A Funny Thing Happened on the Way to the Final

Xan Vongsathorn

June 1, 2016

> If you found this problem easy, great! If you found this problem hard, great! Whether life gives you hard cheese or soft cheese, grate! (But if life gives you runny cheese, *run*).
>
> — Homework 1, *Microeconomic Theory*

Below are a few of my favorite problems written for Principles of Microeconomics (Econ 52) and Microeconomic Theory (Econ 102) during my year as "Professor X" at my alma mater, Pomona College. Not all of them are humorous, but generally the more boring the topic, the harder I have worked to keep things lively. Before we get to the problems, I'll share some thoughts on my process, and the place of humor in the classroom.

An Interesting Boring Example. Suppose we are writing a question about insurance. The way I see it, we can either pretend that students *don't* find insurance boring, or we can confront the problem head on. One particularly bold approach would be to title our question *Boring Insurance,* and see if escape is possible from such a dismal premise. The problem could begin:

> **Boring Insurance (10 points).** It's true that insurance can be a boring topic, but did you know that everything Interesting in the world is really just the sum of enough Borings? In this problem, we will consider the impact of dental insurance on your beloved but—let's face it—unremarkable molars. Indeed, molars are dull in every sense of the word, even for teeth. Moreover, even dentists agree that dentistry is a quintessentially *boring* profession. Granted, it's not that dentists find teeth boring so much as the fact that they spend all their time *boring into teeth*.
>
> Interestingly, it could be said that the very purpose of insurance is to make life boring, even when it's not—even when the *dentist* is boring.

We're off to the races now. We can ask what insurance policy will be purchased given some utility function, and explore flossing behavior under different policies. Why floss less when you have great dental insurance? **I sacrificed a goat to Ludiverse**, the god of wordplay, and he delivered an answer: *molar hazard*[1]!

On Joking and Joke Discovery. *Boring Insurance* isn't a real problem, although it could be. For now, it's just an example I concocted to illustrate my own style and approach to humor. My feeling is that irreverent whimsy doesn't preclude tight logic, and in fact can *facilitate* it. We're joking around, but somehow it all fits together, and if we're lucky the **fantasy** gives us a new perspective on the **reality**. Hey, couldn't the same be said of economic models? On some level, all economists agree that it's possible to be fanciful and yet serious at the same time, which is really my preferred state. By contrast, I'm not so interested in *solemnity,* which presents only the veneer of seriousness with none of the depth.

[1] As econ puns go, this one may be the G.O.A.T. Indeed, note that there's a serious molar hazard problem distorting incentives on the dentist's side as well! To drill or not to drill? Of course, my dentist would say he's a pure soul motivated only by a love of dentistry, not financial gain. Even so, should I really trust someone who's deeply fascinated with my teeth and just can't wait to find out what's inside? Molar hazard! It was worth the goat.

As you can see, I especially like linguistic humor[2]. I like to play with quirks of English that are baked right into the language, which has forced me to realize that I'm not *creating* these jokes so much as *discovering* them. English is a dense web of words connected to other words by meanings and spellings and sounds. And it just so happens that **conditions are ideal for life**. In my experience, starting from any arbitrarily boring point, there's almost always a nearby source of wordplay. Often I simply decide an already-written but humorless problem should be funny, and don't stop exploring the vicinity until I discover some decent jokes. And it works!

Joke discovery can be time-consuming, of course, but I became much more willing to invest my time once I realized that it would almost always pay off. I can't say what your return on investment will be; **I can only tell you what's possible.** And what's possible is *more than you think.* More than you think! **More than you think.** I'm hoping you just updated your prior a few times, because I have been repeatedly surprised at how many nearby jokes exist, waiting for someone, anyone, to discover them. *Boring Insurance* is not a cherry-picked example; rather, I chose insurance on the spot as an example of a topic students find boring, and *Boring Insurance* is what came out[3].

Wherever you're starting from, there are nearby jokes waiting to be found. And you don't have to be a wizard to find them. It takes magical powers to be a wizard, but anyone can be an explorer *simply by exploring.*

The Point of Humor. Humor has many purposes, of course. Students will be happier and more engaged, and work harder while complaining less, if they are entertained, and if they know their professor is working hard to reduce the boredom quotient of the class. I've had students tell me they are *almost* excited to do my homeworks! But of course, it's hard to gauge the true size of these effects. Students are not always honest, even if they know the effect humor is having on them. If you ask, **"Who's bored?"** in class, no one will raise their hand, even if many of them are. Incidentally, though, if you ask the same question again—secretly substituting homophones for both words—while holding up someone's *skateboard*, you are guaranteed both honesty and retroactive honesty: one student will raise her hand to claim ownership of the board, and even better, now nobody is bored[4].

And then there is the matter of the elephant. As teachers, we want to feel that we're having a long-term impact on our students. Yet the **elephant in the classroom** is, ironically, that most students quickly *forget* most of what they've learned. It's hard for me to ignore this[5], and although I don't have a perfect solution, I'd like to think that humor can help to bridge the gap by vivifying important concepts—that while "moral hazard" may be doomed, "molar hazard" has a fighting chance.

In any case, for every purpose that humor serves, there is the ever-present teaching multiplier: **the impact of every minute spent improving your homework problems is multiplied by the number of students who will solve them**. Personally, I found my efforts to be worthwhile even at a liberal arts college with small classes I would only be teaching for one semester apiece. I cannot say why textbook authors aren't making a greater effort, at their scale. That said, I can't pretend to be motivated *only* by a concern for my students. **I enjoy writing these problems**, and I wouldn't

[2] *De gustibus non est dispuntandum:* Literally, "There's no disputing a taste for puns." Unfortunately, there's also no disputing a distaste for puns. Even so, if you can't tell a *good* pun from a *bad* pun, at least try not to guess. Yes, it's true that in polite company, society expects us to groan at all puns, and to laugh at all other jokes. But from this, surely we cannot infer that all puns are truly groan-worthy, unless we are also willing to infer that all jokes are funny. Don't be a sheep! If you need some help, the pun at the beginning of this footnote is really good (so good, in fact, that it will only be noticed by people who appreciate it!), whereas the pun at the end is—and here we are in full agreement with the sheep—*baad.*

[3] For a completely different take on insurance, see *Gobble Gobble* below.

[4] This one will get you a laugh, and maybe even some money if you play it right. "Who's bored? *No one?* Sigh...students are never honest with me. Okay, I'm going to ask again, and Joe, I bet I can at least get *you* to raise your hand. No? Even if you swear you will be honest? Care to put a dollar on that? Easy money. OK...*whose board?*" Everyone knows not to bet against a magician, but nobody has been warned about verbal magic tricks. If Joe is foolish enough to bet a dollar, take a moment to emphasize the deeper lesson that whenever someone promises "easy money," he generally means easy money *for himself.*

[5] "Don't think of an elephant!"

work nearly as hard on them if I didn't. You will find ample evidence of this below, including a joke about vexillophily, which I *love*[6], and I don't really mind that none of my students will get it—in fact, the less appreciated the joke is, the *better* it becomes[7]. At some point, it is art to me.

You don't have to feel that way, of course. I can't say if *your* homeworks should be more humorous. **But at the margin, we should be doing more of it.** Frankly, isn't it incredible that you are still reading this, when you could be watching cat videos on YouTube? That's the power of humor. Without it, you'd be long gone by now, yet here you are. And while it's true that students are a captive audience with no choice but to solve our homeworks, we can dream of a world where the constraint doesn't bind, where students do homework *because they want to*.

That's a lofty goal, but every step in that direction is a good step to take. **Feel free to use the problems below**, in modified or unmodified form. Detailed solutions are available upon request.

[6] The joke, that is, not the vexillophily. I'm not a vexillophile, let alone a vexillophilophile, although I do recommend Roman Mars' Ted Talk on the subject.

[7] It just amazes me, that such a thing could exist. I'm not sure there's a word for the feeling of deep satisfaction I get from discovering **logical contraptions** that work in surprising ways. The best I can do is to paraphrase Yoda:

> *For my ally is logic. And a powerful ally it is. Logic surrounds us and binds us. Luminous beings are we, not this crude matter. You must feel the logic around you. Here, between you, me, the tree, the rock, everywhere!*

Isn't this the exact feeling that drew so many of us to economics, or for that matter physics, math, computer science? And it is the same feeling that draws me to humor. Try it sometime, maybe you'll like it!

Problems

1. **Bull Markets and Bear Markets. [42 pts].** *(Econ 52, HW 2).* As this is a microeconomics class, we will take a bull market to mean a market for bulls. Suppose that the annual Texas market for bulls is perfectly competitive[8], with demand and supply given by

$$\begin{aligned} Q_D &= 10000 - 2P \\ Q_S &= 3P - 2000, \end{aligned}$$

where price is in dollars[9] and quantity is number of bulls.

   (a) **[4 pts]** Plot supply and demand, and find the equilibrium price and quantity.

   (b) **[4 pts]** What are consumer surplus, producer surplus, and total surplus in equilibrium?

