Name: _____

Quiz # 2 **PAI 723**
November 15, 2023 **Professor David Popp**

You have the entire class period (80 minutes) in which to take the quiz. The questions are worth a total of 100 points. The number of points for each question should serve as a guide to the amount of time to spend on each question. Each question is designed to be answered in the space provided. A short, direct answer is preferable to a long-winded explanation that includes unnecessary information. Also, please keep in mind that partial credit is available for each question. It is in your best interest to attempt each problem on the quiz. If you do not have time to finish the math, at least include an illustration to show that you know how to proceed.

This is a closed book quiz. No notes, texts, or other reference materials may be used. The use of calculators is permitted.

Be sure to show all your work for each question. Providing a correct answer without showing how you got it will not get you full credit. You may use the back of the page for scratch work. I will not look on the back for answers or work unless you specifically tell me to do so. *Thus, if there is anything on the back of the page that you want graded, be sure to note this on the front of the page*.

Helpful formulas:

$$elasticity = \frac{\%change\ Q}{\%\ change\ P} = \frac{\frac{\Delta Q}{Q_0}}{\frac{\Delta P}{P_0}} = \frac{\Delta Q}{\Delta P}\frac{P_0}{Q_0}$$

area of a triangle = 1/2 (base) x (height); area of a rectangle = (length)x (width)

Bisection Rule:
If demand is given as P = a – bQ, then MR = a – 2bQ

NOTE: PLEASE READ THE FOLLOWING AND SIGN BELOW TO ACKNOWLEDGE READING THE HONOR CODE BEFORE BEGINNING. ALSO NOTE THAT BY HANDING IN THE QUIZ, YOU IMPLICITLY AGREE TO THE FOLLOWING, WHETHER OR NOT A SIGNATURE FOLLOWS:

Providing or receiving help on this quiz is a violation of both class rules and Syracuse University's policy and academic honesty. I will not (or have not) discuss the contents of the quiz with other students until all classes have had an opportunity to complete the quiz.

Signed by: _____

Good luck!

1. (20 points) You are the manager of Best Foot Forward, a non-profit organization providing sports and recreation activities for underprivileged children. Best Foot Forward uses two types of workers. Professional coaches earn $50 per hour. They are currently able to work with 25 children per hour. College student staff are less expensive, earning only $15 per hour. However, they currently are able to work with only 5 children per hour, and require supervision from professional coaches.

a) Based on the data above, is Best Foot Forward currently minimizing costs? How do you know this? If so, explain why this combination is the best for the organization. If they are not minimizing costs, what changes should be made to the current allocation of coaches and college student staff to lower costs?

Best Foot Forward is not minimizing costs. To see this, we need to compare the marginal product per dollar for each type of employee. Professional coaches currently work with 25 children per hour and earn $50 per hour. Thus, they work with 0.5 (= 25/50) children per dollar earned.

In contrast, college student staff work with only 5 children per hour and earn $15 per hour. Thus, they work with 0.333 (=5/10) children per dollar. Thus, while college student staff are paid less, spending one dollar on college student staff is less productive than a dollar spent on professional coaches. Best Foot Forward should hire more professional coaches and fewer college student staff.

b) Suppose that any changes you may have proposed in part (a) have been made, so that Best Foot Forward is now minimizing costs. After receiving a new grant from the state, Best Foot Forward plans to double the number of children they serve. As a result, you will need to hire more workers. The owner suggests that you should only hire college student staff, since they cost less to hire. How would you respond to his suggestion?

Just hiring college student staff would not be a good idea. Once the cost-minimizing point is reached, simply hiring more college student staff would be inefficient. Because of diminishing returns, as more college student staff hired, their marginal productivity will decline. For instance, note that college student staff require supervision. Thus, without professional coaches to supervise them, adding additional college student staff will not provide good value. Best Foot Forward would be better off hiring both college student staff and professional coaches, most likely in proportions similar to what they use after making the changes suggested in part a.

One point to remember is that the marginal products presented in the data may change after you implement the changes in part a. Thus, it isn't sufficient to explain that professional coaches have a higher marginal product per dollar, as those marginal products will change as you move towards the cost minimizing solution recommended in part a.

