Possible Solutions to Homework 1

Due Tuesday February 11, 2014

Economics of Sustainability

K Foster, Colin Powell School CCNY, Spring 2014

You are encouraged to form study groups to work on these problems. However each student must hand in a separate assignment: the group can work together to discuss the papers and comment on drafts, but each study group member must write it up herself/himself. When emailing assignments, please include your name and the assignment number as part of the filename.

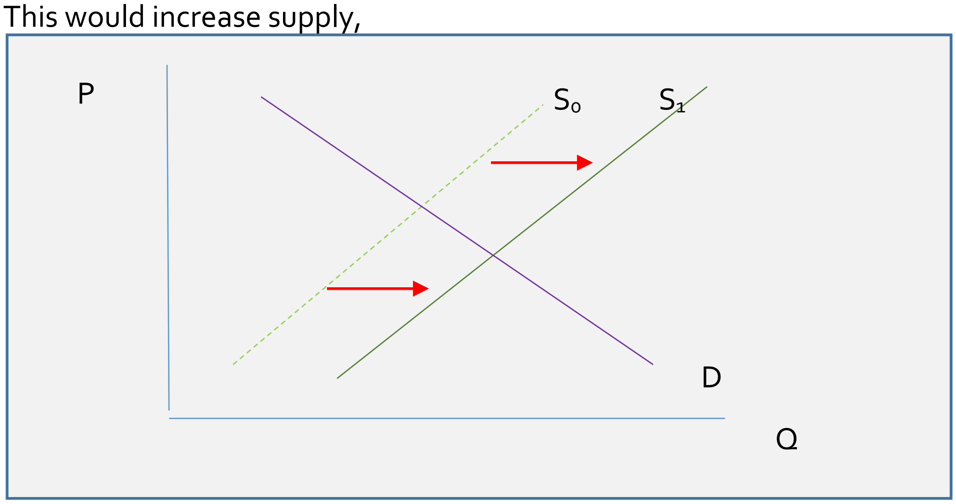
Please write the names of your study group members at the beginning of your homework to acknowledge their contributions.

1. *Consider demand elasticities.*
    a. *What goods do you personally demand, which have a low price elasticity?*
    b. *Which have a high price elasticity?*

   Answers will vary. Necessities have a low price sensitivity while highly discretionary items have a high elasticity.

2. *Consider the supply and demand for gasoline. Sketch the changes (if any) for each contingency.*
    a. *What would be the effect, on supply and demand for gasoline, of Brazil's pré-sal fields coming online and beginning production? Would price increase or decrease? Would quantity increase or decrease?*

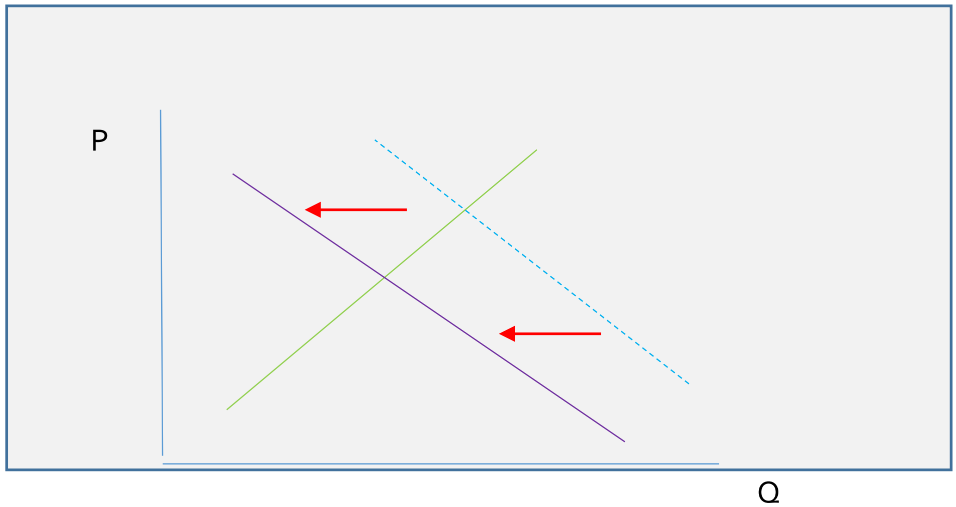
       This would increase supply,



       So Quantity would increase while Price falls.