   The Society of American Rodeo Clown and Almighty Saddle Mavens is a powerful political lobby dedicated to preserving our nation's fine tradition of rodeo. People *talk* about them. You can't go five minutes on the fine tradition of rodeo without SARCASM coming into the conversation. It's a very important group.

   SARCASM believes that bulls have gotten too pricey for the struggling rodeo industry to afford. To address this, they have successfully lobbied for a regulation that would set a maximum market price of $1800 per bull.

   (c) **[4 pts]** Add the price ceiling to your plot above. What is the new equilibrium price and quantity of bulls? Is the rodeo industry likely to face any unforeseen consequences of this new policy? Who benefits and who loses from the new policy?

   (d) **[4 pts]** Calculate producer surplus under the new equilibrium – has it risen or fallen? Does something prevent you from calculating consumer surplus when the price ceiling is in place? Can you say which buyers are purchasing bulls in equilibrium?

   Due to overwhelming complaints from the very rodeos it was trying to help, the price regulation is immediately repealed. But rodeos still face a serious problem. Ticket sales have declined in recent years, owing to the increased popularity of alternative forms of entertainment. Noting that spectacles like *Game of Thrones* are both popular and violent, the rodeos are hoping to boost demand by increasing the *danger factor*.

   SARCASM aside, rodeos are no laughing matter. Bull riding is a dangerous business[10]! However, it is not as dangerous as *bear wrestling*[11]. Therefore, the rodeo industry acquires a stock of

[8] This is not an unreasonable assumption; livestock are a lot like other agricultural commodities, the only real difference being that corn does not have feelings (or as cows like to call them, moo'ds). Furthermore, corn and cows are lexically similar, in that if you join together the last two letters of "corn" and flip them over and squint a bit, you will see a cow. It must also be said that cows have been in the business of producing natural gas – our textbook example of a commodity with a highly competitive market – since before there *was* a business of producing natural gas. Inquiring minds may google "cow wearing backpack."

[9] Known, for obvious reasons, as *moolah* in the industry.

[10] It is quite a long way to fall, after all – that is to say, the steaks are high. Some have argued that all good cow puns – which is universally understood to mean *bad* cow puns – must revolve around the moo, a claim which we have now definitively disproven (or, as cows would say, rendered moo't). In any case, no human can truly resist a good cow pun, just as no human can resist making animal sounds at animals. However, it is interesting to observe that *we* decided "moo" is the sound that cows make. *We* decided that sheep go "baa" and pigs go "oink." And whenever we see these animals, we make "their" sounds at them. This leads to the curious realization that **all animals think that the sound humans make is the sound humans think those animals make.** In other words, all cows now believe that humans communicate exclusively through a series of moos, a fact supported by years of close observation of the human species in the general vicinity of cows.

[11] Which in turn is not as dangerous as algebra, because your professor once had an algebra teacher whose claim to fame was that he wrestled a bear in college and (allegedly) won, which meant that algebra errors may be subject to disciplinary measures more severe than a genuine bear attack.

ferocious 1,200-pound Kodiak bears, and decrees that all bull riding will henceforth be replaced with bear wrestling.

The monthly market for rodeo tickets in San Antonio **before** the change has demand and supply curves given by

$$\begin{aligned} Q_{D_0} &= 16000 - 200P \\ Q_{S_0} &= 200P \end{aligned}$$

where quantity is number of rodeo tickets, and price is in dollars. The addition of bear wrestling proves popular, immediately increasing demand to

$$Q_{D_1} = 20000 - 200P.$$

Unfortunately, bear wrestling also results in a precipitous drop in the supply of available rodeo clowns[12]. In turn, this reduces the number of rodeos – and therefore rodeo tickets – that can be provided at a given cost. The new supply curve is

$$Q_{S_1} = 200P - 8000.$$

(e) **[4 pts]** What are the equilibrium price and quantity before and after the change? Do they increase or decrease due to the addition of bear wrestling? If we did not have the exact formulas for demand and supply but knew that demand shifted right while supply shifted left, could we say anything about the direction of the effect on price and quantity?

(f) **[4 pts]** Calculate total surplus before and after the addition of bear wrestling. Does it rise or fall?

(g) **[4 pts]** What is the price elasticity of demand at the original equilibrium? At the final equilibrium? In each case, are we at an inelastic, unit elastic, or elastic part of the demand curve? Interpret each elasticity. Do these elasticities have units?

After a year of bear wrestling, rodeos are beginning to fear that, despite their popularity, the bears are taking an unsustainable toll on the supply of rodeo clowns. Fortunately, a brilliant idea has just been proposed by SARCASM director and 2015 Name of the Year winner Amanda Miranda Panda[13]. At the annual SARCASM-fest, she calls for the immediate replacement of all Kodiak bears with *panda bears*[14], reasoning that the giant panda is simultaneously *much less dangerous* and *much more popular* than the Kodiak bear. Amanda Miranda Panda estimates that, with panda wrestling[15] in play, supply and demand for rodeo tickets will be given by

$$\begin{aligned} Q_D &= 24000 - 200P \\ Q_S &= 200P. \end{aligned}$$

(h) **[4 pts]** Plot supply and demand, and find the equilibrium price and quantity. What are consumer, producer, and total surplus?

---

[12] For reasons that do not *bear* thinking about.

[13] This is true, actually. The Name of the Year tournament is held every year alongside March Madness. In 2015, Amanda Miranda Panda beat out a strong field of 63 other contenders, including Swindly Lint, Dr. Electron Kebebew, and my personal favorite, Infinite Grover. For more information, you are welcome to visit nameoftheyear.com, and be sure to vote next March.

[14] *Bear in mind* that Amanda Miranda Panda always has her favorite *bear in mind*. But it should be noted that pandas and wrestling do actually have a strange history together, as the panda is the logo of the WWF. The World Wrestling Federation and the World Wildlife Fund both claimed the WWF acronym until 2002, when the World Wildlife Fund wrestled it away from the World Wrestling Federation, which has since become the WWE.

[15] Which is more like panda cuddling, as long as you don't take away their bamboo.

Amanda Miranda Panda's plan is very well-received. Unfortunately, it turns out that the supply of pandas is tightly controlled by the Chinese government[16]. Thus, rodeos are able to get their hands on only a few pandas, which in turn means they cannot offer as many rodeo shows, and therefore cannot supply more than 8,000 rodeo tickets.

(i) **[4 pts]** Interpret this as a *quota* of 8,000 rodeo tickets, and add the quota line to your plot above. Assume that panda owners rent out their pandas to rodeos, effectively charging rodeos a price-per-ticket-sold in order to use the pandas. In equilibrium, what will be the price and quantity of rodeo tickets? What will panda owners make per ticket sold?

(j) **[6 pts]** Which sellers and buyers operate in equilibrium? What are consumer and producer surplus? What is the total magnitude of quota rents? What is total surplus, including consumer, producer and also quota rents? What is the deadweight loss resulting from the quota?

(k) **[0 pts]** How much would you be willing to pay to attend a rodeo that featured panda wrestling? Be honest.

[16] In fact, panda immigration laws are even more restrictive than human immigration laws. Even pandas born on American soil are not citizens of the US! All pandas belong to China and can be recalled at any time, even if they have lived here their whole lives and never learned to speak panda Chinese. For more information, see Matt Yglesias' recent Vox.com article, *We need birthright citizenship for pandas.*

2. **Exotic Budget Constraint *(There Will Be Blood).* [25 pts]**. *(Econ 102, Final Exam).* The San Diego Zoo has a budget of 100 pounds of meat per day to feed its **exotic cats**, namely Sumatran tigers and snow leopards. It can freely allocate as much of this budget as it desires to tiger food, x_1, and leopard food, x_2, both of which are measured in pounds.

   This problem starts out as tame as a heavily sedated tiger. However! *There Will Be Blood*[17].

   (a) **[2 pts]** Draw the budget constraint, putting tiger food, x_1, on the x-axis.

   (b) **[3 pts]** The zoo's utility function is

   $$u(x_1, x_2) = x_1^{3/4} x_2^{1/4}.$$

   Circle the utility functions below that are "equivalent" in the sense that they represent the same ordinal preferences over consumption bundles:

   i. $u = x_1^{3/4} x_2^{1/4} + 47$
   ii. $u = 2x_1^{3/4} x_2^{1/4} - 47$
   iii. $u = -2x_1^{3/4} x_2^{1/4}$
   iv. $u = \frac{1}{2} x_1^{3/4} x_2^{1/4} + 47x_1$
   v. $u = 3 \ln x_1 + \ln x_2$

   (c) **[7 pts]** Construct the zoo's Lagrangian, using their original utility function or (if you prefer) an "equivalent" utility function of your choice. Find the zoo's optimal consumption bundle.

   So far so good, but here's where things start to get dark.

   The Case of Tiger Blood: The zookeepers notice that if they decrease tiger food, x_1, below 20 pounds per day, tigers start to die. And—so they reason—meat is meat, so we may as well feed the dead tigers to the leopards. In particular, below this threshold, reducing x_1 by 1 pound per day generates an extra 1 pound of tiger meat per day, which snow leopards view as equivalent to regular meat.

