; that is, the firm will have an incentive to reduce pollution not just by reducing widget production, but also be allocating labor and capital specifically to reducing pollution. If such abatement is possible, efficiency dictates that the efficient amount of labor and capital be allocated to pollution abatement. The efficient amounts will, in general, not be zero. The per-unit tax on pollution will achieve this efficient amount of pollution abatement. A per-unit tax on widget production would not, because while a per-unit tax on widget production gives the firm an incentive to reduce pollution by reducing widget production, it gives the firm no incentive to reduce pollution by allocating labor and capital to pollution abatement (it won't save any taxes by doing so).

When there is no abatement technology, then the only way to reduce pollution is to reduce widget production so a tax on pollution or a tax on widgets will work equally well. If abatement is not possible, there is a fixed relationship between widget production and pollution so one only needs to worry about the efficient level of pollution/widget production.

Insert second graph

With the potential for abatement, pollution can be reduced by either decreasing widget production and/or allocating labor and capital to the abatement of pollution. In which case, one needs to worry about the efficient level of widget production and the efficient level of pollution abatement. The problem with the widget tax is that, unlike the pollution, tax, it gives the firm no incentive to allocate L and K to pollution abatement.

4. Should the government try to internalize all externalities? When shouldn't the government intervene?
5. Discuss under what conditions a ban on smoking will, or will not, eliminate the inefficiencies caused by cigarette smoking.
6. Discuss under what conditions a ban on mountain biking in Boulder Mountain Parks, will, or will not, eliminate the inefficiencies caused by mountain biking in the parks.
7. Consider a situation where there are no restrictions on cigarette smoking, and where some individuals hate cigarette smoke. In these circumstances, might society end up with the efficient amount of cigarette smoking? Explain. Discuss the conditions under which this is more or less likely to happen.

8. Make a Coasian argument that the market will internalize externalities such that government intervention is unnecessary. Now argue that, in practice, government intervention will sometimes be required to eliminate the inefficiency caused by the externality

Answer: Coase argued that the market would naturally internalize externalities.

His argument is as follows: If an externality exists and the producer of the externality has the right or ability to produce the externality without restraint, then the recipient of the externality has an incentive to bribe the producer of the externality to reduce the external effect until efficiency is restored. And, if the recipient of the external effect has the right to not be the recipient of the external effect, the recipient can force the stoppage of the external effect, in which case the producer of the external effect will have an incentive to pay the potential recipient of the external effect to accept an efficient amount of the external effect.

For example, assume I have no right to smoke without your permission. In which case, I can pay you to allow me to smoke; that is, as long as my wtp to smoke another cigarette is greater than your wta the smoke from another cigarette, I have an incentive to pay you to smoke more and you have an incentive to accept my smoke and the payment. These incentives will bring about the efficient amount of smoke because until the efficient amount of smoke is reached we both can be made better off by a trade of money for acceptance of smoke.

Note that if my wtp to smoke is less than your wta smoke for all levels of smoke, the efficient amount of smoke is zero.

Alternatively, if I have a right to smoke and/or you cannot stop me from smoking, then you will have an incentive to bribe me not to smoke. That is, if your wtp to reduce my smoking is greater than what I need to be paid to smoke less, we can both be made better off if you pay me to smoke less. These incentives will bring about the efficient amount of smoke because until the efficient amount of smoke is reached we both can be made better off by a trade of money for acceptance of smoke.

Note that if your wtp to reduce my smoking is less that what I have to be paid to reduce my smoking, my current level of smoking is efficient. It might or might be fair, but it is efficient.

Such negotiations between parties do occur, in which case the externality is internalized. But often it is impossible and inadvisable for economic agents to enter into such transactions.

Coase's argument depends on either an agent(s) having the right/ability to produce the external effect, or an agent(s) having the right/ability to stop the production of the external effect. Both parties must know and accept these rights. It also requires that there are only a smaller number of producers of the external effect and a small number of affected parties.

In many cases, these rights/abilities are ambiguous and/or unacceptable to one or more of the parties.

For example, the recipient of pollution will be less inclined to bribe the polluter to pollute less if the recipient thinks he can get the rights clarified to his advantage and/or he anticipates the laws/regulations will be changed to ban or reduce pollution. You would not pay someone to smoke less if you thought it would decrease the probability that smoking would be banned. Alternatively, if the polluter thought that the rights of others to reduce or stop the pollution were not definitive, he would be less inclined to pay those parties to accept his pollution.

Crimes are a type of externalities and on some occasions potential victims pay protection money (bribes) to the potential criminal to not do the crime, e.g., the store owner paying protection to the mafia or the parents paying a ransom for their kidnapped child. But, for the most part, these types of transactions do not happen because it is often difficult or inadvisable for the criminal to identify himself before the crime, the contract is not enforceable, there are many potential criminals and there are many potential victims, and potential victims often reject the potential criminal's rights on moral grounds.

External effects often involve many agents, and when many agents are involved, negotiation costs can be sufficiently high to preclude the types of trades that Coase envisioned, even when everyone knows who has the rights.

