# PPOL 8640/ECON 6090 Exam 1 Answers

October 4th, 2022

Directions: Answer all questions completely. If you are unable to work out the math for the problem or unsure how to use the graph as an aid, at least write down the process you would use to think through the question. And yes, there are 105 points; I have added 5 extra points in case a question is unclear.

1. (15 points) The graph below represents the budget constraint for a consumer in a two good economy. The consumer has \$400 of income. The price of Good 1 is \$5 and the price of Good 2 is \$12. Suppose the consumer is considering choosing bundle A, which has 44 units of Good 1 and 15 units of Good 2, on indifference curve $I1$.
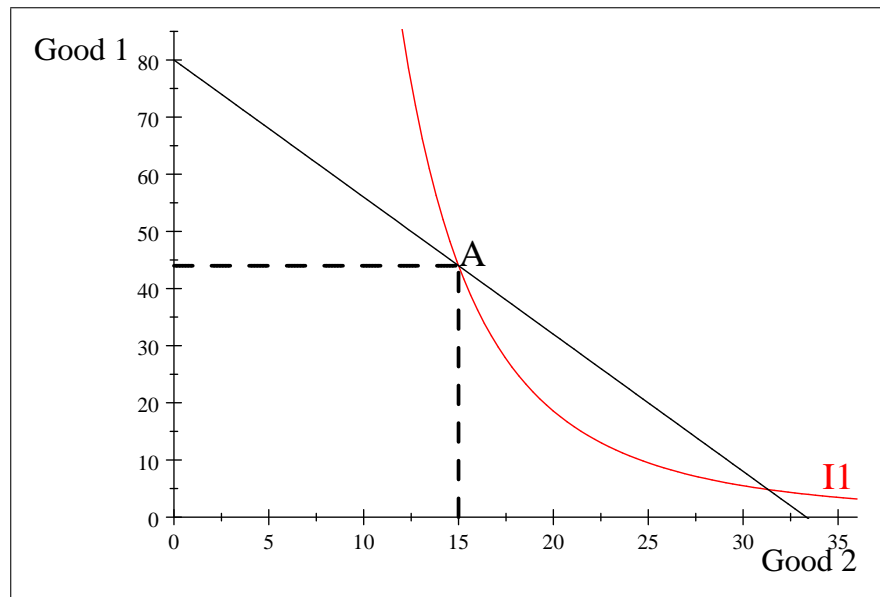
a (2 points) Verify (numerically, do not just look at the graph) that the consumer is spending all \$400 in income at the bundle 44 units of Good 1 and 15 units of Good 2.

Answer:

The bundle has 44 units of Good 1 at \$5 and 15 units of Good 2 at \$12, so $44 * \$5 + 15 * \$12 = \$220 + \$180 = \$400$.

b (3 points) At bundle A, the condition $\frac{MU_1}{P_1} = \frac{MU_2}{P_2}$ is not satisfied. Explain how you know that condition is not satisfied.

Answer:

In order for that equality to be satisfied, we need the consumer to be at a point at which the slope of the budget constraint is equal to the slope of the indifference curve, or the tangent point. We can rearrange $\frac{MU_1}{P_1} = \frac{MU_2}{P_2}$ as $\frac{MU_1}{MU_2} = \frac{P_1}{P_2}$ which more directly shows that these two slopes must be equal. As the indifference curve intersects the budget constraint at point A, and is not tangent to it, the slopes cannot be equal and the equality cannot hold.

1

c (4 points) At bundle A, is $\frac{MU_1}{P_1} > \frac{MU_2}{P_2}$ or $\frac{MU_2}{P_2} > \frac{MU_1}{P_1}$? Explain how you know.

