Case Study # 1: Bottled Water (70 points total)

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The bottled water industry is a large industry in the United States. The major competitor is "other" drinks sold in vending machines. Consumption of salty snacks, such as popcorn, increases the demand for beverages of all types. Gasoline is a major input into the production and delivery of bottled water. Except for hand-drawn answers, please write your responses in Word in red. Also, please imbed your graphs and regression results directly in the Word file where requested. In general, solve to two decimal points. Let me know if you need any help!

In this case study, you will: use graphs and equations to analyze supply, demand, elasticity, and equilibrium price and quantity.

Skills needed to complete this case study:

1. Enter data, enter formulas, and create charts in Excel
2. Estimate a regression equation using Excel
3. Use basic algebra

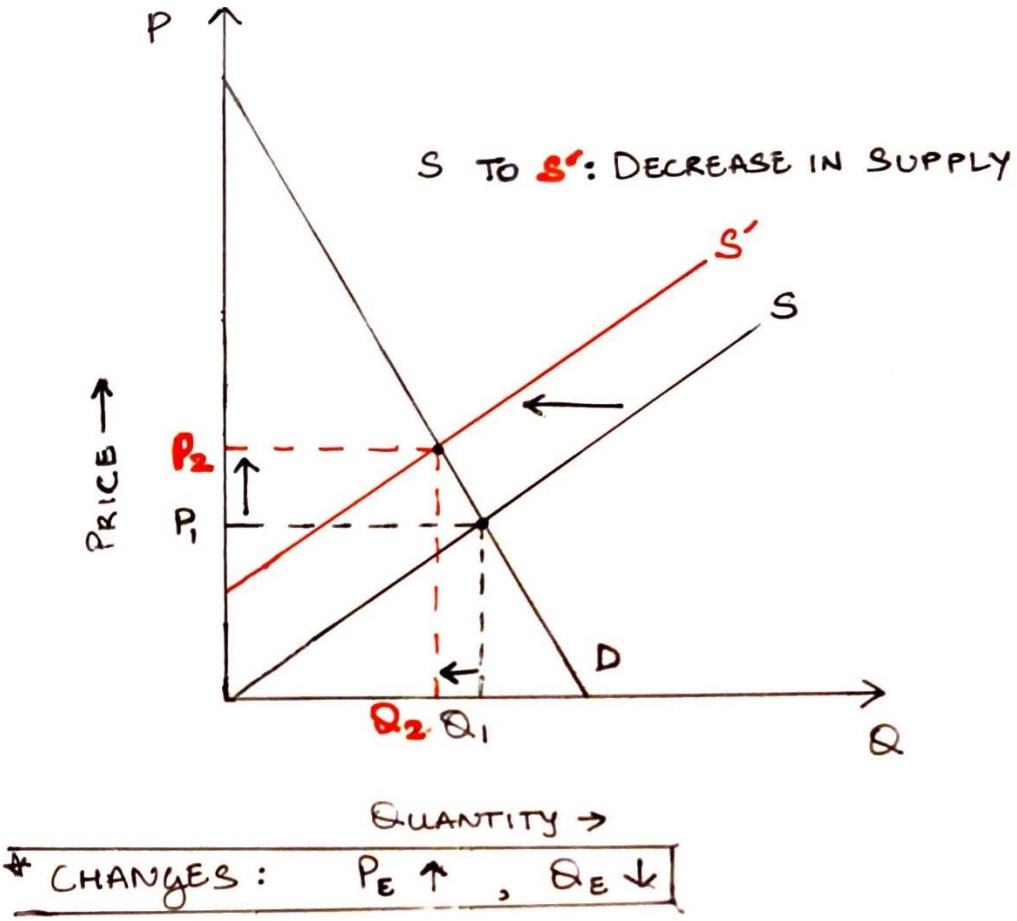
Your Excel program may need some added features:

- Click on the "file" and click on "Options"
- Click on "Add-Ins"
- Click on the *Analysis ToolPak* add-in, then click "go"
- In the new box, click *Analysis ToolPak* and click "ok"
- This will give you a new section in *Data* called *Data Analysis* (on the far right).