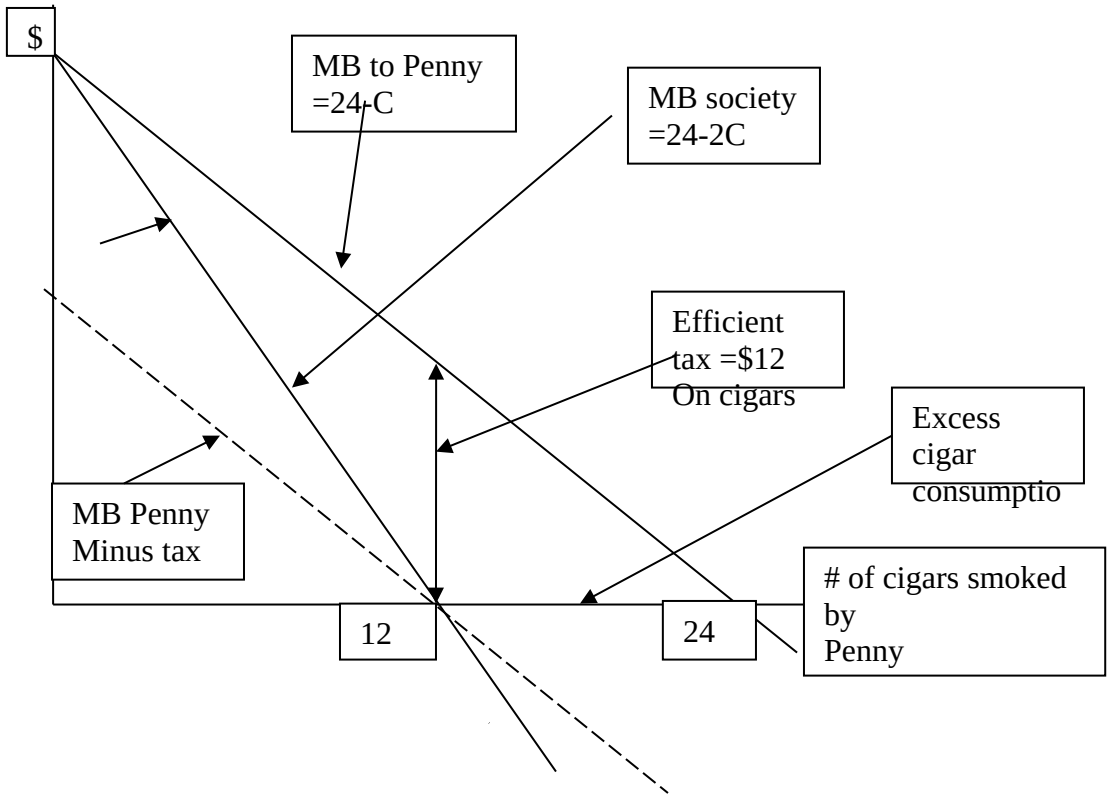
For example, automobile pollution is caused by millions of cars and affects millions of people. Even if the rights/abilities were clearly defined, it would be impossible for all the parties to get together and make an enforceable deal to reduce car pollution to an efficient amount.

In addition, when there are many parties affected by pollution, there is an incentive for each impacted party to free-ride on the payments made by others, and the efficient amount of pollution will not be achieved.

Another factor that complicate implementation of Coasian-type arrangements is the ability of firms to enter and exit an industry, the ability for parties to relocate, and income effects.

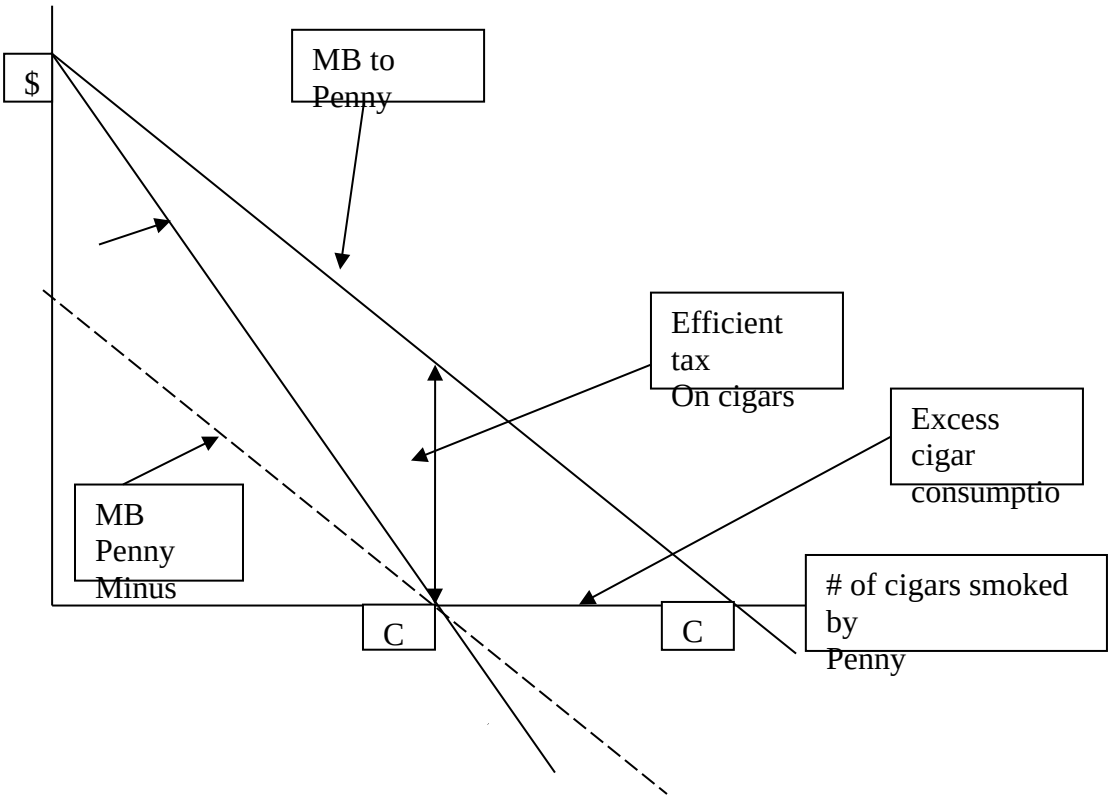
9. Remember Penny the smoker. Assume a two-person world. Penny is a smoker, Fred is not and the smoke makes him sick. Cigars are provided for free by God, marginal cost of cigars is zero for both Penny and society. The marginal benefits Penny gets from smoking, in dollars, are $MB_P = 24 - C$, where C is the number of cigars she smokes. Fred hates the smoke. The marginal cost to Fred of each cigar Penny smokes is an increasing function of the number of cigars Penny smokes. Specifically, $MC_F = C$. Determine the efficient number of cigars for Penny to smoke from society's perspective and the per-unit cigar tax the government might charge to entice Penny to smoke that number of cigars. Draw a graph to demonstrate what you are doing and to help you to figure out the answer.