Answer:

Looking at the graph, we know that bundle A is not an optimal point because the indifference curve is not tangent to the budget constraint. We also know, given the graph, that the consumer needs to shift towards consuming more of Good 2 and less of Good 1 because moving along the budget constraint consuming more of Good 2 will increase utility by putting the consumer on a higher indifference curve, while moving along the budget constraint towards consuming more of Good 1 will put the consumer on a lower indifference curve and decrease utility. Because the consumer will shift towards consuming more Good 2, we know that $\frac{MU_2}{p_2} > \frac{MU_1}{p_1}$ because if those two ratios are unequal the consumer will shift income towards the good that has the higher $\frac{MU_i}{p_i}$, which in this case is Good 2.

d (6 points) Suppose the consumer is considering the following bundles listed below. Are any of these bundles potential optimal bundles given the consumer's preferences, income, and prices faced? Explain why or why not.

  i Bundle B: 40 units of Good 1 and 25 units of Good 2

Answer:

While bundle B has more utility than bundle A, bundle B is not affordable ($40 * \$5 + 25 * \$12 = \$200 + \$240 = \$440 > \$400$). So bundle B cannot be an optimal bundle.

  ii Bundle C: 20 units of Good 1 and 25 units of Good 2

Answer:

Bundle C could be a potential optimal bundle. The consumer is spending all \$400 of income ($20 * \$5 + 25 * \$12 = \$100 + \$300 = \$400$). Also, the bundle has more of Good 2 and less of Good 1 than bundle A, and we know the consumer needs to shift towards more of Good 2 from either looking at the graph or from part **c**.

  iii Bundle D: 20 units of Good 1 and 20 units of Good 2

Answer:

Bundle D cannot be a potential optimal bundle because the consumer is only spending $20*\$5+20*\$12 = \$340$ of the \$400 of income.

2. (25 points) Consider the following supply and demand model for wheat.
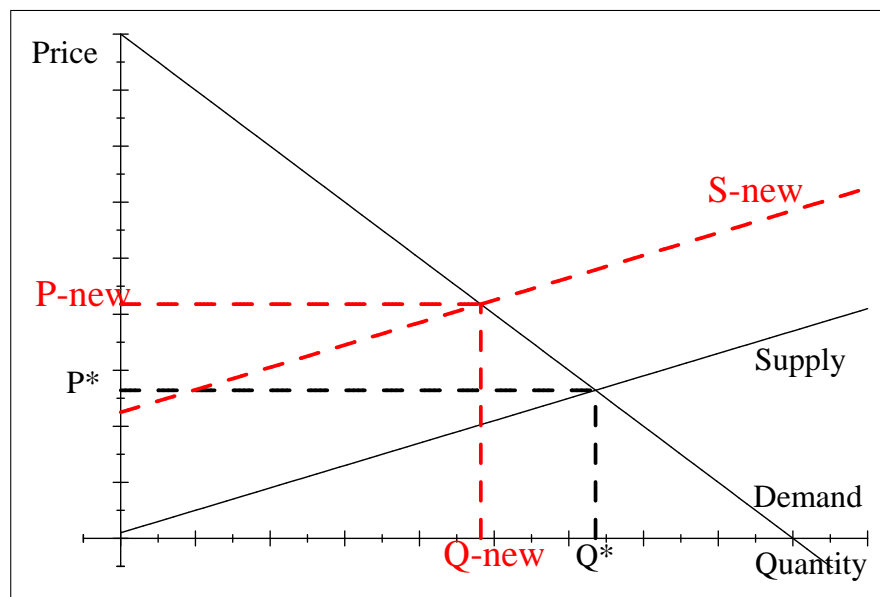
Market for wheat

a (2 points) Identify the equilibrium price and quantity on the graph.

Answer:

Identified by P^* and Q^* at the intersection of supply and demand.

b (4 points) Suppose there is a drought that negatively affects the wheat harvest. Show how this drought affects the market for wheat and identify the new equilibrium price and quantity based on your change to the market.

