# Suggested Answers <br> Problem Set 1 <br> Economics 40565 

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1. Increases in agricultural production should increase both the marginal and average productivity of medical care spending. In the graph below, the health production function shifts up from \#1 to \#2.
2. Baseline five year mortality rates are 0.03 . When income doubles (from $\$ 10,000$ to $\$ 20,000$ ), mortality declines by $25 \%$ or by $(0.03)(0.25)=0.0075$ to 0.0225 . When income doubles again to $\$ 40,000$, mortality will fall by another $25 \%$ by $(0.0225)(.25)=0.005625$ to 0.016875 . When it doubles again to $\$ 80,000$, it drops another $25 \%$ or $(0.016875)(0.25)=0.0043$ to 0.0125 .
3. Relative risk is the ratio of mortality for a group with a particular characteristic divided by the average mortality for the population. A relative risk of 1 means an average risk of mortality. Looking at figure 2.3 , there are four equal step between 0.88 and 2.14 so each step increases the relative mortality by $0.315=(0.214-0.88) / 4$. So the three lines up from 0.88 represent $1.195,1.51$, and 1.825 . Thos with a BMI of 19 have a relative risk somewhere half way between 1.51 and 1.195 or roughly 1.35 . Someone with a BMI of 19 has a $35 \%$ higher mortality rate. Someone with a BMI of 31 has a relative risk of roughly 1.5 or a $50 \%$ higher mortality rate.
4. The Gompertz equation explaining mortality at age A is $\mathrm{M}_{\mathrm{A}}=\mathrm{c} \exp (\mathrm{bA})$. Taking the logs, we find that $\ln \left(\mathrm{M}_{\mathrm{A}}\right)=\ln (\mathrm{c})+\mathrm{bA}$ or, $\log$ mortality rate is linear in age. Therefore, taking the derivative of the $\log$ mortality equation with respect to age, we find that $d \ln \left(M_{A}\right) / d A=b$. The derivative of a $\log$ is equal to $\mathrm{dln}(\mathrm{M})=\mathrm{dM} / \mathrm{M}$ which is nothing more than a percentage change in M . Therefore, $\mathrm{b}=$ the percentage change in the mortality rate for a one year increase in age. Since $b=0.0852$, a one year increase in age is estimated to increase mortality rates by 8.52 percent. In this case, mortality rates increase by 8.52 percent for every one year increase in age. A 15 -year increase in age will generate a $15(0.0852)=1.278$ or a 1.278 percent increase in mortality. Since $\ln (c)=-9.944, \exp (\ln (c))=\exp (-9.944)=4.80 \mathrm{E}-5$. Using this number, and the original Gompertz equation $\mathrm{M}_{\mathrm{A}}=\mathrm{c} \exp (\mathrm{bA}), \mathrm{M}_{\mathrm{A}}=4.8 \mathrm{E}-5[\exp (0.0852 \mathrm{~A})]$. Plugging 50 and 65 into this equation, we get $\mathrm{M}_{50}=0.0034$ and $\mathrm{M}_{65}=0.0122$
5. At age 30, those with more education smoke less. However, the results also suggest that those at age 30 with more education were also less likely to smoke at age 16 as well. The sample contains only high school graduates so everyone at age 16 has the same years of education. Therefore, the fact that education that occurs after age 16 appears to be correlated with higher smoking rates at age 16 leads one to suspect that the relationship between smoking at age 30 and education is not causal - the fame factors that lead one to get additional years of education are the same factors that lead one to smoke. For example, suppose that some people are more forward looking than others. They will be more likely to invest in health and invest in human capital.
6. There are many cofactors that predict high low birth-weight rates, such as low parental socioeconomic
status, parental smoking, unhealthy home environment, etc. Unfortunately, these same factors are present after birth and also predict higher cardiovascular disease rates later in life. So although the results suggest a link between in utero conditions and later health, the results could be driven by some unmeasured factor not accounted for in the model.
7. As a result of the law change, the graph illustrates a sharp drop in SS income for those born in 1917 and after. If reductions in income increase mortality, we should see a sharp increase in mortality, relative to trends, for those born in 1917 and after
8. Please see the final page of the answer key for the graph. To determine the market clearing level of quantity, set inverse supply equal to inverse demand and solve for $\mathrm{Q} .40+4 \mathrm{Q}=400-8 \mathrm{Q}$, so $360=12 \mathrm{Q}$ or $\mathrm{Q}=30$. Initial equilibrium is point a below. Substitute this back into either inverse demand or supply and solve for $\mathrm{P}, \mathrm{P}=40+4 \mathrm{Q}=40+4(30)=160 . \mathrm{CS}=0.5(400-160)(30)=3600 . \mathrm{PS}=0.5(160-40)(30)=$ 1800.