   The Case of Human Blood: Furthermore, it turns out that if the zookeepers try to reduce snow leopard food, x_2, below 30 pounds per day, the snow leopards will break out of their cage, go on a bloody rampage, and start eating the customers. In particular, in this contingency they will convert exactly enough customers into leopard food so that $x_2 = 30$.

   (d) **[8 pts]** The San Diego Zoo's new and horrifying budget constraint is like nothing you've ever seen. **Draw it, being as clear as you can about any intercepts and points of interest.** Shade in the region of affordable bundles, clearly delineating it from unaffordable bundles.

   (e) **[5 pts]** Assume that the zoo's utility function has not changed[18]. Given your answer to the utility maximization problem above, can you say anything about the new optimal bundle of tiger and leopard food? **Will there be blood?** If so...can you say **what kind,** without solving a new utility maximization problem?

[17] In the style of the most recent wave of Geico commercials, I'm telling you up front how this problem ends. It ends in blood. The idea is that now you are curious and can't help but solve it to find out *why*. However, the true twisted genius of this problem is that even if you *don't* solve it, there will still be blood, or—to call it what it really is—red ink, bleeding through the paper. Under the circumstances, I'm sure we would all prefer the euphemism, so again I say: *There Will Be Blood.*

[18] To be clear, this dubious assumption is equivalent to the zoo not caring about the particular *source* of the meat for its leopards and tigers.

3. **Just Keep Optimizing. [15 pts].** *(Econ 102, Midterm 2).* Dory is a fish with short attention span. At any given time, Dory can only concentrate on the next 3 minutes[19]. Furthermore, she is especially fixated on the current minute, and thus she discounts her future utility quite heavily. In minute 1, her utility function is

$$U(c_1, c_2, c_3) = \ln c_1 + \delta (\ln c_2 + \ln c_3)$$

where $0 < \delta < \frac{1}{2}$, and c_t is consumption of fish food in minute t. At the beginning of period 1, Dory receives a windfall[20] of M flakes of fish food, and does not expect to receive more in the near future. She chooses how much food to eat in each period, and therefore her goal is to choose consumption (c_1, c_2, c_3) to maximize U subject to the constraint that $c_1 + c_2 + c_3 \leq M$.

(a) **[2 pts]** Construct Dory's Lagrangian, using λ as the multiplier.

(b) **[8 pts]** Take first order conditions and find Dory's optimal choice of consumption in each period, (c_1^*, c_2^*, c_3^*).

(c) **[1 pt]** How does Dory's planned consumption in minutes 2 and 3 compare?

In minute 2, Dory's utility function becomes

$$U(c_2, c_3, c_4) = \ln c_2 + \delta (\ln c_3 + \ln c_4).$$

Assuming that she has already eaten c_1^* (the optimal quantity found above), her remaining budget of fish food is $M' = M - c_1^*$.

(d) **[4 pts]** Does Dory have time consistent preferences? If we were to solve out Dory's maximization problem in minute 2, should we expect her to change her mind about the optimal choice of c_2^* and c_3^*, or will she agree with her plan from minute 1? Why or why not? [**Don't** solve this out. Just tell me your expectations].

[19] That is, the current minute and the two that follow it.

[20] or perhaps...waterfall?

4. **Kidney Exchange! [20 pts].** *(Econ 52, HW 9).* We now turn to perhaps the most important application of the Top Trading Cycles algorithm: **kidney exchange.** It turns out that, although we used TTC to trade **mere pieces of candy** in class, the candy can be thought of as a direct metaphor for kidneys. And when Ross asked if he could trade away *half* of his Twix bar, the answer was that while candy is divisible, internal organs generally aren't, even if Aaron did make a good point about chopped liver. TTC is a simple thing, and trading candy is a light diversion, and we're all joking around as usual, but **don't be fooled by appearances.** *Even when we're kidding around, the underlying economic logic can be deadly serious.* This has been true again and again in this class, but perhaps it has never been more obvious than now, when we are talking about matters of life and death.

   The fundamental unit in kidney exchange is a donor-recipient pair. For instance, suppose John and Jane are married, and John needs a kidney. Jane has two kidneys but needs only one, and she is happy to donate a kidney to John, but her blood type[21] is not compatible. In this case, Jane and John form a donor-recipient pair, where Jane is the donor and John is the recipient.

   Now suppose that Angela and Abe are another such donor-recipient pair: Angela is happy to donate her kidney to Abe but her blood type is not compatible. If Angela is compatible with John, and Jane is compatible with Abe, then they could swap kidneys, and both John and Abe would get the transplant they need.

   For simplicity, we can actually forget about the donor-recipient pair and just think about kidneys as goods that are allocated to individuals like John and Abe. Just as a student may have a piece of candy or a dorm room but prefer that of someone else, John effectively *has* a functional kidney – which happens to be inside Jane – but prefers the kidney of someone else, namely that of Abe.

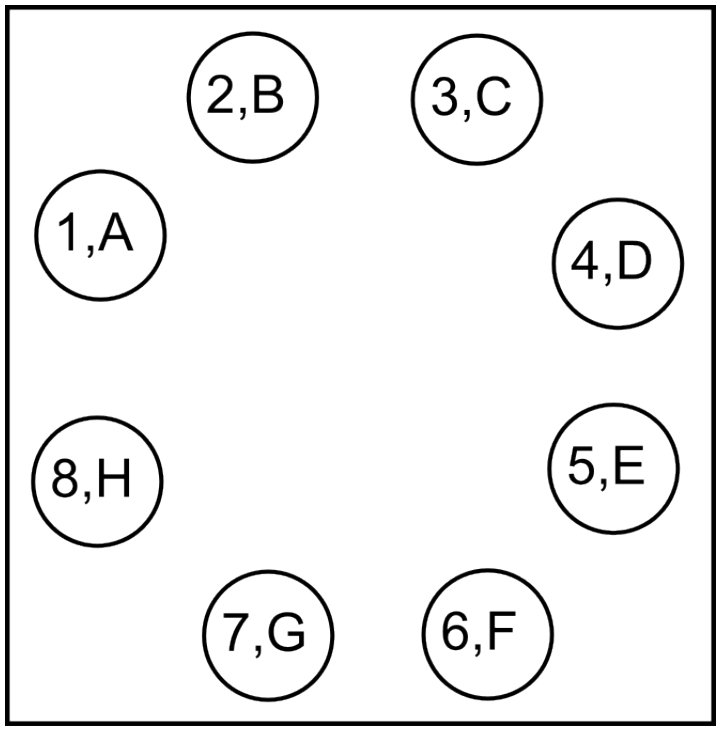
   Now suppose that we have **eight recipients, numbered 1 through 8, each with a kidney, numbered A through H**. Person 1 owns kidney A, 2 owns B, and so forth. Each recipient has preferences over kidneys, which may take into account compatibility (blood type and other factors), as well as the overall quality of the kidney (influenced by age and health of the donor). We can represent, say, recipient 1's preferences with a rank-order list like B>C>D>G>H>A. This means that recipient 1 likes kidney B best, followed by C, D, G, H, and then his own kidney, A. Some of the kidneys (E, F) are not on this list, because they are incompatible with recipient 1. The idea here is that recipient 1 would rather hold onto kidney A (which he can use to trade at a later date), rather than accepting a kidney that is incompatible. So there is no need to specify his preferences over E and F since he will never consider trading for them.

   Preferences over kidneys are as follows:

Recipient, Original Kidney	Preferences
1, A	B>C>D>G>H>A
2, B	D>F>B
3, C	G>A>B>E>F>C
4, D	A>C>G>F>D
5, E	A>D>H>G>E
6, F	H>B>A>F
7, G	H>G
8, H	A>D>C>F>B>H

[21] Other factors also come into play, including tissue type.

(a) **[6 pts]** In the diagram below, draw arrows that depict each recipient's top choice. Describe any cycles. (You can describe a cycle compactly as follows: if 1 points to 2 points to 3 points to 1, that can be written as $1 \to 2 \to 3 \to 1$).



(b) **[4 pts]** Eliminate all cycles found in the previous step (that is, allow these recipients to execute trades and exit the market) and redraw the diagram with the remaining recipients. Indicate each remaining recipient's top choice among the remaining kidneys. Describe any cycles.

(c) **[4 pts]** Eliminate all cycles found in the previous step and redraw the diagram with the remaining recipients. Indicate each remaining recipient's top choice among the remaining kidneys. Describe any cycles.

(d) **[4 pts]** What is the final allocation of kidneys? Answer by filling out the below table (if solving on looseleaf, you may simply provide the final column).

Recipient, Original Kidney	Preferences	Final Kidney
1, A	B>C>D>G>H>A	
2, B	D>F>B	
3, C	G>A>B>E>F>C	
4, D	A>C>G>F>D	
5, E	A>D>H>G>E	
6, F	H>B>A>F	
7, G	H>G	
8, H	A>D>C>F>B>H	

(e) **[2 pts]** How many recipients end up with their most preferred kidney? How many are unable to trade at all?