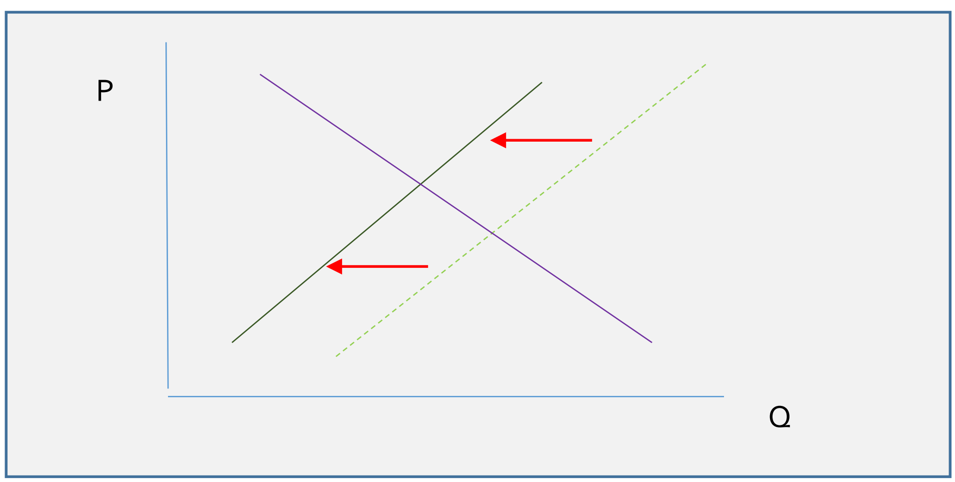
    b. *What would be the effect of new regulations raising the fuel economy of vehicles sold? Would price increase or decrease? Would quantity increase or decrease?*

We would expect that this would decrease demand, so quantity and price would both fall.



c. *What would be the effect of a civil war beginning in a big oil producer? Would price increase or decrease? Would quantity increase or decrease?*

This would be expected to lower supply so reducing quantity while raising the price.

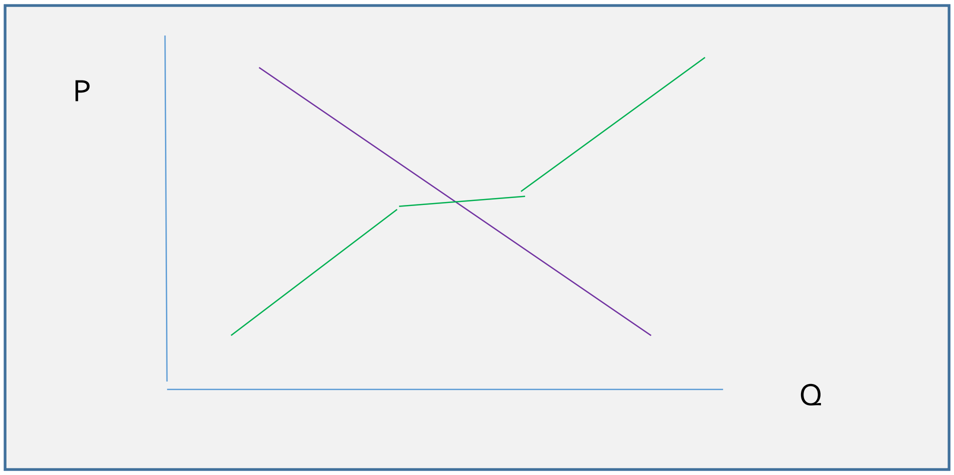


d. *What would be the effect of a recession? Would price increase or decrease? Would quantity increase or decrease?*

A decrease in demand would be the same situation as the previous answer, (b), so price and quantity would fall.