Answer: The marginal benefits to society from Penny's smoking is the benefit to Penny, $MB_P = 24 - C$ minus the cost to Fred, $MC_F = C$. That is, $MB_S = MB_P - MC_F = 24 - C - C = 24 - 2C$. Since the marginal cost to society of providing cigars is zero by assumption, efficiency dictates that Penny keeps smoking as long as $MB_S > 0$. That is, efficiency dictates that Penny smoke 12 cigars. What tax rate would entice Penny to smoke 12 cigars. The tax should be set so that the marginal benefit to Penny of a cigar, including the effect of the tax, is zero when she smoke 12 cigars. Without the tax the marginal benefit to her of the 12^{th} cigar is 12 ($MB_p(12) = 24 - 12 = 12$), so the tax would have to be \$12 to get her marginal benefit net of the tax to zero.



10. Consider Penny, Fred and the cigars. Explain why subsidizing the party damaged by a negative externality will not eliminate the inefficiency. We will read your answer as if we do not know the answer and see how much we understand after we have read what you wrote. You can assume we got a good grade in intermediate micro theory.

Answer: In explanation, the market is initially failing because the cost to Penny of smoking an additional cigar is less than the cost to society of her smoking the cigar – she does not account for the damage done to Fred by her cigar smoke. This causes her to smoke up to a point where the marginal social benefit of her cigar smoke is negative. In this graph, it would be where MB to Penny is zero, but, as one can see, at this point marginal benefit to society is highly negative (zero marginal benefit to Penny plus a big negative benefit to Fred)



Simply put, giving money to Fred will make him happier, but it will not eliminate the wedge between the MB to Penny of smoking a cigar and the MB to Society from her smoking that cigar. In explanation, a subsidy to Fred gives Penny no incentive to smoke the efficient number of cigars from society's perspective.

In fact the subsidy might make the wedge larger. Consider the following possibility. A fixed amount of money (independent of the number of cigars she smokes) is taken from Penny and given to Fred. This makes Penny poor and Fred rich, causing Penny to want to smoke more, the despair of being poor. Now that Fred is rich, he has a much larger WTP to stop the smoke, so his marginal damages from cigar smoke, in dollars, is much larger. There is now a bigger wedge between the marginal social and marginal private benefits from cigar smoking. This will make the gap between the number of cigars Penny smokes and the efficient number of cigars from society's perspective even larger than it was before the subsidy.

Paying those injured by a misallocation of resources might be a nice thing to do but it does not eliminate the waste caused by inefficient allocation of resources.

11. Remember our widget producer located on the river that flows into the lake Wungabunga. Assume it is a competitive widget firm, and that P =MB to society from widgets. Also assume there is a one-to-one relationship between widget production and the amount of waste dumped in the river.

Further assume P=MBs=10, where MBs is the marginal benefits to society from widget production. Assume the marginal private cost of producing widgets is MCw=2W, and that the marginal damage to the resort from the pollution is MDp = 5T, where T=2W; T is units of toxic pollution and W is the number of widgets produced.

What tax on each unit of widgets produced would eliminate the inefficiency associated with widget production. What if the tax was instead on pollution directly? Explain your result and include all of the steps. As part of your answer, draw the graph for this case.

12. I smoke and you suffer from the second-hand smoke. Property right with respect to smoking are not well defined, there is no regulation of smoking, and I am smoking an inefficient amount (too much) – there is an externality-type market failure. The government "feels for you" so compensates you for the damages you are incurring from the smoke (pays you a dollar amount such that your total utility ends up being what it would have been if did not smoke). Has efficiency been achieved? Yes or No? And explain your answer.

Answer: the inefficiency remains. The problem is that I smoke too much from society's perspective (the net benefits to society of my last cigarette smoked is less than the net benefits to me (the pleasure I get from the cigarette), so society's net benefits would go up if I smoke somewhat less. Compensating you for my second-hand smoke, while maybe a nice thing from an equity point of view, does nothing to encourage me to take account of the damage to you when I smoke. After the compensation, the net benefits to me from my last cigarette are still greater than society's net benefits from my last cigarette.

Think of it this way. Even after the government gives you a bunch of money there is still the potential for us to enter into an exchange trade (I smoke less and you pay me off) such that both of us will be better off. In fact, after the compensation there is likely more potential for such an efficiency increasing exchanges because you now have more money so a higher WTP to reduce the amount of second-hand smoke you incur.

Said another way, even after the compensation, the net benefits to me from my last cigarette are zero, so I gained nothing from smoking it, and you are made worse off by it, not an efficient thing.

Comments on answers: A few are still quite confused on how to determine whether an allocation is or is not efficient, and this caused those in the confused group to get things backwards on this question.

First I will state the confusion in general terms and then as it applies in this case.

If it is possible to make someone better off without making someone else worse off the current allocation is inefficient. Everyone seems to understand this.

If an action is then undertaken that makes one party better off and no other party worse off, this action is a Pareto Improvement. We all seem to understand this.

However, just because one Pareto Improvement has occurred does not mean there is not the potential for more. Or said differently, things might still be inefficient.

Consider, for example, two people on a desert Island, you and me. You have good wine and lots of white truffles (you hate both but I love both). I, on the other hand, have two things I hate but you love: bud light and pickled herring. We trade the wine for the bud light making us both better off (there has been a Pareto Improvement). But at this point the allocation is not efficient because there is still the potential for another Pareto Improvement (we trade the pickled herring and the truffles).

So what does this have to do with the government compensating you for the damages from my second-hand smoke? The compensation makes you better off without making me worse off (OK fine) but things are not efficient after the compensation because there is still the potential to make one or both of us better off without making the other worse off.

Efficiency only exists when all of the potentials have been exhausted.

For those of you still suffering from some confusion, consider the term *fully grown*. It means that one will grow no more; there is no more *potential* for growth. Now consider a small child. That child is not fully grown because she will grow more (potential for growth remains). If between the ages of 6 and 7 the child grows 3 inches, we would say that some of the potential growth has been realized but we would not say the kid is fully grown – potential remains. As long as there is potential to make some members better off and none worse off, the allocation is not efficient. The fact that there have been some efficiency gains, does not mean there is not potential for more gains. As long as potential exists, the allocation is not efficient.