2. (24 points) Luigi's Tire Shop sells tires to the residents of Radiator Springs. Luigi owns the shop and the land where it is located. Luigi sells tires for $250 per set. At this price, he is able to sell 100 sets of tires per month.

Currently, Radiator Springs receives few visitors, as it is located several miles from the nearest highway exit. However, state officials are considering a new exit ramp from the highway that would make it easier for visitors to reach the town. This question asks you to consider how the new ramp would benefit businesses in Radiator Springs, using Luigi's tire shop as an example. His costs are described below:

- Each set of tires costs Luigi $125.
- Luigi currently hires one assistant at a cost of $5,000/month. To accommodate additional demand, if the ramp is built he will hire a second assistant, for an additional cost of $5,000/month.
- The cost of depreciation and maintenance for Luigi's equipment comes to $2,500/month. After the ramp is built, Luigi will double the amount of equipment used, raising this cost to $5,000/month.
- If he didn't run his own shop, Luigi could work at the local junkyard and earn $5,000/month.

a) How much revenue per month does Luigi earn selling tires before the highway ramp is built?

Each set of tires sells for $250. Since Luigi sells 100 sets of tires per month, he earns **$25,000** (= 250 x 100).

b) What are Luigi's costs per month before the ramp is built? Be sure to include all costs relevant to an economist, and explain how you calculated them.

First, Luigi needs tires. Each set costs $125. Since he sells 100 sets, these cost $12,5000 (= 125 x 100). In addition, his assistant costs $5,000/month, and his equipment costs $2,500/month. Finally, we need to consider the opportunity cost of his time. If he didn't run the tire shop, Luigi could work at the local junkyard for $5,000/month. We need to include this opportunity cost in our calculation. Thus, his total costs are:

tires	$12,500
assistant	$5,000
equipment	$2,500
opportunity costs	$5,000
TOTAL	**$25,000**

c) Does Luigi earn an economic profit before the ramp is built? Why or why not?

Notice that once we account for the opportunity costs, Luigi does not earn an economic profit. This is typical of a long run equilibrium in a competitive market. Luigi is no better off selling tires than he would be working at his next best opportunity.

d) After the ramp is built, the increased traffic leads to greater sales. He now sells 200 sets of tires per month. How do the costs of selling tires change after the ramp is built? Calculate the new total costs per month.

Except for the opportunity cost of working at the junkyard, his costs are higher. He now needs 200 sets of tires, which cost $25,000. His labor equipment costs are also higher. Thus, his new total costs are:

tires	$25,000
assistant	$10,000
equipment	$5,000
opportunity costs	$5,000
TOTAL	**$45,000**

e) The higher demand also enables Luigi to charge a higher price. A developer offers Luigi $20,000/month to buy Luigi's property and build a restaurant. Luigi refuses the offer. Since Luigi turned down this offer, the price of tires must be larger than what?

If Luigi turns down this offer, he must be earning more than $20,000 after accounting for all the costs in part (d). In that case, he would be better off continuing to earn that money, rather than taking the offer from the developer. We know that the costs are $45,000. Thus, we need to find a price that yields enough revenue so that "profits" are greater than $20,000.

The cutoff where Luigi is indifferent between selling and staying in business is where this profit exactly equals $20,000. This satisfies the equation:

$$200P - 45{,}000 = 20{,}000$$

Here, P is the new price. The terms on the left hand side represent profit: total revenue minus total cost. Solving for P, we get:

$$200P = 65{,}000$$
$$P = 65{,}000/200 = \mathbf{\$325}$$

Since Luigi turned this offer down, the price must be higher than $325.

f) Does Luigi earn economic profit? Why or why not?

Despite what we have found above, Luigi does not earn economic profit. Rather, he earns economic rent. There is an opportunity cost to staying in business – he chooses not to sell the land. However, as revealed in part (e), this land is now very valuable. In fact, it is worth more than $20,000 per month. By continuing to run the tire shop, he chooses not to cash in on this value. This is an example of economic rent, which is the value of a scarce resource (in this case, land near the highway). Economic rent is a form of opportunity cost.