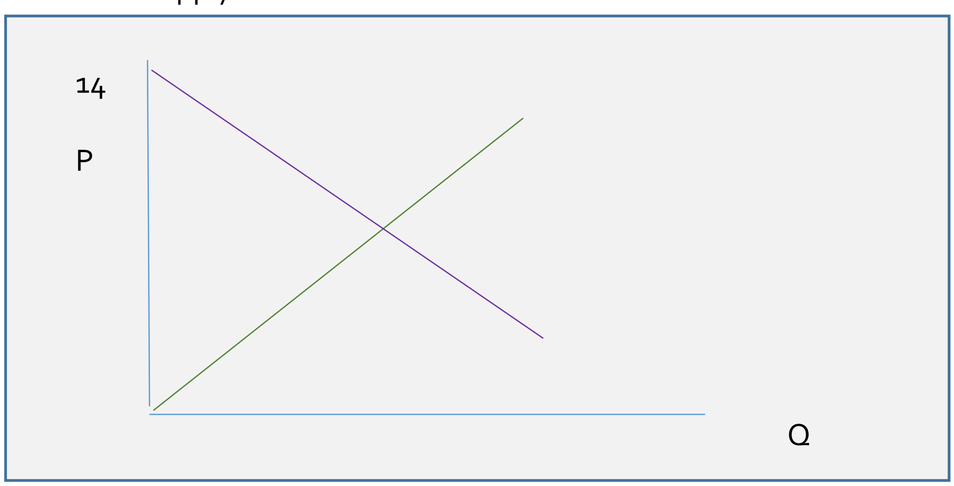
e. Suppose the Saudis kept enough reserve production capacity to be able to increase or decrease production by 2%, with the aim of steadying prices?

This moderation could be represented as a flat portion of the supply curve.

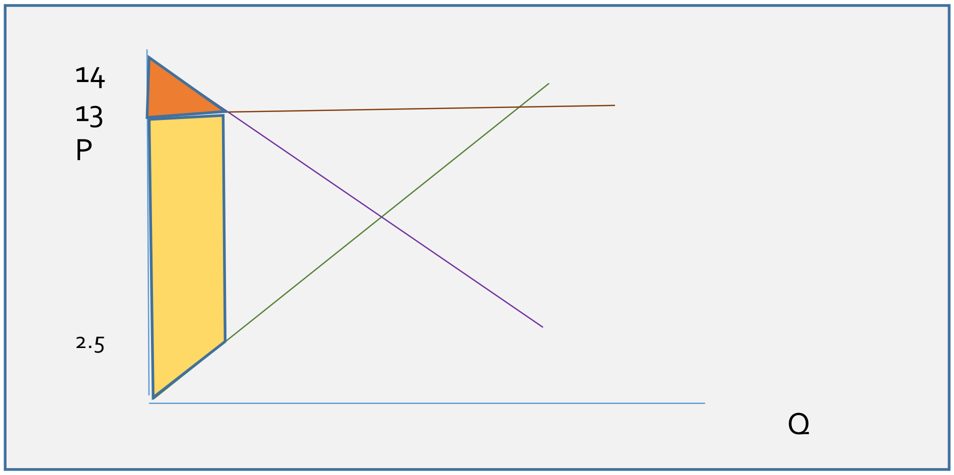


So that shifts in the demand curve would produce only very slight changes in price.

3. *Consider a market that can be represented by a linear demand curve, $Q_D = 70 - 5P_D$, (where Q_D is the quantity demanded and P_D is the price that demanders pay) and a linear supply curve that $Q_S = 2P_S$ (where Q_S is the quantity supplied and P_S is the price that suppliers get).*
   a. *Graph the two functions with P on the vertical axis.*
   Typically we write a function with the y-axis variable on the left, so demand is $P = 14 - .2Q$ while supply is $P = ½Q$.