NOTE: The step-by-step Excel instructions apply to Office 2010 Excel, but will generally work for some earlier or later versions.

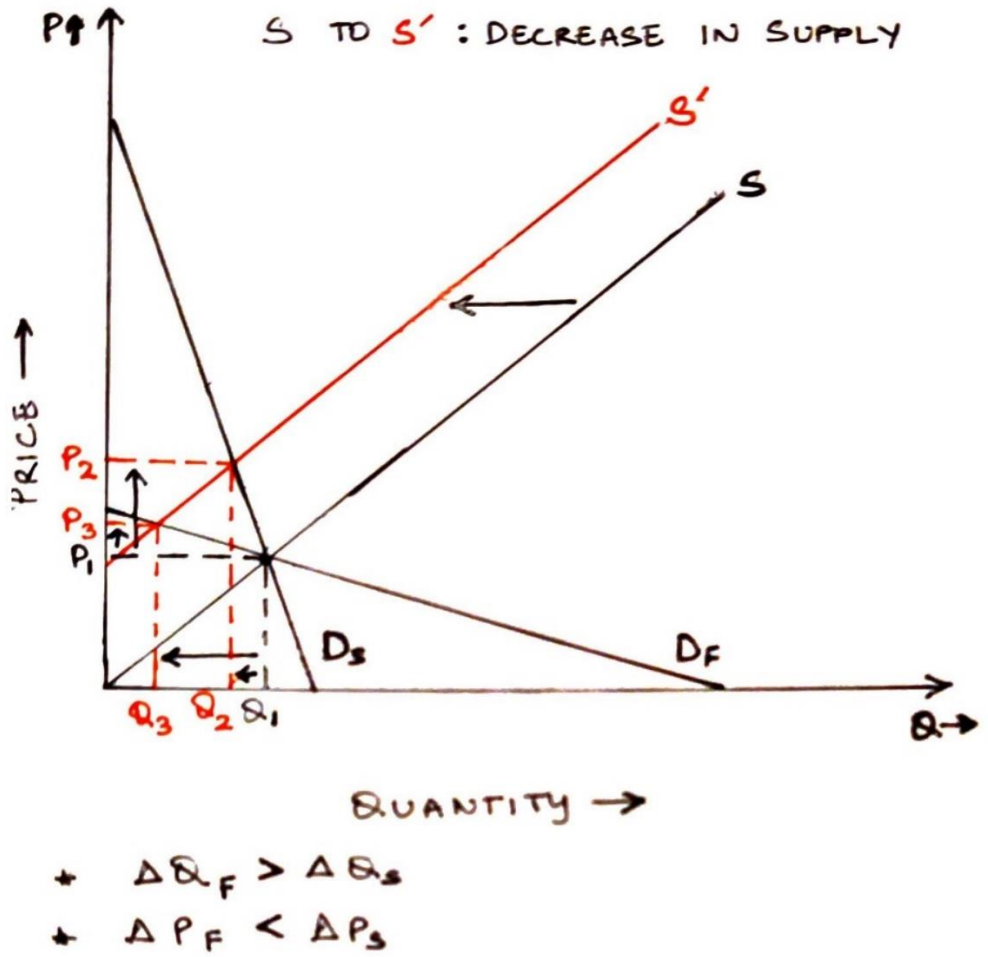
Steps to complete Case Study #1:

1. (2pts) Use a Supply and Demand graph of the bottled water market to explain the impact of an increase in the price of gasoline on the equilibrium P & Q of bottled water.
   - Label the axes. Put Q on the horizontal axis.
   - Draw S & D and show the equilibrium Price and Quantity (P_1 & Q_1). [Note: you are just free drawing S & D.]
   - Ask yourself whether the increase in the price of gasoline will impact the S or the D of bottled water. (Check the description provided above for the bottled water industry).
   - (1pt) Shift the appropriate curve in the appropriate direction. Label the new curve either D' or S'.
   - Find and label the new equilibrium P_2 & Q_2 on your graph and note the changes.
   - (1pt) Use words to explain what happened.