5. **Upscale Dining. [20 pts].** *(Econ 52, HW 1).* You would like to patronize El Ranchero – a classy fine dining destination[22] on Foothill – for dollar margaritas and dinner. It's a 30-minute walk from your dorm, or alternatively a 6-minute drive, although you don't have a car. Your options are to walk or catch an Uber[23], which will take 6 minutes but cost $6. You value your time at $20/hour.

   (a) **[4 pts]** What is the net benefit of walking, in dollar terms? What is the net benefit of catching an Uber? Bear in mind[24] that the net benefit may be negative. What is the opportunity cost of walking? You may answer this question with a table like we drew in class.

   Hint: You don't need to know the value of visiting El Ranchero to answer this question, because it is not part of the choice. You are going to El Ranchero regardless, and simply deciding whether to walk or Uber. As stated, walking and Ubering have only costs, not benefits, so we expect the net benefits to be negative.

   (b) **[2 pts]** Should you walk or catch an Uber? Why?

   Above, we assumed you were definitely going to El Ranchero, and simply deciding *how* to get there. Now, suppose you are deciding whether to go at all. You derive $25 in value from dinner at El Ranchero, and the meal will cost $13. In addition, if you go, you will Uber (which has both a $6 monetary cost and a 6-minute time cost). Your alternative is to go to a dining hall, for which you have previously paid a non-refundable $2500 for unlimited access to the 250 available dinner meals over the school year. It takes no time to get to the dining hall, and it is taco night, which notably lacks margaritas, and so you value it at only $6.

   You may ignore the fact that if you went to El Ranchero, you'd also have to get home again. (For instance, we can suppose that you are planning to catch a ride back with a friend, and you enjoy your friend's company exactly enough to cancel out the time cost of the journey).

   (c) **[4 pts]** What is the net benefit of visiting El Ranchero? The dining hall? What is the opportunity cost of visiting El Ranchero?

   (d) **[2 pts]** Should you eat at El Ranchero or the dining hall? Are all of the numbers in this problem relevant to your decision? If not, why not?

   Now suppose you have obtained a $6 Uber ride credit (that is, $6 you can use toward Uber rides) for referring a friend.

   (e) **[4 pts]** Suppose first that the credit expires tomorrow, so that you cannot use it for any other rides. What is the net benefit of visiting El Ranchero now? What should you do and why?

   (f) **[4 pts]** Now suppose that the credit never expires, and you are a frequent user of Uber. You are certain to use more than $6 worth of Uber rides in the near future. What is the net benefit of visiting El Ranchero now? What should you do and why?

---

[22] El Ranchero is a truly *upscale* place, in the sense that a visit is sure to move the numbers on your bathroom scale in the general direction of *up*. It must be said that college dining halls, too, are generally recognized as some of the most upscale establishments in the nation. And that's saying something, as America is itself a country built on a strong tradition of upscale dining.

[23] For those students who have been living under a particularly large slab of pegmatite – a very nice rock, but even so you should get out from there – Uber is an increasingly popular "ridesharing" company, which is something of a misnomer as it does not actually involve sharing rides. In many cities (including LA), rather than catching a cab, you can now simply open up the Uber app and order a car. Uber is a convenient and cheap way to get to Ontario Airport. However, be careful as the Uber app will currently take you to the back entrance. In fairness, you will find practically no security line back there, owing to the general lack of other passengers and, when it comes right down to it, doors.

[24] For the rest of your life, you will never be able to hear this expression without thinking of a bear. (You're welcome.)

6. **Scary Farm. [19 pts].** *(Econ 52, HW 7).* Every Halloween, Knott's Berry Farm turns into Knott's Scary Farm[25], under the premise that people will actually pay money to be scared. In fact, Knott's estimates that customers who scream more are generally willing to pay more. Thus, it wires up some giant spiders to descend on customers as they purchase their tickets. If they scream, they are charged an extra \$10 "scream surcharge" on top of the \$50 entrance fee.

   (a) **[2 pts]** What form of price discrimination is this?

   (b) **[4 pts]** Do you think this pricing strategy would be popular in practice? Why or why not?

   (c) **[4 pts]** Suppose instead that the entrance fee is \$60 and those who *don't* scream are offered a \$10 "fearless discount." Do you think this would be more or less popular than the previous policy? Is it any different, economically speaking?

   (d) **[4 pts]** List two real-world examples of price discrimination couched in the form of a "discount" rather than a "surcharge."

   (e) **[5 pts]** Suppose instead that Knott's Scary Farm discovers that each consumer's valuation (that is, willingness-to-pay) is given by $v = 30 + 2s$, where s is the number of times the consumer screams while at the park. Furthermore, Knott's is able to monitor each consumer's total number of screams via a complex network of remote-controlled, camera-equipped wheely rats that patrol the grounds at all times. Furthermore, these rats are able to immediately deliver "scream bills" to any screamers they discover, effectively enabling Knott's to charge consumers per scream. Suggest a two-part pricing strategy that maximizes Knott's Scary Farm's profits[26] Is this an example of perfect price discrimination?

[25] As LA-area amusement parks go, "Scary Farm" is a much more promising premise than "Berry Farm," although neither premise is very compelling when compared to their nearby competitor, Disneyland. Of course, vexillophiles would argue that all of these are easily trumped by Six Flags. However, their word carries little weight, perhaps because nobody knows what their word – namely "vexillophile" – actually *means*. Such a shame...it really is a wonderful word. Unfortunately, this means that literally *no one* laughs at jokes about vexillophiles. The only people that get the jokes are vexillophiles, and *they* think that vexillophily is no laughing matter. They have *standards*, after all. (Oh, why do I even try).

[26] The pricing strategy is not allowed to make consumers any worse off than they would be by not attending the park. However, consumers are allowed to be indifferent between attending and not.

7. **Gobble Gobble. [36 pts].** *(Econ 52, HW 11).* You can learn a lot about a country from its animal sounds. Some animals spark widespread disagreement—for instance, a pig may oink (English) or grunz (German) or knor (Dutch) or groin (French) or boo boo (Japanese)[27]. Other animal sounds are remarkably consistent across countries. In particular, the turkey says clou clou in Spain, glou glou in France and Greece, glu glu in Turkey[28], and in the United States...gobble gobble. In other words, we are clearly the outliers here, and it's telling. "Gobble gobble" is the sort of sound you would pick if you had a national holiday devoted to the only form of "turkey appreciation" that is not actually appreciated by turkeys[29].

   No one can say that we *only* learn about economics in this class. However, at some point, we must stop our gobbling and face the harsh economic realities of the world. In early 2015, American turkey farmers were hit hard by an outbreak of H5N2 avian flu. Millions of turkeys died, and many farmers lost their entire stock of turkeys[30]. Understandably, this type of event poses a significant threat to the livelihoods of many small-time farmers, especially those who raise only turkeys.

   Wolfgang Grape[31] is a small-time Minnesota turkey farmer with utility function $u(v) = v^{1/4}$, where v is annual income in *thousands of dollars*. In normal years, Wolfgang earns an income of \$60 (thousand). However, he faces a 5% chance of losing his entire stock of turkeys to flu, in which case he will lose \$45 thousand, earning only \$15 thousand in net income. Naturally, Wolfgang would like to purchase insurance to insulate himself from risk if possible.

   (a) **[2 pts]** What is Wolfgang's expected utility[32] in the absence of insurance? **(Here and below, give your answer to 3 decimal places).**

   (b) **[2 pts]** Consider a *full* insurance policy, i.e. one that pays out 100% of the claim (\$0 if there is no flu, and \$45,000 if there is flu). Calculate the *fair* insurance premium D_0.

   (c) **[2 pts]** What is Wolfgang's expected utility under full, fair insurance (again, give your answer to 3 decimal places)? If this policy were offered, would Wolfgang want to purchase it?

   (d) **[3 pts]** Would Wolfgang be willing to pay a premium of \$2500 for full insurance? What about a premium of \$3000? \$4000?

   (e) **[2 pts]** Now consider a partial insurance policy in which the insurer pays nothing when there is no flu, and \$30,000 when there is flu. What is the fair insurance premium D_1 now?

   (f) **[3 pts]** Suppose that for this partial insurance policy, the insurer actually charges a premium of \$2000. Is this fair insurance? Will Wolfgang buy insurance now? How much profit can the insurer expect to make from Wolfgang on average?

---

[27] Source: http://www.eleceng.adelaide.edu.au/Personal/dabbott/animal.html. What exactly these sounds say about their respective countries is left as an exercise for the reader.