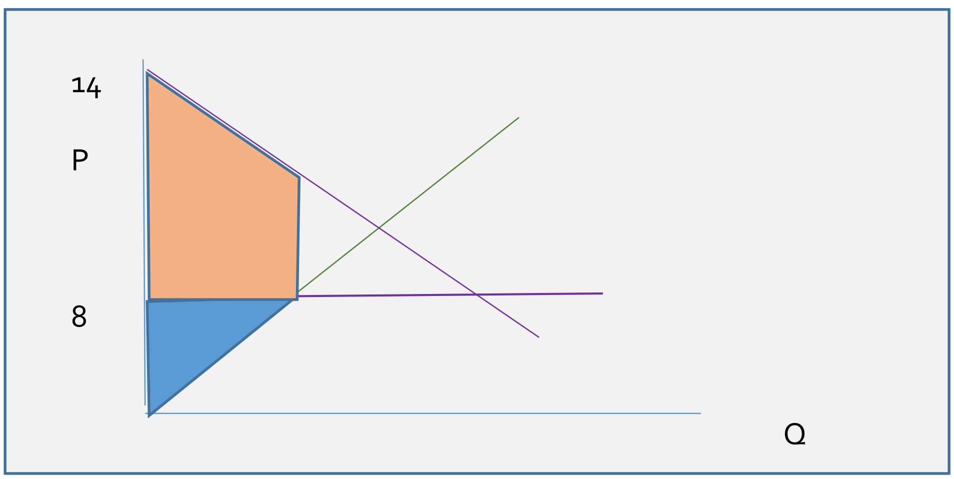


   b. *At a price of 13, how many units are demanded? How many are supplied? What would be Consumer and Producer Surplus if this price prevailed? (Recall that the area of a triangle is half the base times the height.)*
   Demand is just 5 while supply is 26, so only 5 are produced and sold.



Consumer Surplus is the small triangle above, with base of 5 and height of 1 so area is 2.5. Producer Surplus is the narrow trapezoid; to find the area note that suppliers would be willing to supply just 5 units for a price as low as 2.5, so the area is the rectangle with height (13 – 2.5) = 10.5 and width 5, plus the triangle with base 5 and height 2.5. So the total PS is (10.5)(5) + .5(2.5)(5) = 58.75.

c. At a price of 8, how many units are demanded and supplied? What would be Consumer and Producer Surplus if this price prevailed?



At a price of 8, there are 70 – (5*8) = 30 units demanded but 16 supplied so only 16 are produced and bought. Now PS is the bottom triangle, with height 8 and base of 16 so area is 64. CS is the trapezoid; note that the upper right corner is where Q=16 and P=14 - .2(16) = 10.8. So area of CS is a rectangle plus a triangle. Rectangle has height (10.8 – 8) = 2.8 and width 16 so area is 44.8. Triangle has base 16 and height (14 – 10.8) so area is .5(16)(3.2) = 25.6. Total CS is 44.8 + 25.6 = 70.4.

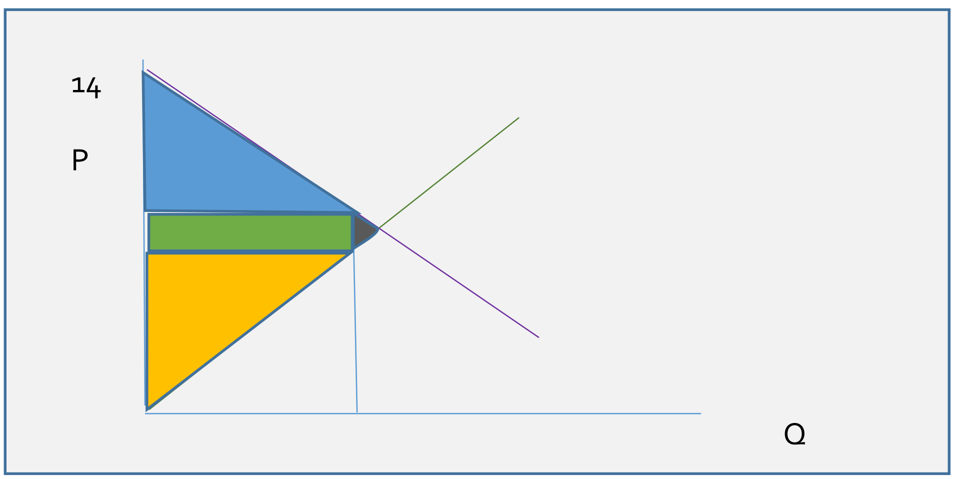
d. *Set $P_D=P_S$ and $Q_D=Q_S$ and solve the system of equations to find the equilibrium (find the intersection of the lines). Show on the graph.*
So 70 – 5P = 2P and P*=10, Q* = 20.