Some of you said that, after the government compensated you, making you whole, you were indifferent to the smoke. This is not a correct. The smoke still makes you worse off: you prefer the compensation and less smoke to the same compensation and more smoke. The critical issue, from an efficiency point of view, is whether after the compensation, there is still the potential for a Pareto Improvement, and the potential still exists if you are compensated.

Consider my in-class exchange of chocolates for diet cokes.

13. Jenny B is a rich socialite living on the Upper East Side of Manhattan. Jenny enjoys marijuana smoke but never buys or smokes the stuff. It is against the law and Jenny is a law-abiding citizen. I, on the other hand, am Pierre, the French ambassador to the U.N. I have diplomatic immunity (can't be arrested) and I love weed (slang for marijuana) very much. Jenny follows me around inhaling my second-hand smoke, which she much enjoys–inhaling second-hand marijuana smoke is not against the law. Given it cost, I smoke the efficient amount from my perspective (12 hours a day) but smoke an

inefficient amount from society's perspective (too little) because I do not take the benefits of my smoking on Jenny into account when I smoke.

The more second-hand smoke Jenny inhales the better off she is.

The government is morally outraged that Jenny has found a legal way to use drugs, so decides there should be a Jenny tax of $100 a month (paid only by Jenny). The tax is levied every month for the rest of Jenny's life, independent of whether she follows me around, she is addicted and the government has no expectation that she will be reformed. They chose $100 because that is her monthly WTP for my second-hand smoke. Of course, Jenny continues to follow me around – why wouldn't she. For the purpose of this question, you can assume that Pierre is not a member of society, but Jenny is.

Convince your reader that the tax on Jenny has not eliminated the externality market failure associated with my smoking.

Answer: see my answer to the other second-hand smoke question.

Some comments on students' answers: To achieve efficiency we need to encourage Pierre to smoke more (not less). One way to do this is with a subsidy – pay him so much per hour smoked. The tax on Jenny won't eliminate the inefficiency because it does not get Pierre to smoke more (change his behavior in the desired direction). Not that after Jenny is taxed the marginal benefit to Pierre of another hour of smoking is still less than the marginal benefit to society.

If Pierre behavior is unchangeable and fixed (something some of you assumed), there is no inefficiency. His smoke is like a sunny day (just part of the world). Something that is fixed is fixed, so can't be at an inefficient level. If something can't be changed, its level of use cannot be inefficient.

There was some mixing up of marginal benefits and marginal costs. The cost to Pierre of his smoking is the cost of the weed. The problem is that marginal benefits to Pierre from his smoking are less than the marginal benefits to society from his smoking.

For efficiency, it does not matter whether Jenny is or is not taxed.

14. Excess pollution from wood bringing stoves is a major problem in many Colorado mountain communities. Why has the problem arisen? Explain why, without government intervention, there is a market failure. Suggest a government strategy for internalizing, or reducing, the market failure. Discuss the efficiency, equity and political feasibility of your suggested strategy.

15. Discuss the advantages and disadvantages of using criminal law to internalize externalities.
16. Discuss the advantages and disadvantages of using civil law to internalize externalities. Why has no one in class asked me about this question?

17. The city of Boulder has many miles of trails, but bicycles are allowed on only a few of them. On the trails open to mountain bikes, the bikes cause damage to the trails, particularly when the trails are wet. In addition, their presence bothers hikers and other users. (1) Are external effects present? Yes, No, or Maybe, and explain. (2) Are the bikers who use the open trails producing externalities? Yes, No, or Maybe, and explain.

Answer: (1) Yes there are external effects. The bikes presence decreases, directly, the utility of other current users and decreases the utility, directly, of future mountain-bike riders because they rut the trails, mostly in wet conditions. (2) I do not know whether the current level of use (highly restricted – only a few trails are open to bikers) is or is not efficient. It might be, so my answer is "maybe". Recollect that there is only an externality when the level of the external effect is at an inefficient level, and, in this case, we do not have enough information to provide whether it is or is not.

18. Does the existence of pollution imply the existence of one or more externalities?
19.

Questions relating to common-property resources:

1. Assume a purely competitive society that has a common property oil field (many drillers have access to the same pool). This society is also characterized by excessive pollution since no one owns the air. Will the allocation of resources become more efficient if the government can correct the C.P. problem in the oil field? Explain.
2. What is the difference between a scarce textbook common-property resource and a public commodity? (1) As part of your answer define both terms and explain how they are different. (2) Explain why there is a market failure if a resource is a scarce and common property. (3) Explain why there is a market failure if a commodity is a public commodity. (3) Give the reader an example of an environmental commodity that is public in nature, convincing her that it is predominately public in nature. Answer the questions in the order asked.

Answer: A common-property resource is a resource for which access is not controlled. That is, anyone can harvest units of the resource for only the cost of harvesting. Said another way, there is no gatekeeper that can keep one from harvesting.

A public commodity, as defined in class and in the notes, is a commodity that is noncongestible in consumption, and that has the property that consumption by one implies consumption by all. In explanation, a commodity is noncongestible (non-rivalrous) if one individual's consumption of a unit of the commodity does not preclude other individuals from consuming that same unit of that commodity. The second condition says that if x units of the commodity are produced everyone in society is forced to consume those x units.

Scare, common-property resources and public commodities are different beasts.
Scare, common-property resources are congestible. Public commodities are, by definition, non-congestible. If everyone considers a public commodity a good, once produced, limiting access to it is inefficient.

The market fails in the allocation of scare, common-property resources because the private cost of harvesting an additional unit of the resource, by either an individual or a firm, is less than the cost to society of harvesting that last unit. This results because the private harvester is not required to pay or account for the full loss to society: because of their actions, there is less of the resource for others to harvest either now or in the future.

If access was controlled by a private profit-maximizing owner, the owner would require every harvester to pay this opportunity cost, if they want access. If access was controlled by the government, and the government behaved efficiently, they would either require harvesters to pay a harvest fee equivalent to the opportunity cost of the stock reduction, or allow no harvesting beyond the efficient amount.