Answer:

The drought should decrease supply as it is "bad weather" for this market. As supply shifts to the left, the price will increase and the quantity will decrease. The shift is shown in the graph as S-new and the new equilibrium price and quantity are marked as P-new and Q-new.

c (4 points) Assume that the market for wheat is perfectly competitive and the drought affects all firms equally. Should the change in the equilibrium price you found in part **b** lead to an increase in economic profit for an individual firm based on this analysis from the supply and demand model only? Explain.

Answer:

If the price in the market increases, then that will increase the price each individual firm faces for their own product. If only the price increases, this should lead to an increase in profits for the individual firms. At a minimum, it certainly shouldn't lead to a decrease in profit; if the firm is selling 100 units at $4 and the price increases to $5 the firm could continue selling 100 units and just earn an additional dollar per unit. More likely is that the firm would expand production some to earn an even larger profit.

d (5 points) A policy response could be to provide monetary aid to the affected wheat farmers. Based on your answers to parts **b** and **c**, from an economic perspective, does affected farmers seem like an appropriate group to which to provide monetary aid? Explain.

Answer:

In part b there was a price increase in the market, which should lead to an increase in profits for the firms (part c). If these farmers are seeing an increase in profit, it would seem an odd choice of group to whom to provide monetary aid. We do not typically think of firms that see an increase in profits as the target of monetary aid, or at least not directly targeted.

e (4 points) Explain the relationship between a firm's marginal cost in a perfectly competitive market and that firm's supply.

Answer:

In a perfectly competitive market, a firm's marginal cost curve is its supply curve, at least when the marginal cost is above the minimum of average variable cost (if the price is below the minimum of average variable cost the firm should produce zero). That result occurs because the demand, price, and marginal revenue are all the same, so when there are price changes in the market the firm responds by producing the quantity associated with its marginal cost at the new price level. As these pairs are price and quantity pairs, they trace out a supply curve (when price is $\widehat{p}$, quantity is $\widehat{q}$, etc.)

f (6 points) The focus has been on the supply and demand model of the market. Now consider a model of a representative firm in a perfectly competitive industry, including the cost curves. In part **c** you were asked about how firm profits would be affected looking at just the change in market price. Explain

i Whether you would you expect the drought to have an effect on the firm's cost curves

Answer:

A drought that negatively affects the wheat harvest should make it more costly to produce the same amount of wheat, either because more resources (water, fertilizer, etc.) need to be applied to the land than when there is no drought or because some land may become completely unusable. Thus I would expect the cost curves to increase (shift upward).

ii If there is a change in the firm's cost curves how that change would affect the firm's profits

Answer:

In part i, I expected the firm's costs (and cost curves) to increase, so at a minimum the firm's profits should not increase as much as if price increased and costs remained stable. It is possible that costs increase enough that profits decrease relative to the initial profit level or that the firm is now making an economic loss.

iii Whether, from an economic perspective, when including the firm model in addition to the supply and demand model, affected farmers seem like an appropriate group to which to apply monetary aid.

Answer:

When looking just at just the supply and demand model, we neglect that there may be underlying factors that change for the perfectly competitive firm. If price in the market increases, but supply is decreasing, then that must mean there has been some effect on the firm's costs, otherwise the firms should expand production. If the costs have increased, it is possible now that the firms are making an economic loss, and thus would be a more appropriate group to which to apply monetary aid.

3. (20 points) Individual A has expected utility function $u_A(x) = \sqrt{x}$ (which is the same as $u_A(x) = x^{1/2}$) while individual B has expected utility function $u_B(x) = \sqrt{\sqrt{x}}$ (which is the same as $u_B(x) = x^{1/4}$). These individuals face the following lottery: they receive \$81 with 50% probability, \$625 with 30% probability, and \$6561 with 20% probability.

a (5 points) Calculate the expected value of the lottery.

Answer:

The expected value of the lottery is the weighted average of the payoffs, where the weights are the respective probabilities of the payoffs:

$$
\begin{aligned}
EV &= \$81 * 0.5 + \$625 * 0.3 + \$6561 * 0.2 \\
EV &= 40.5 + 187.5 + 1312.2 \\
EV &= 1540.2
\end{aligned}
$$

b (5 points) Calculate the expected utility of the lottery for each individual.