[28] It goes without saying that Turkey is the world authority on this matter. Turkey sounds are, by definition, the *only* sounds they ever make in Turkey. What's more, a disproportionate number of Turkey sounds are actually Turkish turkey sounds, as -glu is a very common surname ending. For a maximum dose of Turkish turkeyness, look no further than former NBA star Hedo *Turkoglu*, which may be the most gloriously nationalistic name in the history of names. Indeed, in violation of the combined laws of probability, linguistics, and probably Russia as well, this name has managed to attain **150%** Turkishness. Because -oglu is the equivalent of our -son, Turkoglu basically means "Son of Turk" *while simultaneously ending with the sound a turkey makes in Turkey.*

[29] Most livestock raised for food are blissfully ignorant of their impending doom. However, from HW2 you will recall our penchant for making animal sounds at animals. So there is a certain amount of disagreeable foreshadowing where turkeys are concerned. Their entire interaction with humanity consists of people essentially saying, "I'm going to eat you!" over and over again.

[30] For more information, see http://www.nytimes.com/2015/11/20/business/the-american-turkey-farmer-takes-on-mother-nature-and-wins.html

[31] It should be noted that, in vying for this homework gig as token farmer of the 2014 Name of the Year tournament, Wolfgang Grape faced intense competition from Denver Beanland.

[32] You should be plugging numbers like 60 into the utility function, not 60,000.

(g) **[2 pts]** TurMinnKey[33] is a small Minnesota-based turkey insurance company. It offers a full insurance policy with a premium of $3000. Its customer base consists of 1,500 farmers identical to Wolfgang[34]. What is TurMinnKey's total revenue from premiums? Suppose that TurMinnKey will go bankrupt this year if it has to pay out more in insurance claims than it collects in premiums. If TurMinnKey is to stay in business, what is the maximum number of farmers that can be hit by turkey flu?

(h) **[3 pts]** TurMinnKey argues that it is unlikely to go bankrupt because it is able to pool risk across many farmers, and bird flu is unlikely to hit too many farmers in any given year. Are you convinced by this argument? Why or why not?

(i) **[2 pts]** In practice, insurance against bird flu is not available for purchase in Minnesota. However, the United States, as a proud nation of gobblers[35], will not stand for a turkeyless Thanksgiving. Thus, federal farm assistance programs routinely compensate farmers for the loss of infected livestock, effectively providing them with insurance. In light of the above, could this program improve social welfare, even if insurance is not feasible for a free market enterprise like TurMinnKey?

(j) **[5 pts]** Suppose now that farmers differ in their risk of turkey flu, perhaps because some farmers have better facilities that reduce the risk of disease. If the insurer cannot tell farmers apart, this may lead to an adverse selection[36] problem. Explain in a few sentences how this might cause the private insurance market to fall apart. Could a federal farm assistance program fix this problem?

(k) **[3 pts]** Suppose now that farmers can take actions to reduce their risk of bird flu. In particular, suppose that by default, each farmer is identical to Wolfgang, facing a 5% risk of bird flu. However, each farmer can pay $1000 to install an air filter that reduces the probability of a bird flu outbreak from 5% to 1%. Will a farmer be willing to install the air filter in the absence of insurance?

(l) **[7 pts]** Suppose that a federal farm assistance program provides farmers with free insurance (that is, the farmer pays no premium, which is effectively funded by taxpayers). Will the farmer install the air filter if insurance covers 25% of losses? 75%? 100%? [37] Does the government face a moral hazard problem here? Explain.

---

[33] That reminds me. There are three common 6-letter animal names ending with KEY. What are they?

[34] In particular, they will each be paid $45,000 if they are hit by turkey flu.

[35] In a particularly cruel twist of fate, we have gone so far as to nickname the *turkeys* "gobblers." Once again, the traits we ascribe to animals really describe ourselves.

[36] Another Thanksgiving dilemma: Casseroles vary in quality, and the contents of a casserole are not always evident from the outside. If you get your EVIDENT CASSEROLE mixed up, ADVERSE SELECTION may result. It's one of those anagram things.

[37] That is, in the event of flu, losses are $45,000. 50% insurance is partial insurance that compensates the farmer for half the losses, whereas 100% insurance is full insurance.

8. **Hotelling's Web Browser. [16 pts].** *(Econ 52, HW 8).* The table below shows web brower market shares worldwide as of 2014[38].

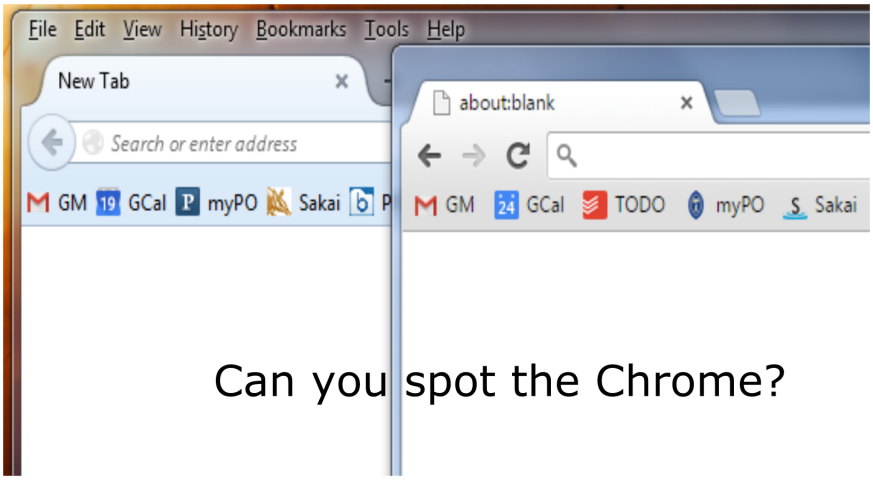
Browser	Market Share
Internet Explorer	58%
Firefox	18%
Chrome	16%
Safari	6%
Other	2%

Note that, whereas Internet Explorer and Safari are default browsers for Windows and Mac users, respectively, Firefox and Chrome must compete actively for new users. In fact, they are the two main players in the market for users who would consider switching from the default browser[39], and thus they are in direct competition with each other.

(a) Map the components of Hotelling's beach model, which we discussed in class, to competition between Firefox and Chrome. In particular, give the analog to the following components.

i. **[2 pts]** Two hot dog vendors.
ii. **[3 pts]** A linear beach[40].
iii. **[3 pts]** Consumers are located along the beach and want to buy from the closest vendor.
iv. **[3 pts]** Each vendor takes the location of the other vendor as given and chooses where to locate, in order to make as many sales as possible.

(b) **[5 pts]** In recent years, Firefox and Chrome have gotten more and more similar, to the point that they can be difficult to visually distinguish at a glance[41].



Explain why this might be the case, in light of the above.

[38] Source: http://thenextweb.com/insider/2014/02/01/ie11-passes-ie10-market-share-firefox-slips-bit-chrome-gains-back-share/

[39] No one switches *to* Internet Explorer. Only away. Far, far away.

[40] You may suppose, for simplicity, that browsers differ only in their default color scheme: some color schemes are more subdued, some are more intense.

[41] It's unbelievable, honestly. I used to use both browsers side by side and I had to stop when I could no longer *tell them apart.* This phenomenon has not gone unnoticed by others. For instance, see an article from The Verge on 8/21/2015 entitled, *Firefox is about to work a lot more like Chrome;* or from How-To Geek on 9/11/2015, *Firefox is About to Become an Almost Complete Copy of Chrome.*

9. **Short and Sweet. [31 pts].** *(Econ 52, HW 3).* Flavious Coffee[42] has written an exposé about the perils of sugar addiction confronting today's youth. Unfortunately, his article has been sabotaged by Cherries Waffles Tennis[43], strongarm and henchperson extraordinaire of a powerful sugar lobby. Cherries Waffles Tennis is the kind of henchperson who would most certainly go by *The Enforcer* if her name weren't already Cherries Waffles Tennis[44]. A formidable adversary, Cherries Waffles Tennis has a taste for sugar and irony, but she hates coffee of all kinds, and Flavious is the worst flavor in her book. Thus, she has broken into Flavious' office and spilled coffee all over his article, obscuring key words and phrases. Before making her getaway, she nails Flavious in the head with one of her signature overcooked pancakes delivered by tennis racket at high speed[45], knocking Flavious unconscious.

   When Flavious regains consciousness, Cherries Waffles Tennis is gone, and so, unfortunately, is his memory. The exposé is due tomorrow, but he cannot remember how to complete it! **Use your knowledge of economics to help Flavious out by filling in the missing information in his article. Be sure to show your work so that Flavious can verify your reasoning.**

Short and Sweet, by Flavious Coffee

(a) **[2 pts]** For millions of years, sugar could save a life. Nowadays, though, it is more likely to *enslave* than to *save*. Why is it that the sugary cereals are always found on the bottom shelves at the supermarket? To catch the child's eye! After all, children are short, and sugar is sweet. A recent study estimates that at current prices and sugar levels, the elasticity of demand for cereal with respect to sugar content is 2.3, which means that...

(b) **[2 pts]** In other words, demand for cereal is quite responsive to sugar content – and cereal makers have noticed. In the last ten years, the average sugar content of cereals has increased by about 8%. Due to rising health concerns, regulators are hoping to discourage unhealthy behavior by instituting a tax on sugary cereal. Under the proposed policy, any cereal with a sugar content over 15 grams per serving would be subject to an additional $1 excise tax levied on the cereal seller.