The market will not produce public commodities in at efficient levels from society perspective.

Efficiency dictates that society produce commodities (private or public) up to the point where the marginal cost to society of producing an additional unit is equal to the marginal benefit. For private commodities the marginal benefit to society is the simply the marginal benefit to the individual that consumes the unit, but for public commodities, the marginal benefit is the sum of the marginal benefits (positive and negative) to every member of society. The problem is that a private producer cannot get people to pay their marginal benefit from consumption because there is no way to exclude anyone from consumption once the commodity is produced. Everyone can "free ride" on the consumption of others. Public commodities that are goods for all will be under-produced by the market. A major reason for governments is their ability to produce public commodities in efficient amounts. They have the ability to tax, so can force everyone to pay.

An aside: imagine a public commodity that everyone really hates. The efficient amount from everyone's perspective is zero. If I were a private firm with the rights to produce this commodity, I might threaten to produce it and try and get people to pay up to get me not to do it. But as with public goods, some people will not contribute hoping to free ride on the contributions of others.

An example of an environmental commodity that has a strong component of public-ness: Remember no commodity is purely public or private in nature. I am thinking of environmental commodities that individuals can get benefits from without actually being in contact with or without consuming in the "using up" sense of the word. These types of benefits are called "non-use benefits". Such benefits are non-congestible – my enjoying the thought of it does not preclude you from thinking about it. Examples might include knowing that the Alaska wilderness is protected or that a species has been saved in that wilderness. I choose the Alaska wilderness example because most of us will never go there, so most of benefits and costs are non-use in nature. A more complicated example would be the re-introduction of wolves in Colorado. For most of us, most of the benefits or costs we will receive are of a non-use, non-congestible nature. However, there are other effects that are not public in nature. For example, if the wolves eat my cows, they are less likely to eat yours, and I suffer the consequences, not you.

Some comments on answers: Non-congestible (non-rivalrous) is necc but not sufficient for a commodity to be a public commodity. Many of you incorrectly **defined** a public commodity as a commodity that is non-congestible.

Some commodities are non-congestible but not public commodities.

FM radio is an example. It is con-congestible but everyone does not have to listen to every song played on FM radio, you can exclude yourself. Another example is cable TV: Cable TV is non-congestible but it is not a public commodity because the supplier can exclude people.

A definition includes the necessary and sufficient conditions.

For example "a long neck" is not a definition of a giraffe

There are lots of things with long necks (e.g. some beer bottles) that are not giraffes.

3. Does the existence of a common property resource always cause market failure?

Answer: No. As explained in class, the market will only fail in the allocation of a common property resource if the resource is scarce.

If a resource is not scarce, everyone should be able to use as much of it as they desire at a zero price and that is how it will be priced if it is common property.

Remember that all resources basically started out as common property. There is no incentive to develop property rights for a resource as long as there is no expectation that it will become scarce.

Questions relating to excessive market power:

1. Assume one has a purely competitive society except for one monopolistic industry which is a heavy polluter. Will the allocation of resources become more efficient if the government can make the monopolistic industry competitive? Discuss your answer.
2. In what sense is a monopolist the conservationist's friend? If there are no other market failures, will a monopolist produce the efficient amount of the commodity?
3.

Questions specifically about efficiency:

1. Ralph needs a kidney and I want to buy a house in Tuscany. He gives me $250,000 in exchange for one of my kidneys. (One can live with just one kidney.) I use the money as partial payment for the house (houses in Tuscany are expensive).

Is this exchange a potential Pareto improvement (PPI)? A Pareto improvement (PI)? Or neither?

Yes or No and explain. As part of your answer define *Pareto improvement* and *potential Pareto improvement*. Grading: 3 pts max for defining *Pareto improvement*, 2 pts max for defining and *potential Pareto improvement*, 2 pt max for telling me whether it is a PI, a PPI or neither, and 3 points for explaining why.

Answer: A potential Pareto improvement is a reallocation of resources such that the gains to the gainers from the reallocation, measured in some common units, is greater than the loss to the losers. A Pareto improvement is a reallocation of resources such than some members of society are made better off by the reallocation and no member is made worse off.
A potential Pareto improvement has the adjective potential because it is not a Pareto Improvement, but has the potential to be one in the sense that if the gainers compensated the losers for their losses the reallocation would be a Pareto improvement. Whenever, the current allocation is inefficient there is always the potential for a Pareto improvement.

The exchange is a voluntary market transaction that makes us both better off, otherwise we would not have done it. If there are not external effects produced (no third-parties are affected), it is a Pareto improvement. If there are positive external effects it is a PI. If there are negative external effects produced, it is not a PI, but might be a PPI.

2. Is the efficient amount of pollution zero?
3. If the amount those injured by pollution would pay to reduce pollution is less than the amount the profits of the polluting firms would decrease if they reduced pollution, what can we say about the level of pollution?

Answer: Decreasing the level of pollution would be inefficient; doing so would not be a Potential Pareto Improvement. We cannot say for sure that the current level of pollution is efficient, it might be efficient or it might be efficient to increase the level of pollution, but we don't know: not enough information is provided.

4. What is a potential Pareto improvement? Why is it called a "potential" Pareto improvement?

Answer: A potential Pareto improvement is a reallocation of resources such that the gains to the gains from the reallocation, measured in some common units, is greater than the loss to the

losers.

A Pareto improvement is a reallocation of resources such than some members of society are made better off by the reallocation and no member are made worse off.
A potential Pareto improvement has the adjective potential because it is not a Pareto improvement but has the potential to be one in the sense that if the gainers compensated the losers for their losses the reallocation would be a Pareto improvement.

If there is inefficiency in the allocation of resources, is there always the potential for a Pareto improvement?

If the amount those injured by pollution would pay to reduce pollution is greater than how much the profits of the polluting firms would decrease if they reduced pollution, what can we say about the level of pollution?