Answer:

The expected utility of the lottery is the weighted average of the utilities of the payoffs, where the weights are the respective probabilities of the payoffs:

$$
\begin{aligned}
EU_A &= \sqrt{\$81} * 0.5 + \sqrt{\$625} * 0.3 + \sqrt{6561} * 0.2 \\
EU_A &= 9 * 0.5 + 25 * 0.3 + 81 * 0.2 \\
EU_A &= 4.5 + 7.5 + 16.2 \\
EU_A &= 28.2
\end{aligned}
$$

$$\begin{aligned}
EU_B &= \sqrt{\sqrt{\$81}} * 0.5 + \sqrt{\sqrt{\$625}} * 0.3 + \sqrt{\sqrt{\$6561}} * 0.2 \\
EU_B &= \sqrt{9} * 0.5 + \sqrt{25} * 0.3 + \sqrt{81} * 0.2 \\
EU_B &= 3 * 0.5 + 5 * 0.3 + 9 * 0.2 \\
EU_B &= 1.5 + 1.5 + 1.8 \\
EU_B &= 4.8
\end{aligned}$$

c (5 points) Calculate the certainty equivalent for each individual.

Answer:

The certainty equivalent is the sure amount of money that provides the same expected utility as the lottery:

$$\begin{aligned}
u_A(x) &= 28.2 \\
\sqrt{x} &= 28.2 \\
x &= (28.2^2) \\
x &= \$795.24
\end{aligned}$$

$$\begin{aligned}
u_B(x) &= 4.8 \\
\sqrt{\sqrt{x}} &= 4.8 \\
\sqrt{x} &= (4.8)^2 \\
\sqrt{x} &= 23.04 \\
x &= (23.04)^2 \\
x &= \$530.84
\end{aligned}$$

For individual A, the certainty equivalent is $795.24; for individual B, the certainty equivalent is $530.84.

d (5 points) Both individuals are risk averse, but one is more risk averse than the other. Which individual is more risk averse and explain why that individual is more risk averse.

Answer:

Individual B is more risk averse than individual A because individual B's certainty equivalent is lower. Because individual B's certainty equivalent is lower, that individual is willing to pay more, in terms of taking a reduced amount of sure money, to avoid facing this lottery.

4. (20 points) The following picture shows the market for a monopolist's product
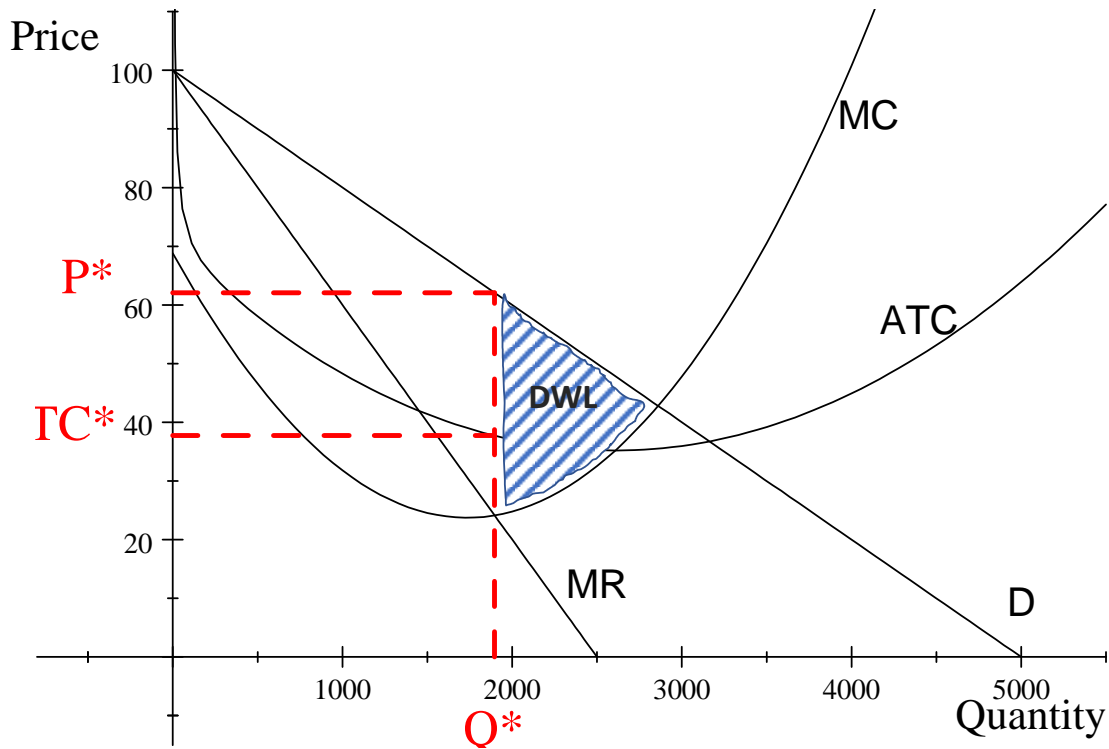
a (2 points) Label the demand (D), marginal revenue (MR), average total cost (ATC), and marginal cost (MC) on the figure.