Note that this doesn't mean that Luigi acts as a monopoly, and it doesn't mean that firms will enter to drive prices down again. The price can remain high, even if the market is competitive, because the land is worth more. By paying more to use Luigi's tire shop, customers are paying a premium for convenience. This is the same reason that gasoline costs more at a busy intersection, or why restaurant meals are more expensive in Manhattan. These price differences persist, but are due to the value of the location, not the service itself. It isn't that the ingredients themselves are more expensive in Manhattan, but that the cost of serving food in a Manhattan location is more expensive.

3. (32 points) To reduce travel time between San Francisco and Los Angeles, the state of California has built a Hyperloop transport system, allowing riders to complete the journey between these cities in just 35 minutes. They must now decide what price to charge riders. After some careful research, you estimate the following demand curve for Hyperloop rides:

$$P = 6{,}000 - 3Q$$

where Q represents the number of riders per month. The marginal costs of a ride are $300. The fixed costs of running the Hyperloop come to $1,000,000 per month. Three commissioners of the California Hyperloop Intercity Transport System are debating pricing strategies.

a) Because the Hyperloop is a one-of-a-kind transportation system, the state of California can act like a monopolist when setting prices. Commissioner Kirk argues that acting as a monopolist and maximizing profits from the Hyperloop system will bring in needed revenue to the state. Find the number of rides per month, along with the price per ride, if the state maximizes profits as a monopolist. Illustrate on a graph.

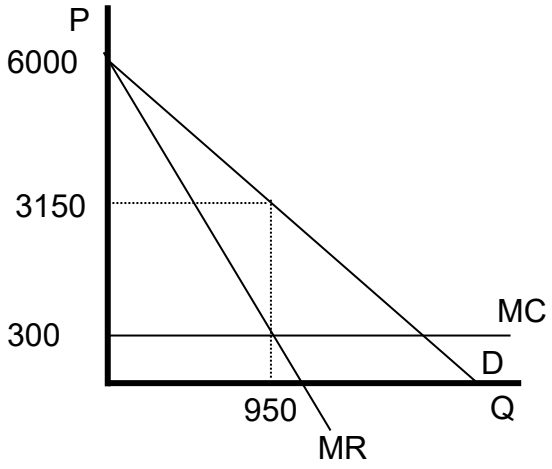
Profits are maximized where MR=MC. If the state acts as a monopolist, the marginal revenue curve will bisect the demand curve. Thus, MR = 6,000 – 6Q.

$$MR = 6{,}000 - 6Q = 300 = MC$$
$$5{,}700 = 6Q$$
$$Q = 5{,}700/6 = \mathbf{950}$$

To get the price, we need to look at the demand curve, to see how much citizens are willing to pay for 950 rides on the Hyperloop. We get:

$$P = 6{,}000 - 3(950)$$
$$\mathbf{P = \$3{,}150}$$

The graph for this market is shown below. Note that the equilibrium quantity is found where MC=MR, and the price is found from the demand curve. The price charged is how much consumers are willing to pay for 950 riders.



b) How much profit does the state make if it acts as a monopoly?

To calculate the profit, note that we need to consider the fixed cost. Thus, profit is not just the producer surplus from the graph. Rather, we must calculate profit as total revenue minus total cost. Total costs include the per unit costs (= 950 rides at $300 per ride) plus the fixed costs:

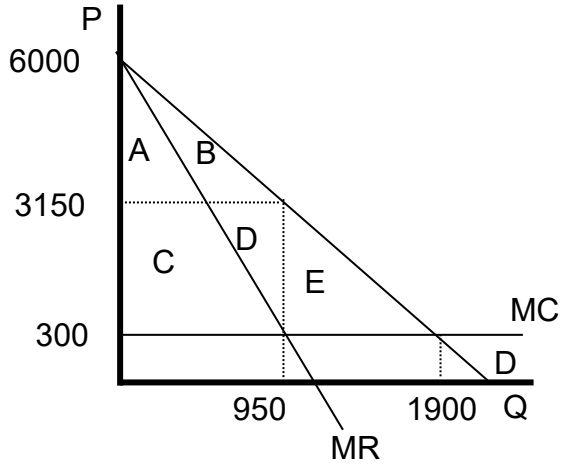
$$\text{profit} = TR - TC$$
$$\text{profit} = PxQ - TC$$
$$\text{profit} = (3{,}150)(950) - 300(950) - 1{,}000{,}000$$
$$\text{profit} = \mathbf{\$1{,}707{,}500}$$