5. Consider the following scenario originally devised by the psychologist Jonathan Haidt:

Julie is traveling in France on summer vacation from college with her brother Mark. One night they decide that it would be interesting and fun if they tried making love. Julie was already taking birth-control pills, but Mark uses a condom, too, just to be safe. They both enjoy the sex but decide not to do it again. They keep the night as a special secret, which makes them feel closer to each other. What do you think about that — was it O.K. for them to make love?
In terms of efficiency, how would you describe their having sex?

Answer: If one accepts the scenario as described, the sex made two members of society better off and no member of society worse off, so before they had sex the world was inefficient and their having sex was a Pareto Improvement. Interestingly, students I have surveyed on this issue overwhelmingly say their sex was wrong. The implication is that those students do not believe a Pareto Improvement is always a good thing –interesting. Often when asked why it is wrong, they reject the assumptions.

6. Imagine a guiltless economist with the opportunity to painlessly euthanize a poor, friendless unconscious, hospital patient, and have no one find out. Everyone will think he died of natural causes peacefully in his sleep. Further assume that the economist knows that if the guy dies, his organs will be harvested and used to save the lives of five productive, rich and liked members of society who need transplants. Assume the guy is the only genetic match. Should the guiltless economist euthanize the poor guy? Might it be efficiency increasing.

Answer: The killing could pass a benefit-cost test, so yes. The economist suffers no cost; the dead guy has no friends and feels no pain in death; the five rich guys are made better off along with their friends and families. The only cost is the loss in utility to the poor guy because he might have enjoyed living longer. Note all the adjectives are used in the question. That it might

be efficiency increasing in no implies that it is the right thing to do.

7. My experience is that most undergraduate econ majors do not understand the concept of efficiency. That is they don't really know what it means, or its implications.

   Please write a short essay that defines overall efficiency in a system/society. Include one or more examples of efficiency or inefficiency. Make sure you distinguish between the definition and the examples. You might want to distinguish between efficiency from society's perspective vs. efficiency from the perspective of an individual economic agent. As part of you answer walk through typical wrong answers and what makes them wrong. Make sure clearly distinguish between the right answer and your section of wrong answers. A good way to get a list of wrong notions of efficiency is for each in the group to start by writing down what they think efficiency means, and then the group can critique the answers to see if they are correct, or incorrect, and if so, why. You could also ask other econ majors how they would define efficiency.
   Two pages or less, hopefully less. Remember that the more you write the more likely you are to say something that is incorrect.

   Ideally I would like something I could post on the 4545 web site and the 2010 web site. Assume your reader had little prior knowledge of the concept.

I was disappointed in terms of the amount of thought that went into the answers. This is a difficult class that requires serious critical thought and good writing.

In a society the situation is efficient when it is impossible to make one (or more) members better off without making other members worse off.
This is it! The definition: no more no less.
One can determine that the current situation is not efficient but identifying a change that would make some better off and no one worse off. But knowing that the current situation is efficient is difficult: just because you can't identify a Pareto Improvement does not mean none exist.
To answer the question you needed to define efficiency, and then list a number of mistakes people make in defining efficient. In some of the responses I had no idea which things said you deemed correct and which you deemed incorrect. Some groups never bothered to list bad definitions.

Mistakes people make:
A definition should include both the necessary and sufficient conditions. Often people include on some of the necessary conditions. For example, efficiency requires that everything that is produced is produced at minimum cost from society's perspective. This is necessary for efficiency but not sufficient so is not a definition.
Or you provide a condition that is sufficient but not necessary. For example, "the allocation is efficient if one member of society consumes everything." While this might be a true statement (given your assumptions) it is not a definition. Being Bob the bear is sufficient for being a bear,

but this is not a definition of a bear.
You can't use the word "efficiency" to define efficiency, as in in "efficiency is when there is maximum efficiency."
Efficiency is defined **without using the word** utility and defining efficiency does not require that utility be a measurable cardinal concept (either for an individual or across individuals). The definition of efficiency does not use or imply that there is any such thing as utility. For example, it is wrong to say that efficiency is when total utility (across the members of society) is maximized. There are two problems with saying this: (1) Consumer theory does not assume that utility is a cardinal concept, only that, for an individual, more utility is better than less utility (the utility numbers are immaterial as long as they order situations correctly). And, even if utility were cardinally measurable for an individual there is no assumption that the utility numbers are comparable across individuals. And (2) even if utility numbers had cardinal meaning for the individual and were comparable across individuals, efficiency does not imply that total utility (the sum of everyone's number) is maximized.

> So, the situation is efficient when the only way to make some members better off requires that other members are made worse off. Is there an equivalent way of saying this in terms of compensating variations (WTP if, for you, it is an improvement, and WTA if, for you, it is a deterioration). Yes. If from the current situation there is no change that could be made for which the sum of the CV's for the change is positive, then the current situation is efficient. This definition would only be appropriate for an economy based on property rights and that has a common-unit of exchange (currency)
>
> The following also might be a definition of efficiency for such a society. The situation is efficient when total of consumers' and producers' surplus is maximized. If this were not the case, it seems that it would be possible to change things so that some members are made better off and no members are made worse off. This is a definition one finds in some text books for market efficiency. At this time, we don't really have the knowledge base to assess this common conjecture. Put simply, one can think of the sum of consumers' and producers' surplus as a dollar measure of utility given the existing distribution of income/wealth, but this is getting complicated.

People write down things that they think are equivalent to the definition, but are not equivalent, but the writer is unaware that would they have written is not equivalent.

> Efficient is not necessarily a situation where net utility, summed over all members of society, is maximized.
>
> > See above. And, for example, imagine a situation where a change would increase your utility by 10 utils (whatever the 10 means) and the change would decrease your utility by five. Assume you and I are the only members of society. In this case, before the change the net utility (whatever that means) is not maximized, but before the change the situation is efficient if the only way to increase my utility requires that your utility declines.
>
> Some groups said something to the effect that a situation is efficient if there is a change that would make some members better off would make some members worse off. This statement is wrong, but unfortunately very common.
>
> > For example, I then hit you over the head with a bat, which makes you worse off.