Answer:

They are labelled on the figure.

b (2 points) Identify the profit-maximizing price and quantity in the graph.

Answer:

The profit-maximizing quantity is found at the intersection of MR and MC. Then find the price on the demand curve that corresponds to the profit-maximizing quantity, These are labelled on the figure as Q^* and P^*, respectively.

c (5 points) In a perfectly competitive market, the firm's demand curve and marginal revenue curve are identical. In a monopoly market, the firm's demand and marginal revenue are different. Explain why the marginal revenue curve for a monopolist is not the same as its demand curve.

Answer:

Marginal revenue is the change in total revenue from selling an additional unit of the good. For a monopolist, both demand and marginal revenue are downward sloping but they are not the same because in order for the monopolist to sell an additional unit of the good the monopolist must drop the price on all units of the good. So if the monopolist can sell one unit of the good at \$10, it receives \$10 in total revenue and its marginal revenue is also \$10 because its total revenue increases from \$0 to \$10. If it can sell two units of the good at \$9, the monopolist now has \$18 in total revenue and gains \$9 from the sale of the second unit, but loses \$1 because it was selling the first unit at \$10 and now sells it at \$9. So after the first unit, the monopolist's marginal revenue will differ from the demand curve because while it gains additional revenue equal to the new price it is charging, it also loses revenue from having to reduce the price on each unit it would have sold at the higher price.

d (2 points) Is the monopolist earning an economic profit? Explain how you know.

Answer:

There are at least two ways to determine that the monopolist is earning an economic profit. One is to see that the monopolist's ATC is below its demand curve, meaning that there has to be some quantity where it is profitable for the monopolist to produce. The other is to note that at the profit-maximizing quantity the price is greater than the average total cost, so there is a positive difference from $P^* - ATC^*$. The ATC^* is labelled on the graph to show that it is below P^*.

e (4 points) Define the concept of deadweight loss and, if there is any in this monopolist market, identify it in the graph.

Answer:

Deadweight loss is the unrealized gains from trade in a market, which means that a market has trades that could create some nonnegative producer and/or consumer surplus, but some market inefficiency is stopping those trades from occurring. Graphically it is defined as the area beneath the demand curve and above the supply curve (in this case marginal cost curve) and between the actual quantity traded (Q^*) and the socially efficient quantity which occurs at the intersection of supply and demand. It is shown in the figure as the striped blue area.

f (5 points) Suppose a policy is enacted that limits the price a monopolist can charge for its product and that price limit is below the monopolist's profit-maximizing price; suppose it is $50 in this example. Describe the monopolist's marginal revenue curve when price is capped at a specific dollar amount.