A common error here was to omit either the variable costs (e.g. profits = (3,150)(950) - 1,000,000 = $1,992,500) or the fixed costs (e.g. profits = (3,150)(950) – 300(950) = $2,707,500.

c) Redraw your graph from part (a). On it, please show the consumer surplus that consumers receive and the deadweight loss from this pricing strategy. ***Note that you do not need to calculate the values for these areas, but simply must show where they are represented on the graph.***

Consumer surplus is the area above the price and below demand. It is equal to areas A and B. Although you didn't need to calculate the area, for those who are curious, it is a triangle with base of 950, and a height of 2,850 (= 6,000 – 3,150). Thus, consumer surplus = 0.5(950)(2,850) = **$1,353,750**.

The deadweight loss is area E on the graph. Again, for those who are curious, this area is a triangle with base 950 (= 1,900 – 950) and a height of 2,850 (= 3,150 - 300). Thus, the deadweight loss = 0.5(950)(2,850) = **$1,353,750**. Note that you need the quantity sold in perfect competition, which we will find in part (d), to calculate this area.



d) Commissioner Janeway believes that the state is providing a vital public service, and so should provide access to the Hyperloop without any deadweight loss. To completely eliminate the deadweight loss, what should the price of a ride be? How many rides will commuters take at that price? Will the state make money, break even, or lose money at that price? Explain.

To completely eliminate this deadweight loss, the state should set the price equal to marginal cost. We find the new quantity by equating marginal cost and demand:

$$6{,}000 - 3Q = 300$$
$$5{,}700 = 3Q$$
$$\mathbf{Q = 1{,}900}$$
$$\mathbf{P = \$300}$$

Unfortunately, at this price, the state will lose money, because of the fixed costs:

$$\text{profit} = TR - TC$$
$$\text{profit} = PxQ - TC$$
$$\text{profit} = (300)(1{,}900) - 300(1{,}900) - 1{,}000{,}000$$
$$\text{profit} = \mathbf{-\$1{,}000{,}000}$$

e) Commissioner Picard is not happy with either plan. He does not like the deadweight loss and large profit from monopoly pricing, but is also not happy with the outcome of part (d). Can you suggest a compromise pricing strategy that could reconcile these concerns? (Note: you do not need to calculate any numbers here. Just give a general explanation of an alternative pricing strategy that could work.)

The problem with marginal cost pricing is that it does not cover the fixed costs of the Hyperloop. One solution would be average cost pricing, where the price equals the average cost of each ride provided. This way, the price covers both the marginal cost of $300 per ride and each person's share of the fixed costs, allowing the state to break even. While there is some deadweight loss associated with average cost pricing, the deadweight loss will be less than with monopoly pricing.

Another possibility is to consider price discrimination. For example, low income users could be charged the marginal cost of the Hyperloop, and higher income users could be charged a higher price. This second price simply needs to be high enough so that it covers the fixed costs as well as the marginal costs of the Hyperloop.