e. *What are CS & PS now? Show on the graph. Compare Total Surplus for the 3 cases.*

Now CS is the triangle with height (14 – 10) and base 20 so area is 40. PS is the triangle with base 20 and height 10 so area is 100. Total surplus is 140.
At a price of 13, Total Surplus was 2.5 + 58.75 = 60.25; with a price of 8, Total Surplus was 64 +70.4 = 134.4, still slightly less.

f. *Suppose the government sets a tax of $2 per unit. This means that $P_D = P_S + 2$. What is now the quantity demanded & supplied? (You can substitute in the algebraic expressions for P_D and P_S, then solve.) What are CS & PS now? What is government revenue (which adds to total surplus)? What is DWL (deadweight loss)?*

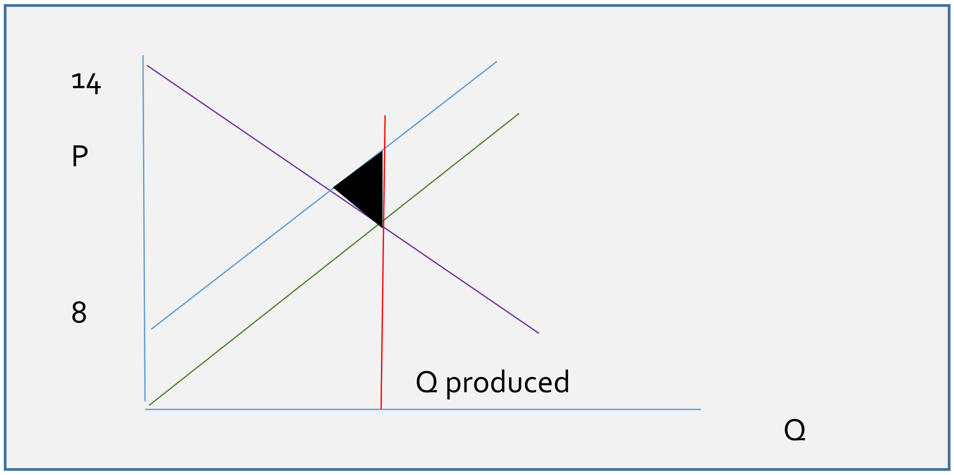
From $P_D = P_S + 2$ substitute (14 - .2Q) = (.5Q) + 2 so Q=12/.7 = 17.14, Pd = 10.57 and Ps= 8.57. So the tax is not entirely paid by either demanders or suppliers, but rather demanders pay .57 more than the 10 paid in part (e) while suppliers get 1.43 less – so suppliers bear more of the burden of the tax. Now



Now CS is the blue top triangle, with base 17.14 and height (14 – 10.57) so area is 29.39. PS is the bottom yellow triangle, base 17.14, height 8.57 so area is 73.47. Government tax revenue is 2*17.14, the area of the green rectangle, 34.29. Total Surplus is the sum, 137.14. DWL is the grey triangle, with base 2 and height (20-17.14) so area is 2.86 – exactly the same as you'd get by subtracting current from previous Total Surplus (140). Yeah math.