9. Given the externality, the $\mathrm{MSC}=52+4 \mathrm{Q}$. The socially optimal output is where $\mathrm{MSC}=$ Inverse demand, $52+4 \mathrm{Q}=400-8 \mathrm{Q}$ and therefore $\mathrm{Q}=29$. Market clearing price should be $\mathrm{P}=400-8 \mathrm{Q}=400-8(29)=$ 168 (point b). Because of the externality, market production is greater than socially optimal. The social cost of producing $\mathrm{Q}=30$ is $\mathrm{MSC}=52+4 \mathrm{Q}=172$. Since the externality is not internalized, consumers receive a benefit of dbae. The social cost is dbce. Therefore, deadweight loss is abc. This value is $0.5(1)(12)=6$.
10. The market equilibrium is determined by setting inverse supply equal to inverse demand and solving for $\mathrm{Q}: 8+2 \mathrm{Q}=80-\mathrm{Q}$, so $72=3 \mathrm{Q}$ so $\mathrm{Q}=24$. Price would equal $8+2(24)=56$. The $\mathrm{MSB}=80-2 \mathrm{Q}$ so the socially optimal consumption would be at the point where inverse supply equals MSB , or $8+2 \mathrm{Q}=80-2 \mathrm{Q}$ so $72=4 Q$ or $Q=18$. Suppliers would supply this amount at a price of $8+2 Q=8+2(18)=44$. However, consumers would only demand this amount if price were equal to $\mathrm{P}=80-\mathrm{Q}=80-18=62$. Therefore, the tax that should be imposed on consumers is (62-44) or $\$ 18$ per unit. Verify your results. When a per unit tax is imposed, the demand falls by an amount equal to the tax, or $\mathrm{P}=80-\$ 18-\mathrm{Q}$, or demand is now $\mathrm{P}=62-\mathrm{Q}$. The market equilibrium when there is a tax is determined by the intersection of the inverse supply and the new demand curve, or $8+2 \mathrm{Q}=62-\mathrm{Q}$, or $54=3 \mathrm{Q}$ or $\mathrm{Q}=18$. The price received by sellers is $8+2 \mathrm{Q}=8+2(18)=\$ 44$ and consumers pay $\$ 44+\$ 18$ or $\$ 62$.
11. Employers typically do not charge smokers or drinkers higher insurance premiums because they can only imperfectly monitor these behaviors and the costs of monitoring may be prohibitive.
12. The annual probability of death from a motor vehicle accident is 0.0001 . A $25 \%$ reduction would reduce that probability by 0.000025 . Consumers are willing to pay $\$ 76$ for this reduction so the value of a statistical life is $\$ 76 / 0.000025=\$ 3,040,000$.
13. In order for these estimates to accurately reflect what people are willing to trade income for risk, one must make a number of assumptions about the labor market. First, one must assume that workers understand the risks they face. If workers systematically over/under state job risks, then workers are not trading income for actual risk. Likewise, the models assume there is free flow of workers across jobs. If workers find their wage too low or risk too high, the models assume they can move to a job that accurately reflects their preferences. But if there are factors that restrict mobility (e.g, fixed costs of a
move, a working spouse, etc.) then the wage/risk gradient will not reflect the true preferences of the workers. Finally, factors that impact wage rigidity like collective bargaining may also mean the estimated relationship does not indicate worker preferences.
14. 
15. This question is a review of elasticities of demand. The price of cigarettes was $\$ 1.90 /$ pack before he settlement and an increase in prices of $\$ 0.55 /$ pack is a $28.9 \%$ increase in price. We are given that the elasticity of demand for cigarettes is -0.40 and $\xi=\% \Delta \mathrm{Q} / \% \Delta \mathrm{P}$. Therefore, $\% \Delta \mathrm{Q}=\xi(\% \Delta \mathrm{P})=-0.40$ $(0.289)=-0.116$. The price hike reduced demand by $11.6 \%$ or by $(21$ billion $)(0.116)=2.43$ billion packs per year.