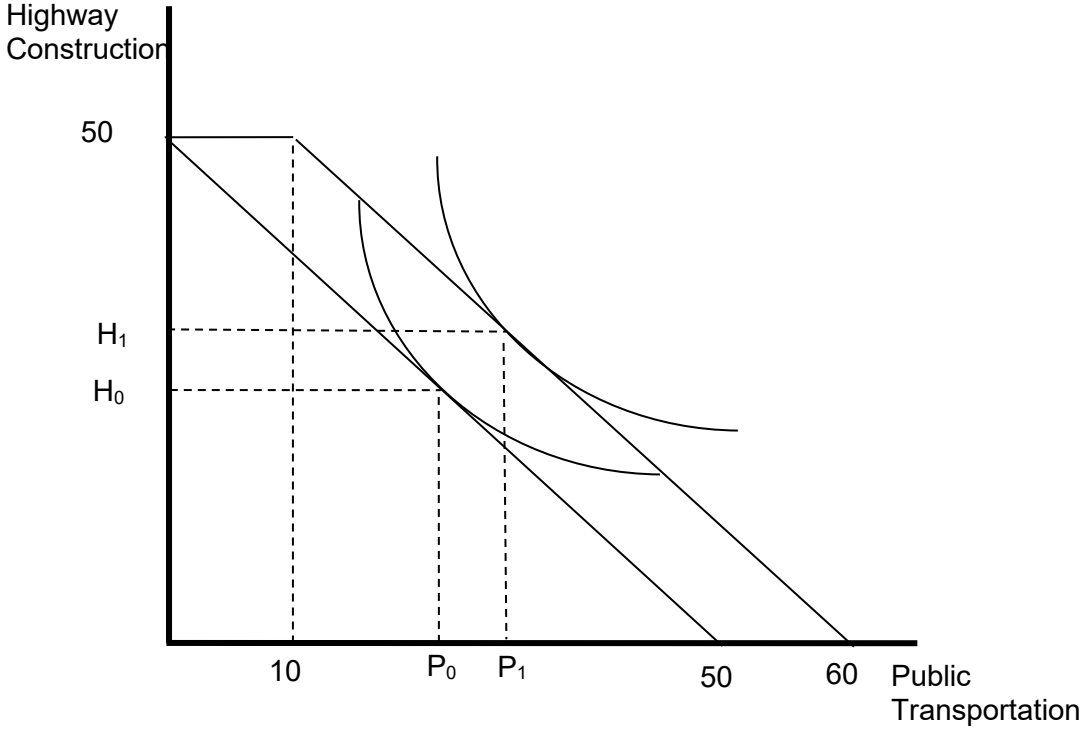
Another price discrimination idea suggested by several students is to vary the price by time of day. Users could be charged more to ride the Hyperloop during peak demand periods. Not only does this pricing scheme bring in more money when demand is high, it also discourages riders from using the Hyperloop when it is overcrowded due to heavy demand. However, it is important to also address whether this would cover the fixed costs. In the example of peak-pricing in class, marginal costs were higher during peak times, and the price simply reflected differences in marginal costs in each period. Here, prices would need to be higher than marginal costs to generate revenue to cover fixed costs.

Finally, a two-part tariff is another option. Each ride could be priced at marginal cost, but users could also be charged an annual membership fee for access to the Hyperloop. The membership fee could be set based on the number of riders to cover the fixed costs of the Hyperloop.

4. (24 points) Green Rides is an NGO that helps finance public transportation projects in cities in emerging economies. Recently, this funding has been criticized by environmentalists, who claim that increased funding for these public transportation projects has also allowed recipients to spend more on highway construction, leading to increased traffic and increased pollution. They argue that for every additional dollar spent on public transportation by recipients, spending on new highways has increased by nearly as much. Green Rides disputes this claim, arguing that they do not provide funding for highway construction.

In the questions that follow, you are asked to draw budget constraints for a recipient city before and after receiving funding from Green Rides. To begin, you may assume that the city has a budget of $50 million to allocate on either public transportation or highway construction.

a) On the axes below, draw a hypothetical budget constraint for the recipient's transportation spending before receiving funding from Green Rides. Suppose Green Rides offers a $10 million grant that can only be spent on public transportation. Add a second budget constraint representing this grant. Add a set of indifference curves that are consistent with environmentalists' concerns that funding enables recipient cities to spend more on highway construction.