> I hit you because I like to hit people, so I am better off. This is a change where some are better off and some are worse off, but that does not imply that the situation was efficient before I hit you.

Efficient is not the same thing as socially optimal. Two things to keep in mind: there might be an infinite number of efficient allocations, and society might prefer a specific inefficient allocation to a specific efficient allocation.

A situation (such as an allocation of resources and a distribution of goods) is either efficient or not; there is no such thing as, for example, half efficient. If the situation is such that changes that make some members better off require that other members be made worse off, then the situation is efficient. If this is not the case, the situation is inefficient. If one goes from an inefficient situation to an efficient one we say the change is efficiency increasing. If the situation goes from inefficient to less inefficient we deem this efficiency increasing. Word-wise it is important to distinguish between "efficient" and "efficiency increasing". They are different things.

Efficient is a well-defined concept. A separate issue is whether we want the situation to be efficient. While economists tend to like efficient, most people do not judge good vs. bad in terms of efficiency. If asked to define efficiency, you can do so without discussing its goodness or badness.

The question did not ask whether efficient is good or bad.

Efficiency does not necessarily require that all machines are run 24/7 and that all people work 24/7.

The guy on the street might define efficiency in terms of how a specific resource is used (e.g. gasoline).[1] Economists don't define efficiency in terms of the use of resources directly but rather only in terms of how a change would affect each of society's members in terms of "better off" or "worse off".

I did not ask about equity or fairness. That said, some groups think equity means equal, which is not necessarily the case.

Efficiency and whether a particular method for allocating resources and distributing goods (e.g. command and control or a market system) achieves efficiency are two different issues

An equilibrium might or might not be efficient

Efficient is given for a given stock of resources and a given level of knowledge. So, increase in knowledge (e.g. technical progress) is not something an economist would describe as efficiency

[1] E.g. a "Prius is more efficient than a Lincoln Town Car because it gets better gas mileage." An economist might respond that "The goal of society is not to maximize gas mileage."

increasing.

Examples:
One group said something to the effect of “switching from coal power to solar power is efficiency increasing.” Another group said something to the effect that “introducing the Prius was efficiency decreasing.” I have no idea about either. To answer each question (is it efficiency increasing or decreasing) one would have to estimate everyone’s compensating variation for the change, which I am sure the group has not done. It would require a gargantuan effort to even estimate such a thing. If the sum the CV’s is negative (net WTP is negative) the change is efficiency decreasing, if positive (net WTP is positive) efficiency increasing. It is often very difficult to determine whether a change or new policy is efficiency increasing.

I would keep my examples very simple. An example of efficient: in a two person society where neither person cares about the other, and with only a fixed amount of one good, wine, one person having all the wine is efficient.

An example of inefficient: in a two-person society where neither person cares about the other, and with only a fixed amount of one good, wine, the distribution of wine is inefficient if the guy with all the wine hates wine.

The following questions have yet to be put in bins. In some cases this is because they do not fit into one of the above bins:

1. Assume that the competitive firms in the widget industry produce excess air pollution from an efficiency perspective because the air is a common property resource. If this inefficiency is eliminated by a Pigouvian tax on air pollution (a per-unit tax on pollution), what will happen to the number of firms in the widget industry? Is this a good or bad thing?
2. What is a market failure? Give me an example of an environmental market failure, and explain why it is a market failure. Choose an example that has not been discussed in class. Note that this question has three parts.

Answer: A *market failure* is something inherent to the market that causes the market equilibrium allocation of resources to be inefficient.

Note that it would be incorrect to say "a market failure exists when the allocation of resources is inefficient" because all inefficiencies are not caused by the market. For example, a nonmarket failure is an inefficiency caused by a nonmarket entity such as the government. Also, you would not call an inefficient allocation of resources in a centrally planned economy with no markets a *market failure*. Remember that there are many institutions, besides markets, that allocate resources.

Example: an inefficient amount of pollution because the private cost of polluting is lower than the social cost of pollution. This discrepancy between private and social costs causes firms to pollute an inefficient amount from society's perspective; that is, the firms pollute too much from society's perspective. Each firm pollutes up to the point where its marginal private benefits from polluting equals it marginal private costs of polluting, but because the marginal private cost of pollution is lower than the marginal social cost of polluting, at the equilibrium level of pollution, the marginal social cost of pollution is greater than the marginal social benefits from pollution, indicating that the firms are polluting an inefficient amount from society's perspective.

That is, net benefits to society would increase if pollution were reduced to the point where its marginal social benefits equals its marginal social costs.

This excess pollution is an externality-type market failure and is typically caused by a lack of well-defined property rights for the media (air, land, or water) into which the pollution is being emitted.

Note that: Presence of pollution is not proof of a market failure. For example, just because global warming is occurring does not mean that the market is failing. You have to remember that the efficient amount of pollution, global warming, crime, etc. is not typically zero, so its presence does not prove market failure. The market is failing when it is producing an inefficient amount of pollution. In fact, in might be the case that the inefficient amount of pollution produced is less

rather than more than the efficient amount.

Historically, bad weather was not an example of a market failure; it was a state of nature that affects us, it was given exogenously. We were not able to affect the weather. One might inefficiently allocate resources with respect to preparing or reacting to bad weather.

3. Argue, on **equity** grounds, that taxes (i.e., effluent charges) are a good way to eliminate the inefficiency caused by pollution type externalities. Now argue, on equity grounds, that they are a bad way to do it.
4. Assume Boulder has two factories that emit a total of 100 tons of particulates into Boulder air every day. Further assume that the EPA has decided that total emissions should be reduced to 70 tons. Is it efficient to achieve this level by requiring each factory to reduce their emissions by fifteen tons? Explain why or why not. If equal reductions are not efficient, what is the efficient way to achieve the 30 unit reduction? As part of your answer, define, in words, efficiency in this context, and mathematically derive the condition for efficiency.
5. What is a futures market? Are there well-developed futures markets for most natural resources? Explain why a lack of futures markets can cause the market to fail.
6. Explain how, under ideal conditions, a pollution permit system will reduce pollution by some specified amount in the minimum cost way. What are some of these *ideal* conditions?
7. Argue in equity grounds that pollution permits should not be given to the polluters. Now argue on equity grounds that pollution permits should be given to the polluters.
8. Discuss the regional implications of a national pollution permit system for SO_2 emissions, where abatement costs vary by region. How will such a permit system effect the regional distribution of pollution?
9. Assume the goal is to reduce pollution to some predetermined level. Compare the informational requirements of doing this with a per-unit pollution tax verses a system of pollution permits.