   However, there is significant pushback from cereal sellers. Sellers have argued that consumers are the ones choosing to consume sugary cereals, whereas sellers are simply providing them with an array of options. Thus, they maintain that it is deeply unfair that *sellers* should have to pay the tax, rather than consumers. However, as any Economics 52 student will tell you, this argument is unfounded, because...

(c) **[2 pts]** In fact, the burden of the tax is actually determined by...

(d) **[4 pts]** Figure 1 (below) depicts a qualitative scenario in which consumers will bear more of the burden of the tax. Relative to the pre-tax equilibrium, consumers pay more and sellers receive less after the tax is instituted. However, as you can see, the price rises more for consumers than it falls for sellers. The reason is that, regardless of who "pays" the tax, consumers will bear more of the burden whenever...

---

[42] REAL PERSON. Why make up names when you can just pull them from the Name of the Year tournament?

[43] 2015 NotY Bulltron Regional #1 seed!

[44] She is also the kind of henchperson who lasts almost to the end of the movie. The same cannot be said of fellow 2015 NotY contender, Joe Henchman, who oozes expendability with every short-lived fiber of his being.

[45] Cherries Waffles Tennis has never stated an official reason for her unexpected use of pancakes. However, it has been hypothesized that pancakes stack better than waffles, potentially increasing holster capacity by up to 130%. Ballistics experts have also observed that a sufficiently overcooked pancake, when lofted overhead and power-smashed by a tightly-strung cherry-red tennis racket moving at upwards of 100 mph, in point of fact *becomes* a waffle. Ballistics experts also agree that the newly minted waffle has about half a second to enjoy itself before impact, at which time the waffle passes briefly back through its pancake state before exploding into batter, leaving the target well and truly *battered*. And, in some cases, buttered.

(e) **[3 pts]** Conversely, Figure 2 (below) depicts a scenario in which sellers will bear more of the burden of the tax.

(f) **[6 pts]** In order to gauge the impact of such a tax, the noted economist Dr. Data Longjohn[46] has estimated that local weekly supply and demand for sugary cereals are given by

$$\begin{aligned} P_S &= 1 + \frac{1}{3}Q_S \\ P_D &= 4 - \frac{2}{3}Q_D \end{aligned}$$

where price is in dollars and quantity is in thousands of boxes. We can learn a lot about the impact of the tax by examining these curves. Figure 3 below depicts the equilibrium price and quantity before the tax. In addition, the \$1 tax is displayed as a wedge between demand and supply. The post-tax equilibrium quantity is indicated, as well as the post-tax prices paid by consumers and received by sellers.

(g) **[2 pts]** As we can see, the incidence of the tax does not fall solely on sellers. Of the \$1 tax, indeed consumers end up paying...

(h) **[3 pts]** This makes sense, because the price elasticities of demand and supply at the pre-tax equilibrium are, respectively, ...

(i) **[2 pts]** Not only does this analysis tell us who will bear most of the tax burden, it also tells us how much of an effect the tax will have on behavior. The above makes clear that the tax will indeed result in a significant decline in the amount of sugary cereals consumed. Without such an analysis, we would have no way of knowing. Indeed, it is possible for a tax to have *no* effect on the amount of cereal consumed, if...

(j) **[3 pts]** Based on the available evidence, it is clear that the proposed tax will achieve the desired goal of reducing consumption of sugary cereal. Furthermore, a growing body of evidence suggests that early-life health interventions can have large effects relative to interventions later in life. Public funds are limited, and we must always be mindful that some interventions are more cost-effective than others. For instance, one possibility is to institute a program aimed at reducing childhood obesity. Another is to treat the consequences of obesity at a later stage – for instance, by providing treatment to adults with Type 2 diabetes. Surely, both programs increase quality and length of life, but \$1,000 may go much farther in a program aimed at reducing sugary cereal consumption in children. Early interventions are potentially brief and high-impact; interventions in the later stages can stretch on for decades and may never undo the damage once it's done. In fact, health economist Littice Bacon-Blood[47] estimates that a \$1,000 health intervention for young children today would save the same number of life-years as an \$84,000 intervention[48] on the same individuals in 60 years time.

In order to make a proper comparison between these amounts, we must convert future dollars into their present value equivalent. Assume a long-term interest rate of 6%, the present value of \$84,000 is...

(k) **[2 pts]** So, is a childhood health intervention today more cost effective than waiting until the problems emerge later in life? The above calculation indicates that the answer is...

This is great news, indeed. Let's keep the intervention short and sweet.

[46] Still not making these up.
[47] Health economist, unexpected fitness guru, 2015 NotY Dragonwagon Regional #1 seed.
[48] You may ignore inflation. These are in real dollars.

10. **Hovernomics [11 pts].** *(Econ 102, HW 2).* Against all odds, a new contender joins the canon of perfectly competitive markets: Hoverboards! They're here! Sort of! True, they don't actually *hover*. Nor, come to think of it, are they really even *boards*. But no matter! The free market cannot be stopped by trivialities like misleading nomenclature or patent law or Angry Mark Cuban. The rising tide of exploding knockoff hoverboards[49] indicates that we are in a perfectly competitive marketplace, for better or for worse or for worst!

    Weekly supply for hoverboards on the Pomona College campus is $P = 6Q_S + 60$, while demand is $P = 360 - 4Q_D$.

    (a) **[4 pts]** Sketch a graph of supply and demand, and find the equilibrium price and quantity.

    (b) **[4 pts]** Pomona College is deeply concerned about the prospect of hoverboard-related dormitory fires. Furthermore, professors have recently complained of students who claim that their hoverboard "exploded" their homework. To address this, the administration introduces a tax of $40 per hoverboard purchased. If hoverboard buyers (students) must pay the tax, what happens to the quantity exchanged, the price buyers pay (net of the tax), and the price sellers receive? Indicate the tax wedge on your graph above.

    (c) **[2 pts]** How is the burden of the tax distributed across buyers and sellers? Why?

    (d) **[1 pt]** Please take a moment to draw a picture of an exploding hoverboard. Try your best to capture the rage of the earthbound hoverboard, forever reminded of the thing it cannot do, doomed to be trodden upon daily by its twisted human tormenters, until finally one day something snaps, most likely in the battery pack[50].

[49] The hoverboard's explosive nature has caused airlines to universally ban it from planes, depriving the hoverboard of its one and only chance to *actually fly*. It's sad, really, like naming your golden retriever Sandy and never, ever taking her to the beach.

[50] Note that just because your homework *contains* flames from an exploding hoverboard does not mean that a hoverboard exploded your homework.

11. **Space Metal Magnetopoly! [22 pts].** *(Econ 52, HW 6).* Magneto, Professor X's nemesis, is able to telekinetically manipulate metals from afar. He realizes that he can use his powers to alter the trajectory of passing asteroids and comets rich in precious metals. Furthermore, Magneto observes that the volume of extraterrestrial precious metals dwarfs the volume found on Earth. Thus, he plans to engage in a lucrative asteroid mining operation in which he captures passing asteroids and brings them down to Earth[51]. This will effectively make Magneto a monopolistic supplier of adamantium, a metal valued for its extreme hardness.

    Magneto estimates that the demand curve for adamantium is given by

    $$P = 60 - 3Q$$

    where quantity is in tons and price is in millions of dollars per ton. Furthermore, Magneto faces no fixed cost but a constant marginal cost[52] of MC = 12 million dollars per ton brought to Earth.

    (a) **[2 pts]** What is the equation for Magneto's marginal revenue curve?

    (b) **[3 pts]** With constant marginal cost and no fixed cost, how does the marginal cost curve compare to average variable cost and average total cost?

    (c) **[4 pts]** Plot Magneto's demand, marginal revenue, and marginal cost curves.

    (d) **[4 pts]** What is Magneto's profit-maximizing quantity and price? Indicate these on your plot above.

    (e) **[5 pts]** What is Magneto's monopoly profit? On your plot above, indicate the regions of consumer surplus, monopoly profit (i.e. producer surplus), and deadweight loss.

    (f) **[4 pts]** Now suppose that there are many mutants with telekinetic powers just like Magneto's. In this case, asteroid mining becomes a perfectly competitive industry. What will be the equilibrium price and quantity of adamantium now? How will consumer surplus, producer surplus, and deadweight loss compare to the above? Create an analogous plot to the one above. Indicate demand, supply, the equilibrium price and quantity, and any relevant areas of surplus.

[51] Asteroid mining is a thing, actually, or at least it will be soon. Planetary Resources, Inc. was formed in 2010 and hopes to mine passing asteroids for the vast wealth of precious metals they contain. In other news, the White House responds to all petitions that gain 25,000 signatures within 30 days, including a recent petition to "secure funding and resources, and begin construction on a Death Star by 2016." Unfortunately, Paul Shawcross of the OMB nixed the proposal, estimating a cost of $850 quadrillion for Death Star construction. As our GDP is under $20 trillion, I find this to be a reasonable position. However, I am deeply concerned that without the Death Star, we will have no way to protect our space platinum from space pirates.