Answer:

In a standard monopoly model, the monopolist's marginal revenue is downward sloping because we assume the monopolist must sell all units at the same price, so that if a monopolist wishes to sell more units it must decrease the price. However, if a policy is enacted that caps the price at a certain amount, then the monopolist cannot charge more than that price for any unit. Essentially what happens is the monopolist's MR curve becomes flat, just like the MR curve for a perfectly competitive firm. However, while the perfectly competitive firm can see as much as it wants at that price because the demand for its product is small relative to the market demand, the monopolist cannot. Technically the monopolist's marginal revenue curve would be flat up until it reaches the demand curve, and then for quantities greater than the quantity from the demand curve that corresponds to the price limit, the MR curve would be the same as it was without the price limit.

For instance, if the price limit was set at $20, the MR would be $20 for all quantities up until 4000, which is the quantity on the demand curve that corresponds to a price of $20. For quantities greater than 4000, the MR curve then becomes exactly what it is in the figure, though you cannot see the part of the MR curve for quantities larger than 4000 in the picture because it is negative.

5. (15 points) Two public sector projects are being considered for implementation, project A and project B. The costs and benefits of those projects over time are listed in the table, with Project A having a large delayed benefit. Assume that there is no uncertainty about the benefits and costs. Assume that the discount rate, r, is 10% ($r = 0.10$).

Year t	Benefits for A	Costs for A	Benefits for B	Costs for B	$(1+r)^t$	for $r = 0.1$ $\frac{1}{(1+r)^t}$
Year 0	$0	$1000	$1500	$900	1	1
Year 1	$0	$0	$900	$800	1.1	0.91
Year 2	$0	$1000	$700	$700	1.21	0.83
Year 3	$0	$0	$600	$600	1.331	0.75
Year 4	$0	$1000	$0	$0	1.4641	0.68
Year 5	$10,000	$0	$0	$0	1.61051	0.62

a (2 points) Define the criteria of admissibility and preferability in cost-benefit analysis.

Answer:

An admissible project is one that has a positive present value. When comparing two admissible projects, the one with the higher present value is preferable.

b (5 points) Calculate the present value for both projects. Show that both projects are admissible and that project A is preferred to project B.

Answer:

The present value formula is:

$$PV = B_0 - C_0 + \frac{B_1 - C_1}{(1+r)^1} + \frac{B_2 - C_2}{(1+r)^2} + ... + \frac{B_T - C_T}{(1+r)^T}$$

For Project A:

$$
\begin{aligned}
PV_A &= (0 - 1000) + \frac{(0 - 1000)}{(1+r)^2} + \frac{(0 - 1000)}{(1+r)^4} + \frac{(10,000 - 0)}{(1+r)^5} \\
PV_A &= -1000 + (-1000) * 0.83 + (-1000) * 0.68 + 10,000 * 0.62 \\
PV_A &= -1000 - 830 - 680 + 6200 \\
PV_A &= 3690
\end{aligned}
$$

For Project B:

$$
\begin{aligned}
PV_B &= (1500 - 900) + \frac{(900 - 800)}{(1+r)^1} + \frac{(700 - 700)}{(1+r)^2} + \frac{(600 - 600)}{(1+r)^3} \\
PV_B &= 600 + (100) * 0.91 + 0 * 0.83 + 0 * 0.75 \\
PV_B &= 600 + 91 \\
PV_B &= 691
\end{aligned}
$$

Both projects have a present value greater than zero, so they are both admissible. Project A has the larger present value so it is preferred.

c (8 points) Now consider how the following might affect a policy maker's choice of project A or B:

i In the U.S., most elected officials have term lengths of 2 or 4 years, with some being longer. How might the shorter (2 or 4 year) term lengths influence an elected official's decision about which project to undertake?