Answer: The current amount is inefficient because there is the potential for a Pareto Improvement (those affected by the pollution has sufficient WTP the firm to reduce its pollution, so that the firm could reduce its pollution and with the compensation not have lower profits.

10. Can bad weather a market failure? First argue no. Then argue yes. What is the critical determinant of whether it is or is not a market failure.

Answer: What is exogenous is exogenous and it makes little sense to discuss the efficient level of things that are given: stuff we cannot change, such as the amount of oil currently in the ground, the fact that the sun rises and sets, and that there are mountains in Colorado. Efficiency is only a relevant concept for things that we can adjust. We do not discuss the efficient speed of

the moon around the earth or the efficient number of mountains in Colorado. Acts of God are beyond our control. The fact that you will die is sad, but not inefficient—we all must die.

For things we can affect, we are concerned with the efficient amount or rate: What is the efficient number of cigars to smoke, the efficient rate to extract minerals from the ground, etc.

So, the issue with the weather is whether we can influence it. In the olden days (when I was a kid) the weather was considered beyond man's control. However, we now have man-induced weather/climate change: the man-created emission of green-house gases is changing the climate. So, I would say the market system can lead to an inefficient amount of bad weather (too much) —global warming being the prime example. But that often the weather is simply the weather, and not a market failure.

Some of you said weather cannot be a market failure, but it could be a nonmarket failure. If we are completely unable to affect the weather it can be neither, if we can affect the weather it can be either.

11. Assume the noted environmental economist Doctor Val Useless has determined that the efficient number of cars in Yellowstone is 5000 per day. His recommendation is that there be no entry fee or reservation system, and every day the park closes the gate after the 5000th car enters. Assume once a car enters it stays all day, and assume he got the number correct. Discuss whether his method of achieving the efficient number of cars is efficient. Discuss how, under his scheme, the benefits and costs of visiting Yellowstone by car will be distributed across the U.S. population (who will and who won't visit the park).

Answer: While Val' scheme will achieve the efficient number of cars to the park, it will not achieve the goal at minimum cost to society—it will not achieve the goal of 5000 cars efficiently. Put simply, we could make everyone, or almost everyone, better off by replacing Val's queue with a reservation system. In explanation, every morning there will be a race to the gate (people will likely sleep in their cars). Many hours will be wasted sitting in line, and the time wasted is by people with limited vacation time who have already spent many hours in the car driving to Yellowstone. Some people will drive thousands of miles only not to get in—what a waste. The people who get in will be those with the lowest value of time; that is, those with the greatest willingness to wait. Since kids have trouble sitting for hours in a car without driving their parents crazy, the scheme biases against children and parents, also people with high hourly wages, like lawyers and Finance professors. A lot of the visitors would be retired people with campers or Winnebagos.

Consider an alternative scheme (like the one used for campgrounds in Yellowstone): one goes online and reserves a spot for a particular day – spots are limited to 5000 a day. In this case, there would be the efficient number of cars/visitors and the efficient number would be achieved at a

much lower cost: no or little waiting time at the gate, demonstrating that Val's scheme is not efficient. (That said, this scheme is probably not the most efficient because efficiency dictates that the spots go to those with the most WTP for a slot.)

Note that I am not saying that an online reservation system with free admission is efficient, just that it is more efficient than Val's scheme, so Val's scheme is not efficient. One could increase the efficiency of a reservation system with free admission if one allowed individuals with reservations to scalp them on EBay. People with high WTP to get in would buy reservations from those with lower WTP and both parties would be better off.

An issue with free admissions, reservations and EBay is that the park would get no money and a lot of the benefits of Yellowstone would go to scalpers – this is an equity issue, not an efficiency issue. Yellowstone could limit cars to 5000 by charging an admission fee that would make just 5000 cars want to enter (it would likely have to vary by day of week, etc.). This would achieve efficiency, as long as one could buy tickets in advance for the day you want (a reservation system with a price – like buying concert tickets). Entry would go to the 5000 cars with the highest WTP.

Note that if you get in the park and I do not, and my WTP to visit the park is greater than yours, things are not efficient. I could pay an amount to switch places that would make both of us better off, and no one else worse off.

The park could efficiently achieve the efficient number of cars and get even more money if, instead of charging everyone the same admission fee, they ran an auction for each day's visitors. Everyone who wants to go next Tuesday enters into a second-price auction. You state your bid/WTP for a ticket. The top 5000 bids get a ticket but you don't pay what you bid, rather you pay what the next highest bidder paid. For example, if your bid was the highest ($5000) and the next highest bid was $20, you would pay $20 for the ticket, not $5000. This is how Ebay auctions work.

Note how the Rockies world-series tickets are being sold.

12. (Part A) Assume that, ceteris paribus, no one likes to stand in line. Imagine that one has to stand in line to get a "free" ticket for entry in Rocky Mountain National Park (RMNP). You get a ticket for entry the next day, which you can use or you can sell it to someone else. When you or the person who bought your ticket returns the next day, there will be no waiting in line. Does efficiency necessarily increase if you sell the entry ticket? Answer and explain your answer. Before answering read

    Matthew Malady, NYT, May 31, 2013, Want to Save Civilization? Get in Line

    (Part B) Now consider another situation: RMNP allows in only 100 people an hour, the first 100 people in line, and demand is such that there is always a line. Again the tickets

are free. The park is considering a new twist on their entry policy. They propose to let people go to the head of the line if they pay $25, and studies show that some people will pay. Will this proposal to introduce these $25 tickets necessarily increase efficiency? Answer and explain, including in your explanation how this situation differs, or not, from the situation in the first half of the question.