Since gasoline is a major input in production and delivery of bottled water, an increase in the price of gasoline will affect the **supply** of bottled water **negatively**, i.e. the supply is going to decrease. Now, a decrease in supply shifts the supply curve to the left, thus Equilibrium Quantity decreases and Equilibrium Price increases.

2. (4pts) Use a Supply and Demand graph of the bottled water market to explain how elasticity affects the impact of an increase in the price of gasoline on the equilibrium P & Q of bottled water
   - (0.5pts) Draw a relatively steep demand curve, labeled D_S and a regular supply curve (the supply curve can be the same as in question 1). [Again, just free draw them]
   - Label equilibrium P_1 & Q_1.
   - (0.5 pts) Draw a new flatter demand line, labeled D_F that goes through the initial equilibrium point.
   - Shift the same curve as in question #1 to show the impact of the gasoline price increase. Label it either S' of D'.
   - (0.5pts) Label the new equilibrium P_2 & Q_2 for the steep Demand line.
   - (0.5pts) Label the new equilibrium P_3 & Q_3 for the flatter Demand line.
   - (2pts) Comparing the two equilibrium shifts, explain how elasticity impacts the magnitude of the adjustment in P & Q when the price of gasoline increases. Be sure to specify which D curve is relatively elastic and which is relatively inelastic.



As seen in question 1, we see that an increase in price of gasoline shifts the supply curve to left, thus supply decreases.

Graphically, we see that when the supply decreases, change in quantity is greater for flatter demand curve than steeper demand curve. Additionally, change in price is lesser for flatter demand curve than steeper demand curve. Thus, $\Delta\, Q_F > \Delta\, Q_S$ and $\Delta\, P_F < \Delta\, P_S$.

Now, we know that Elasticity, $E_D = \frac{\%\Delta Q}{\%\Delta P}$.

If we compute elasticity for D_F (flatter demand curve) and D_S (steeper demand curve), we can say that, $\frac{\%\Delta\, Q_F}{\%\Delta\, P_F} > \frac{\%\Delta\, Q_S}{\%\Delta\, P_S}$, thus $E_F > E_S$.

Therefore, we conclude that, elasticity for flatter demand curve is greater than elasticity for steeper demand curve. In other words, the flatter a demand curve is, the greater is its elasticity.

Thus, **D_F is relatively Elastic, whereas D_S is relatively Inelastic**.

3. (8pts) Estimate the demand equation for bottled water. Download the Excel file, "Data for Case Study 1" in Camino that contains the relevant data (save it to your hard drive). You will find three sets of columns:
   - The first set provides information about observations of variables that are relevant to Demand during the summer.
   - The second set of columns provides information about observations of variables that are relevant to Demand during the winter.
   - The third set of columns provides information about observations of variables that are relevant to Supply year-round (both summer and winter).

Because we wish to estimate Demand, we will focus on the first two sets of columns. The variables included in each set of columns are:

- Qbw: quantity of bottled water sold
- Pbw: price of bottled water
- Pmachine: price of soft drinks available in your competitor's vending machines
- Ppopcorn: price charged by the vendor who sells movie-theater quality popcorn
- Income: average income of your customers

a. (3 pts) Use Excel to estimate the regression equation for summer (first set of columns):

$$Q_{BW} = B_0 + B_1 P_{BW} + B_2 P_{machine} + B_3 P_{popcorn} + B_4 I$$

Step-by-Step Excel Instructions:

- Click Data, then Data Analysis, and then scroll down to find Regression.
- Once in the regression menu select your inputs; for this regression:
  - Qbw is your dependent variable, thus this column is your "Input Y Range." (Click on cell A2 and hold it as you scroll down to the end of the column. When you release, all of the observations will be included.)
  - Click in the "Input X Range" box to all all of the other columns with information on your independent variables (Click on cell B2 and hold it as you highlight across to column E and down all of the observations. When you release, all of the observations for those 4 columns will be included).
- Click the "Labels" box. This will tell Excel that your first observation (the one in row 2) is a label for that variable. Now your results will display the variable names.
- Select OK and a new worksheet will appear with the results

i. Check Results:

Excel will estimate numbers for the betas in the equation above: b0, b1, b2, b3, b4. The b0 is your constant and the others are your estimated "slope coefficients."