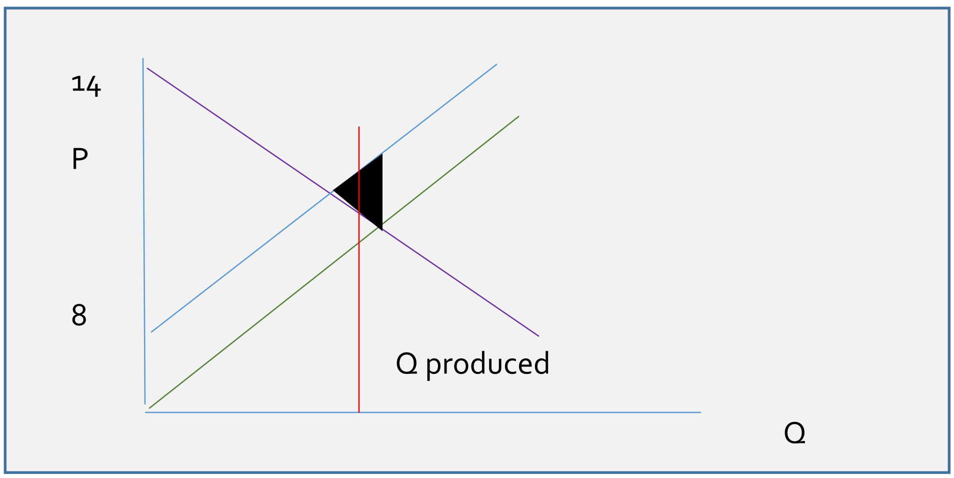
g. *Suppose that production of this good has a marginal external cost of $3 per item. What is the DWL of the free market equilibrium? What is the DWL of the tax case?*

If production has an external cost of $3 per item, then the free market equilibrium imposes a DWL on society since the marginal person valued the product at just $10 while the marginal total cost to society (private cost of $10 plus social cost of $3) was $13.



So DWL is now the other black triangle, showing cost above what people would be willing to pay. Now Social Cost should be Ps = .5Qs + 3; this intersects demand where .5Q + 3 = 14 - .2Q so Q=11/.7 = 15.71. So DWL triangle has base 3 and height (20 – 15.71) so area is 6.42.

The tax case now gets us closer to the social optimum since it lowers the quantity produced



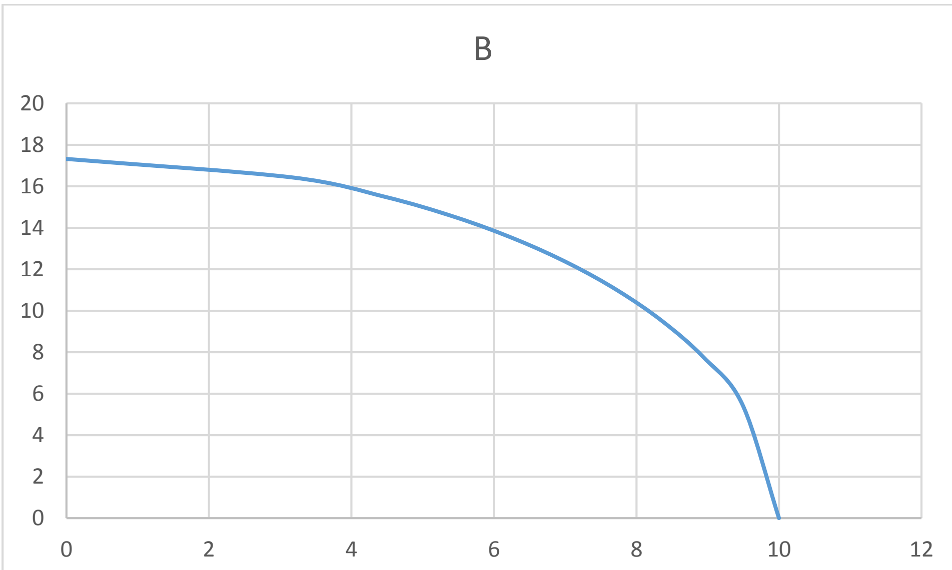
Now with the tax the quantity produced is 17.14, so there is only an excess of 17.14 – 15.71 = 1.43. The smaller triangle has area (I will omit some of the calculations; put 17.14 into the social marginal cost curve, P = .5Q + 3; find that its base is 1) .71.