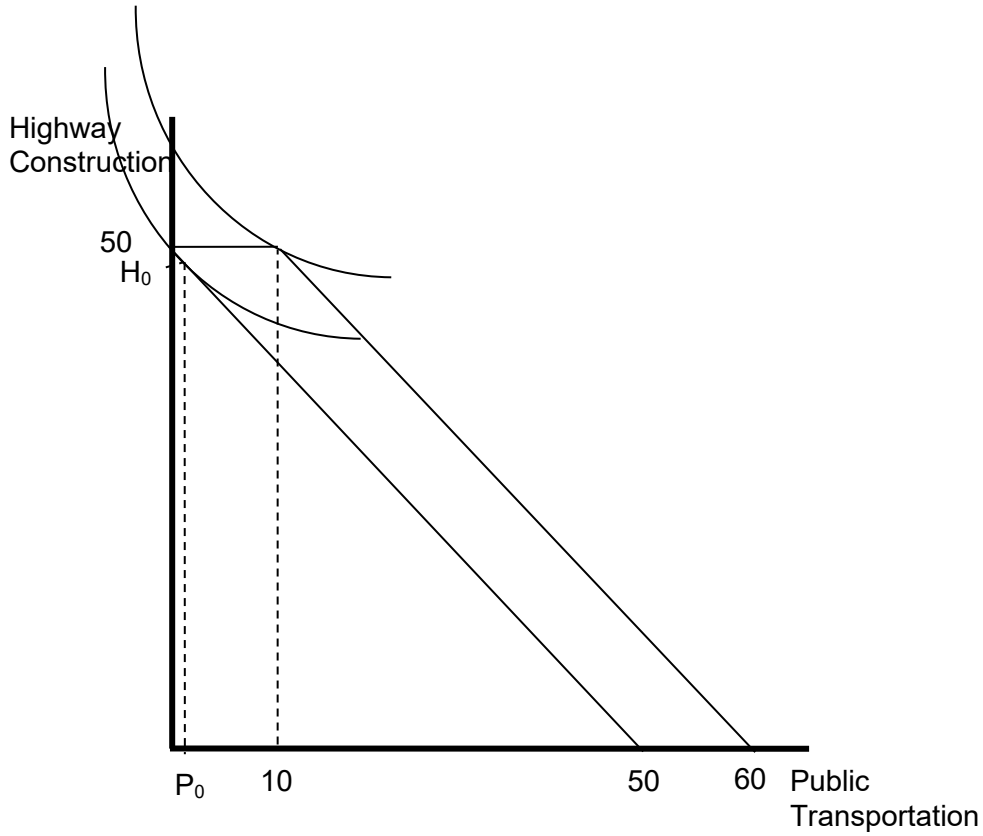


Before the grant, the city has $50 million to spend. This money can be spent on either highway construction or public transportation. Thus, the original budget constraint goes from 50 on the highway construction axis to 50 on the public transportation axis.

With the grant, the city can now spend up to $60 million on public transportation. If they spend all their income on highway construction, they can still only invest $50 million building highways. However, they will still have $10 million to spend on public transportation.

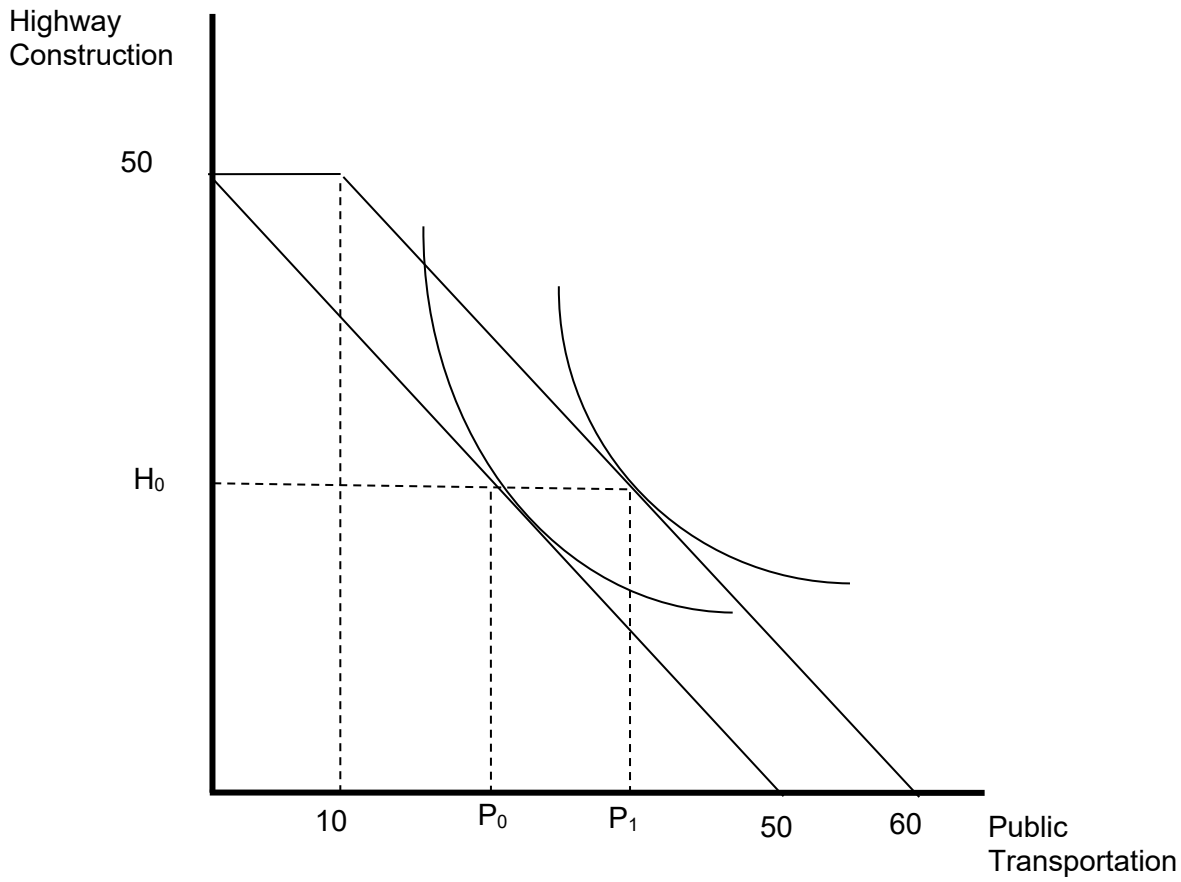
For the indifference curves, in this example, the city is already spending more than $10 million on public transportation. Thus, the recipient can reallocate money it was previously spending so that they can spend more on both highway construction and public transportation. The grant is equivalent to receiving $10 million of income.