[52] This is very realistic. Obviously, in order to harness the adamantium, Magneto needs to pull a fast-moving asteroid onto an Earthbound trajectory and decelerate it so that it (and he) survives the impact – an important part of any successful asteroid mining operation. Magneto doesn't have to pay any fixed costs to build a factory; he was born with his abilities and he can pull in as many asteroids as he wants. However, he must expend a large but constant amount of energy per ton of adamantium, to exert the necessary forces on these passing adamantium-heavy asteroids.

12. **Burgers and Oaters. [15 pts].** (Adapted from Krugman and Wells, Chapter 3, Problem 2). *(Econ 52, HW 1).* In a supply and demand diagram, draw the shift of the demand and/or supply curve for hamburgers in your hometown due to the following events. In each case, what is the effect on equilibrium price and quantity (rise, fall, or uncertain)?

    (a) **[2 pts]** The price of tacos increases. Are tacos and burgers likely to be substitutes or complements, considering that even Carl's Jr. has not yet invented the Taco Burger[53]?

    (b) **[2 pts]** All hamburger sellers raise the price of their french fries[54].

    (c) **[2 pts]** Income falls in town. Assume that hamburgers are a normal good for most people.

    (d) **[2 pts]** Income falls in town. Assume that hamburgers are an inferior good for most people.

    (e) **[2 pts]** Advances in meat grinding technology reduce the cost of producing hamburger meat.

    (f) **[2 pts]** The price of leather increases. Leather and beef are complements of production. For the curious, one cow produces about 500 lbs of beef (worth about $2000) and 50 sq. ft. of leather (worth about $400).

    (g) **[3 pts]** The highly successful remake of *True Grit* (a classic John Wayne oater[55]) convinces a new generation of Americans to become cowboys. The result is both an influx of enthusiastic, cheap labor into the beef industry, as well as an increase in the popularity of burgers[56].

[53] However, we will not have a question on hot dogs, which once were clear substitutes but now are a gray area thanks to Carl's Jr. If you have not laid eyes on the "Most American Thickburger," it is worth a google. But be warned that it will give your arteries nightmares.

[54] It should be noted that the Most American Thickburger includes potato chips but not, as yet, fries. In any case, you may assume that burgers and fries are complements.

[55] Oaters being a better name for westerns, also known as horse operas, in which horses are both the chief mode of transportation and the chief consumers of oats.

[56] Cowboys do not eat chicken. Even "Rooster" Cogburn is known to regard lesser offerings with skepticism and perhaps an exclamation of, "You are not LeBoeuf!" If this makes no sense to you, then you need to watch more oaters.

13. **La Grange. [18 pts].** *(Econ 102, HW 3).* Jazzmar Clax[57] has 60 minutes per day to spend listening to music, and he needs your help to budget his time between songs. Fortunately for you, he only likes three songs: *La Grange* by ZZ Top, *La Granger* by ZZZ Top, and *La Grangest* by ZZZZ Top[58]. Even more fortunately for you, we will henceforth refer to these songs as song 1, song 2, and song 3, respectively. Song 1 is 4 minutes long, song 2 is 6 minutes long, and song 3 is 2 minutes long.

Let x_i denote *plays* of song i, for $i = 1, 2, 3$ (that is, x_1 is the number of times Jazzmar listens to song 1). Jazzmar tells you that his utility as a function of plays is

$$u(x_1, x_2, x_3) = 5x_1^4 x_2^{2/3} x_3^2.$$

(a) **[1 pt]** Denote Jazzmar's budget by M. What is M equal to?

(b) **[1 pt]** Denote the "price" of playing song i by p_i for $i = 1, 2, 3$. What are these prices equal to? Be sure to include units.

(c) **[1 pt]** Construct Jazzmar's La Grangian Lagrangian, leaving M, p_1, p_2, p_3 as unspecified constants. (That is, don't plug in the values you found for them above).

(d) **[2 pts]** At this point, you get into an argument. You claim that it would be easier to solve this problem if you transformed Jazzmar's utility function into $v(x_1, x_2, x_3) = f(u(x_1, x_2, x_3))$ where

$$f(z) = \frac{1}{2}\left(\ln z - \ln 5\right).$$

Jazzmar argues that v does not represent his preferences. Will this transformation change the optimal numbers of plays you compute? Why or why not?

(e) **[2 pts]** Suppose you have persuaded Jazzmar that u and v are, in a sense, equivalent. Construct a new Lagrangian using v instead of u.

(f) **[5 pts]** Take first order conditions and find the optimal number of plays of each song, in terms of M, p_1, p_2 and p_3. Also find λ^*.

(g) **[2 pts]** Given Jazzmar's actual M and prices, how many plays of each song should he consume? (As always, we ignore indivisibilities for convenience. Give your answers to 2 decimal places).

(h) **[1 pt]** What is Jazzmar's utility (according to v, not u) at the optimum?

(i) **[2 pts]** Compute λ^* for Jazzmar's actual M and prices, being sure to include units. What does this quantity represent? Give an interpretation in English.

(j) **[1 pt]** According to the utility function v, does Jazzmar value the first minute of music more, less, or the same than the 60th minute?

[57] 2014 Name of the Year tournament contender.

[58] Whatever your feelings about ZZ Top, there can be no doubt that these knock-off bands are genuine sleep-inducers to a normal person. Of course, Jazzmar prefers a name with lots of Z's.

14. **Car Trouble (Ugh!) [17 pts]**. *(Econ 102, HW 6).* Last week, Professor X's 2002 Toyota RAV4 stopped shifting between gears, indicating a likely problem with the transmission. He took the car to Aamco, where the mechanic gave an estimate of $2600 to replace the transmission. Professor X has determined online that the resale value of a 2002 RAV4 (*without* transmission problems) is also about $2600. The car is in otherwise good condition[59].

    (a) **[6 pts]** Although some car problems can be hidden from buyers when selling a used car, transmission troubles are not one of them. Thus, Professor X's options are to: (a) junk the car[60], (b) replace the transmission and sell the car, or (c) replace the transmission and keep the car. What relevance does Akerlof's market for lemons have to his decision about whether to replace the transmission? What should he do?

    (b) **[2 pts]** A car is "totaled" if it would cost more to fix than it is worth. Could it ever be sensible to fix up a car for *more* than its resale value once fixed?

    (c) **[6 pts]** The Aamco mechanic can observe whether the problem with Professor X's car is the transmission (expensive to fix, high profit margins) or a minor electrical problem (cheap to fix, low profit margins). Professor X, however, cannot tell the difference. This is another type of private information which potentially leads to **moral hazard**[61]. Should Professor X take the mechanic's word at face value? Why or why not? Under what conditions would the mechanic's report convey meaningful information? (Open-ended, do your best).

    (d) **[3 pts]** Toyotas are not normally known for their transmission problems. But in this case, Toyota recognized a systemic problem and extended the warranty for 2001-2003 RAV4's specifically to deal with transmission issues[62]. Could a policy of extending warranties when serious problems arise serve as a form of signaling the quality of Toyotas, or is it cheap talk?

    (e) **[0 pts but possibly a car]** The story has a happy ending. With $2600 on the line, Professor X took the car down the street for a second opinion. The second mechanic determined that it *was* a minor electrical problem, and fixed it for $100. How much are you willing to pay for Professor X's 2002 RAV4, which is guaranteed to be a peach?

[59] If you have any doubts that textbook economic theory problems can be applicable to real life, look no further. The first part of this problem is logically identical to Frank Chapter 6 Problem 5, and yet it is also a completely true story of something that happened to me last week. Sometimes I really wish economic theory *weren't* so applicable.

[60] You may assume this results in no payment. In practice it may be possible to sell the car for parts for a few hundred bucks.

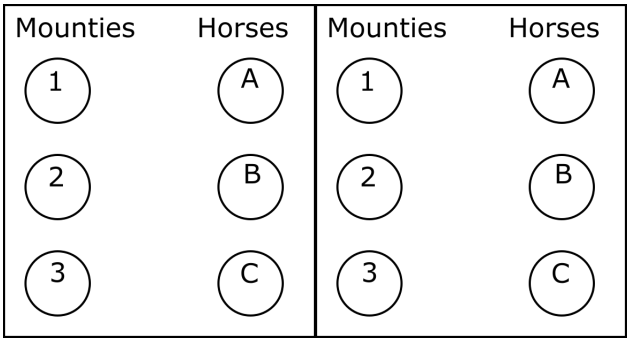
[61] Although we have only discussed moral hazard in the context of insurance, the real key is the misalignment of incentives created by private information. Professor X cannot observe whether the mechanic is being truthful, just as the insurance company cannot tell if "Nub City" residents are truly the victims of accidents, or merely the victims of "accidents." If claims adjusters had a sense of humor (and they do not), the latter type of "accident" would be referred to as an *insurance quote*.

[62] Professor X's car was not covered, unfortunately.