4. *A small country can use its coast for tourism (people are attracted to pristine coastline) or business/industry (which destroys the tourist appeal). It wants to choose what percent of coast should be preserved for tourism and how much should be kept for industry. Assume that the two industries can be modeled as follows. The coast (C) can be used for tourism, T, or business, B, where each is a percentage so* $C_T + C_B = 100$. *The jobs from businesses (in hundreds) can be modeled as* $B = \sqrt{3C_B}$ *and the number of tourists (in thousands) is*

$T = \sqrt{C_T}$. *From combining the first two equations we can write* $B = \sqrt{3(100 - C_T)}$; *from the third equation we can write* $C_T = T^2$.

a. *If 100% of the coast is used for tourism, what is the maximum number of tourists? If 100% were used for business, what is the maximum number of jobs?*
   If CT = 100 then it gets T=10; if CB=100 then B=17.32.

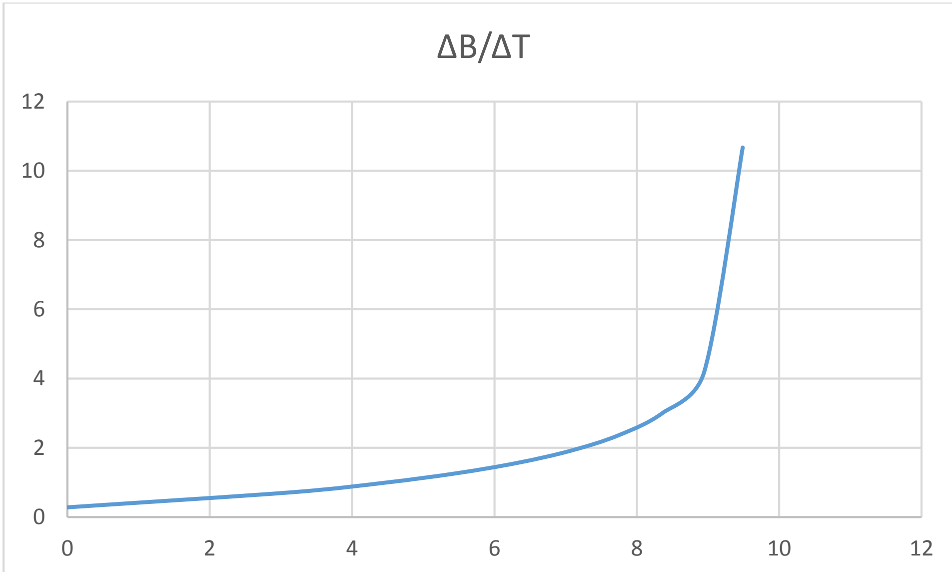
b. *Write the equation giving B as a function of T. Graph it. (You can use Excel to plot points if it's easier.)*
   Put together $B = \sqrt{3(100 - C_T)}$ and $C_T = T^2$ to find $B = \sqrt{3(100 - T^2)}$.
   Check that the calculations from part (a) show the right values – at T=10, B=0; at T=0, B=sqrt(300)=17.32. (See Excel Sheet)



c. *What is the opportunity cost, of business given up, if the island moves from zero to one tourist unit? (You can use calculus or find the change between values.)*
   At T=1, B=sqrt(297) = 17.23, so the cost of the first T is (17.32 – 17.23) = .09 B.

   With a bit of calculus, $\frac{dB}{dT} = \frac{1}{2}\frac{6T}{\sqrt{3(100-T^2)}}$.

d. *What is the opportunity cost, of business jobs given up, for each unit of tourism, if the island moves to 100% tourism? Plot the opportunity cost.*
   This is ΔB/ΔT,



Where clearly the last unit of T costs many more B than the first.

e. *Do the same exercise (find opportunity cost and plot), but find opportunity cost in terms of tourists, for integer units of business jobs.*
   Now this is $\Delta T / \Delta B$, just the inverse.

f. *What is the best combination? What additional information is needed, to answer this?*
   The best combination depends on preferences, what to people want?