b) On the axes below, please reproduce your budget constraints from part (a). Add a set of indifference curves consistent with Green Ride's claim that their funding does not lead to more spending (or at least very little additional spending) on highway construction.



In this example, before receiving the grant, the city is spending most of its money on highway construction. Thus, it does not have much ability to reallocate money previously spent on public transportation to highways. This is an example of a corner solution, where the recipient is affected by the constraint that the grant be spent on public transportation.

A common answer was to simply draw indifference curves in the middle of the diagram that only showed renewable energy increasing:



Since the graph is feasible (as long as you've drawn indifference curves that will not cross if extended further), I gave partial credit for this answer. However, I did not give full credit, as such a graph depends on an assumption that is unlikely to hold.

Recall that at the optimal point, $MU_H/P_H = MU_P/P_P$. This must hold at both tangencies above. Since the grant does not change the prices, the only way these can still be equal at the new tangency is if the marginal utility of public transportation, MU_P, does not change as the city spends more on public transport – that is, if there are no diminishing returns to adding more renewables. Such an outcome is unlikely. For example, a city will build the first public transportation infrastructure in areas where ridership will be highest. Thus, later additions to the public transport system are likely to be less useful.

c) Based on your graphs, what would you need to know about a recipient city's current spending to say whether or not it was likely that funding from Green Rides would enable them to spend significantly more on highway construction?

You need to know how much the recipient city is currently spending on public transportation. If they are already spending more than $10 million on public transport, they will be able to reallocate some of that spending towards highway construction. On the graph, they are below the cutoff on the new budget constraint, so they are not affected by the constraint that the money must be spent on public transportation.

A common error here was to say that if they are already spending a lot on highways, they are likely to continue to spend more on highways. However, as part (b) shows, that is not the case. While they may *prefer* to spend more money on highways, it is the communities already spending a lot on highways that are constrained by the limitation that grant funds only be spent on public transportation. Put another way, if the organization wants their funding on public transportation to have the biggest impact, it would give money to cities that have not decided to invest in public transportation on their own.

Another error was to say that we need to know the marginal utility per dollar, and focus on communities that get more marginal utility per dollar on one or the other. Remember that if communities are maximizing utility, the marginal utility per dollar spent on each will be equal. It is knowing how much they spend on each (e.g. the outcome revealed by their preferences for one type of spending over the other) that matters.