Answer:

Note that I have structured the problem so that both projects have a total cost (undiscounted) of $3000, so it is not that one project "costs" more, in undiscounted terms, than the other. Typically elected officials like to see the benefits of their policies occur during their term, particularly if they are able to run for office again at the expiration of their term. Thus, even though project A has a higher present value, there are costs being paid while the official is in office but no immediate benefits. Supporting policies with future benefits may not be a winning strategy when it is time to campaign for the next election. Project B, on the other hand, has immediate costs but also immediate benefits that are more than the costs, and no future years in which the costs outweigh the benefits. For an official who could be seeking reelection, an admissible project with immediate benefits is likely more appealing than one with benefits a few years in the future, regardless of the present value calculation.

ii Now assume there is uncertainty about the benefits and costs; the numbers in the table reflect the best estimate of the benefits and costs each year. When conducting a forecast, the further into the future, the wider the variance (or the error bars) of the estimate. How might uncertainty affect an elected official's decision about which project to undertake, particularly if the official is risk averse?

Answer:

While project A has a larger present value, its benefits occur five years in the future, meaning it is quite possible that the benefits could be much larger or smaller than the estimated benefits. Also, some costs occur two and four years in the future, so they may also be larger or smaller. If the official is risk averse, they may be unwilling to support the project because of the uncertainty around the large (relative to cost) future benefit and the immediate costs that are certain.

6. (10 points) Short answer questions

   a (5 points) Define the concept of Pareto optimality. Describe how the compensating variation, when applied to policy analysis, reflects the principles of Pareto optimality.

Answer:

Pareto optimality means that we have reached an allocation of goods such that we cannot make one individual better off without making another individual worse off. A slightly different way of stating that is that we cannot increase one individual's utility without decreasing another individual's utility. The compensating variation reflects the principles of Pareto optimality because the goal is to determine how much money an individual would need to receive to return to the same utility level after some policy change. The idea is that if the individuals who benefit from a policy change gain enough that they could compensate those who do not benefit from a policy change to bring those who do not benefit back to their original utility, then the policy is guaranteed to benefit society because some people gain while none lose.

   b (5 points) Our utility functions over goods provide an ordinal measure, meaning it is the ranking of the bundles that is important, not the actual number for utility. Does using an ordinal measure cause any problems when attempting to aggregate individual preferences into a social welfare function to measure society's well-being? Explain.

Answer:

Using an ordinal measure causes problems when attempting to aggregate individual preferences into a measure of well-being for a society. Perhaps the biggest problem is that making interpersonal comparisons between people is difficult if the utility number itself is not important. For example, if one individual has a utility of 12 and another has a utility of 14, it is possible that the two individuals consume the exact same bundle of goods but that the individual with a utility of 12 has some $u(x_1, x_2, ..., x_N)$ while the individual with utility of 14 has the exact same $u(x_1, x_2, ..., x_N)$, only with 2 added to it, so that individual's utility is given by $u(x_1, x_2, ..., x_N) + 2$. But comparing those two numbers, 12 and 14, is not very meaningful if the particular numbers can be changed without changing someone's preferences. One could make the argument that we could use a single utility function to represent all individuals who have the same preferences so that we do not run into the problem of having changing utility numbers by adding a constant, but the problem just reappears in a slightly different fashion. If there are only types of preferences, $u_A(\cdot)$ and $u_B(\cdot)$, which utility function do we use to represent those preferences? $u_A(\cdot)$, $u_A(\cdot) + 1$, $u_A(\cdot) + 2$, etc. all represent the same preferences, but we would need to pick one $u_A(\cdot)$ and one $u_B(\cdot)$ to make comparisons. While it is possible to create social welfare function that adds (or otherwise aggregates) utilities together, the value that results from the social welfare function is not very meaningful if the inputs themselves are not meaningful.

The entire discussion assumes that we would use the utility theory model as the basis for social welfare comparisons; it is completely possible to use some other type of model for those comparisons, but that is beyond the scope of this question.