15. **Mountie Matching. [25 pts].** *(Econ 52, Final Exam).* The National Mountie Matching Program (NMMP) matches Canadian mounties with horses. There is one mountie per horse, and both mounties and horses have preferences[63] over whom they are matched with. We will consider a scenario with three mounties (numbered 1 through 3) and three horses (A-C). Preferences are as follows:

Mountie	Preferences	Horse	Preferences
1	C>B>A	A	1>2>3
2	A>C>B	B	2>3>1
3	C>B>A	C	2>3>1

(a) **[6 pts]** We will first implement the **Mountie-Proposing Deferred Acceptance algorithm**. You may assume that all parties report their preferences truthfully. In the diagrams below, indicate each mountie's proposal in the first and second rounds of the algorithm with an arrow leading from mountie to horse. At each stage, indicate any tentative acceptances[64] at the end of the round with double-headed arrows. Tentative acceptances after the first round should revert to single-headed arrows at the start of the second round.



(a) **[2 pts]** What is the final matching under Mountie-Proposing Deferred Acceptance? Fill out the following table.

Mountie	Horse
1	
2	
3	

(b) **[2 pts]** Can you say if this matching is stable?

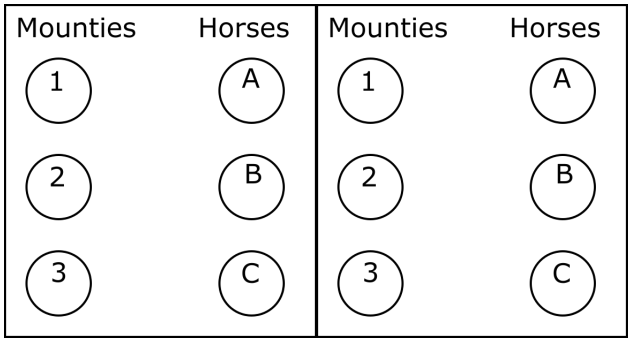
[63] Some mounties are a heavier load, but also give more oats. Horses differ in their willingness to trade off between these important characteristics.

[64] Horses, of course, accept or reject offers by saying yea or neigh. However, you must remember that in horse language, "yea" means "whoa there!" while "neigh" means "okayfine."

(c) **[6 pts]** Now consider the **Horse-Proposing Deferred Acceptance algorithm**. As above, you may assume that all parties report their preferences truthfully. In the diagrams below, illustrate the first two rounds of the algorithm, as you did above.

(Preferences are repeated for convenience)

Mountie	Preferences	Horse	Preferences
1	C>B>A	A	1>2>3
2	A>C>B	B	2>3>1
3	C>B>A	C	2>3>1



(a) **[2 pts]** What is the final matching under Horse-Proposing Deferred Acceptance? Fill out the following table.

Mountie	Horse
1	
2	
3	

(b) **[1 pts]** Can you say if this matching is stable?

(c) **[3 pts]** What is the mountie-optimal stable matching? Which mounties get their top choice in this case? Do any horses get their top choice?

(d) **[3 pts]** What is the horse-optimal stable matching[65]? Which horses get their top choice in this case? Do any mounties get their top choice?

[65] This is a magnificent phrase to design a problem around. However, it is not to be confused with the matching of horses to their most preferred stables.

16. **Monopoly Monopoly. [22 pts]**. *(Econ 102, HW 10).* Hasbro is the monopolistic supplier of the board game Monopoly[66]. It faces a local daily demand curve

$$P = 200 - 40Q + 2Q^2$$

for $0 \leq Q \leq 10$, and a total cost curve of

$$TC(Q) = 10 + 2Q.$$

(a) **[2 pts]** Write an expression for Hasbro's profit $\Pi(Q)$ as a function[67] of Q.

(b) **[4 pts]** Write expressions for marginal revenue and marginal cost[68], $MR(Q)$ and $MC(Q)$.

(c) **[4 pts]** Quickly sketch demand, marginal revenue, and marginal cost for $0 \leq Q \leq 10$. It doesn't have to be perfect[69].

(d) **[3 pts]** Find the monopolist's optimal output, Q^*. Round your answer to two decimal places. (You should have a quadratic with two positive roots. Q^* is the one that's less than 10).

(e) **[3 pts]** What is the monopoly price for Monopoly, P^*? How much profit does Hasbro make?

(f) **[3 pts]** What is the efficient price and quantity, P_e and Q_e? Is P_e more or less than P^*?

(g) **[3 pts]** Suppose the government regulates the Monopoly monopoly and forces Hasbro to price at the efficient price, P_e. What would profit be in this case? Would Hasbro want to stay in business? If not, how much would Hasbro need to be subsidized to break even?

---

[66] Although a homework assignment on the Monopoly monopoly may become semantically confusing, let's roll the dice. As the monopolistic supplier of points in this course, I strongly encourage you to play along. As a "token" of my goodwill, I'll even let you be the racecar.

[67] There should be no P's in your answer.

[68] Much like Boardwalk and Park Place, neither of these is particularly useful on its own, but together they lead to monopoly pricing.

[69] Even if I didn't ask you to do this, you should probably make a habit of doing it anyway. It keeps the reasoning grounded and cuts down on mistakes, since you will easily notice if you get a Q^* or P^* that is implausible given the graph.

17. **Castaways. [15 pts].** *(Econ 102, Final Exam).* Joylord Gumbie and Inta Mulch[70] are the sole inhabitants of a desert island on which there are only two goods: rum (x_1) and coconuts (x_2). Upon washing up on the island, Gumbie and Mulch were quick to establish property rights and claim as much rum[71] and coconuts as they could get their hands on. As a consequence, their initial endowments of goods 1 and 2 are

$$\begin{aligned} \omega^G &= (10, 20) \\ \omega^M &= (20, 50) \end{aligned}$$

Given their initial endowments and preferences, Gumbie and Mulch will trade rum and coconuts until they exhaust all gains from trade.

(a) **[6 pts]** Draw the Edgeworth box for this exchange economy, putting **Gumbie's origin** in the lower left. Label the initial endowment R. Assuming that R is not an efficient allocation, sketch a hypothetical contract curve. Add hypothetical indifference curves for Gumbie and Mulch through point R, labeling them IC^G and IC^M, and assuming they take the usual shape.

(b) **[2 pts]** Define the **bargaining curve**, BC, as the set of all allocations that Gumbie and Mulch could potentially end up at as a result of the bargaining process, given their initial endowments ω^G, ω^M. Indicate BC on your plot above.

(c) **[7 pts]** Now suppose Gumbie and Mulch's utility functions are

$$\begin{aligned} u^G(x_1, x_2) &= \ln x_1 + 3 \ln x_2 \\ u^M(x_1, x_2) &= 3 \ln x_1 + \ln x_2 \end{aligned}$$

Find an equation for the contract curve, expressed from Gumbie's perspective as x_2^G as a function of x_1^G.

[70] Sadly, both have been eliminated from the 2016 Name of the Year tournament. *However,* as of this writing, Pope McCorkle III is still going strong! Those of you who follow Name of the Year "religiously" will know that Taco Pope is also a semifinalist, albeit clearly the lesser Pope.

[71] In case you are wondering, the rum is left over from an old pirate store. Years later, Gumbie and Mulch will be nothing more than a pair of particularly lifelike skeletons lending atmosphere to a desert island scene in *Pirates of the Caribbean*, as well as the true answer to Jack Sparrow's perennial question, "Why is the rum gone?" For their troubles, they will not be posthumously recognized with an Academy Award, despite the fact that it is quite an accomplishment for a skeleton to appear "lifelike."

18. **Bamboozled Supply and Demand. [12 pts].** *(Econ 52, Final Exam).* Urban pandas consume bamboo and bambooze[72], among other things. Urban pandas do not forage for food, but rather pay for these commodities[73] in the marketplace.

In the first three scenarios below, illustrate any shifts of supply and demand in the market for *bambooze*. In each case, what is the effect on equilibrium price and quantity?

(a) **[3 pts]** Urban panda incomes rise, and bambooze is a normal good.

(b) **[3 pts]** An influx of tourists causes an increase in the market price of bamboo leaf hats. Urban pandas do not wear leaf hats, but leaf hats and bambooze are complements in production.

(c) **[3 pts]** David Wang ('09) founds Bamboo Bicycles Beijing. Because much of the bamboo supply is now being used to build bamboo bicycles, the result is an increase in the market price of bamboo. Bamboo and bambooze are complements to pandas. Furthermore, bamboo is an input into the production of bambooze.

(d) **[3 pts] (Difficult) Now consider the market for bamboo.** Suppose that bamboo is a Giffen good, while supply of bamboo is perfectly inelastic. Furthermore, suppose that a bountiful harvest causes the bamboo supply curve to shift right. What happens to price and quantity in the market for bamboo?

[72] As the final exam is less time-constrained than the midterms, I think we can afford a *little* humor. So, bambooze is an alcoholic beverage made from fermented bamboo shoots. Needless to say, pandas do not get drunk; they get *bamboozled*. A proper final exam should always give students a taste of bamboozlement, so you should be glad we've gotten it out of the way.

[73] In this problem, we consider only the upstanding type of urban panda, not the well-known outlaw that walks into a bar and "eats, shoots, and leaves."