(1pt) Look at your t-stats and/or your P-values. Are all of your slope coefficients significantly different from zero? Explain. If they are not, eliminate the insignificant variables, and re-estimate your demand equation. (Note: you always want to include a constant, even if it is not significantly different from zero.)

Looking at the t-stats, we notice that **|t-stat| > 2** for all slope coefficients, thus we can say that our slope coefficients are statistically significant.
We also notice that, **p-value < 0.05** for all slope coefficients, thus we can confirm that all our slope coefficients are statistically significant, and we do not need to re-run the regression.

ii. (2pts) **Cut and Paste your final regression results for summer here:**

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.961621
R Square	0.924715
Adjusted R Square	0.922267
Standard Error	14.59609
Observations	128

ANOVA

	Df	*SS*	*MS*	*F*	*Significance F*
Regression	4	321869.5	80467.37	377.6998	4.79E-68
Residual	123	26204.64	213.0458		
Total	127	348074.1			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	267.7676	27.42306	9.764321	5.06E-17	213.4853	322.0499	213.4853	322.0499
Pbw	-24.5645	2.798672	-8.77719	1.17E-14	-30.1043	-19.0247	-30.1043	-19.0247
Pmachine	21.38688	5.160497	4.144344	6.29E-05	11.17199	31.60176	11.17199	31.60176
Ppopcorn	-57.2359	12.90124	-4.43647	2.01E-05	-82.7732	-31.6987	-82.7732	-31.6987
Income	19.28744	0.51605	37.37516	5.27E-69	18.26595	20.30893	18.26595	20.30893

b. (2pts) Use Excel to estimate the same regression equation as in part "a" but for winter (second set of columns). Follow the same procedure as in part a. **Cut and Paste your final regression results for winter here:**

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.972219
R Square	0.945209
Adjusted R Square	0.943427
Standard Error	13.74265
Observations	128

ANOVA

	Df	*SS*	*MS*	*F*	*Significance F*
Regression	4	400741.9	100185.5	530.4734	1.59E-76
Residual	123	23229.84	188.8605		
Total	127	423971.7			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	219.268	25.81963	8.4923	5.52E-14	168.1597	270.3764	168.1597	270.3764
Pbw	-52.6215	2.635033	-19.97	2.07E-40	-57.8374	-47.4056	-57.8374	-47.4056
Pmachine	17.56163	4.858761	3.614424	0.000437	7.944005	27.17924	7.944005	27.17924
Ppopcorn	-30.9036	12.1469	-2.54415	0.012192	-54.9476	-6.85954	-54.9476	-6.85954
Income	20.05414	0.485876	41.27418	6.45E-74	19.09238	21.0159	19.09238	21.0159

c. (3pts) Write out the demand equations for summer and winter using the estimated betas from your regression results:

Demand in Summer: $Q_{BW} = 267.77 - 24.56P_{BW} + 21.39P_{Machine} - 57.24P_{Popcorn} + 19.29\ I$

Demand in Winter: $Q_{BW} = 219.27 - 52.62\ P_{BW} + 17.56\ P_{Machine} - 30.90\ P_{Popcorn} + 20.05\ I$

4. (4pts) Estimate the supply of bottled water. Now our focus is the third set of columns. The variables included are:
   - Pbw: price of bottled water
   - Pgas: price of gasoline, which is an input into the production and distribution of bottled water

   a. (2pts) Use Excel to estimate the regression equation (follow the same procedure as you did for Demand):

$$Q_{BW} = C_0 + C_1 P_{BW} + C_2 P_{gas}$$

Cut and Paste your final regression results for supply here:

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.960744
R Square	0.92303
Adjusted R Square	0.922421
Standard Error	56.95253
Observations	256

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	2	9841002	4920501	1516.992	1.3E-141
Residual	253	820628.3	3243.59		
Total	255	10661630			

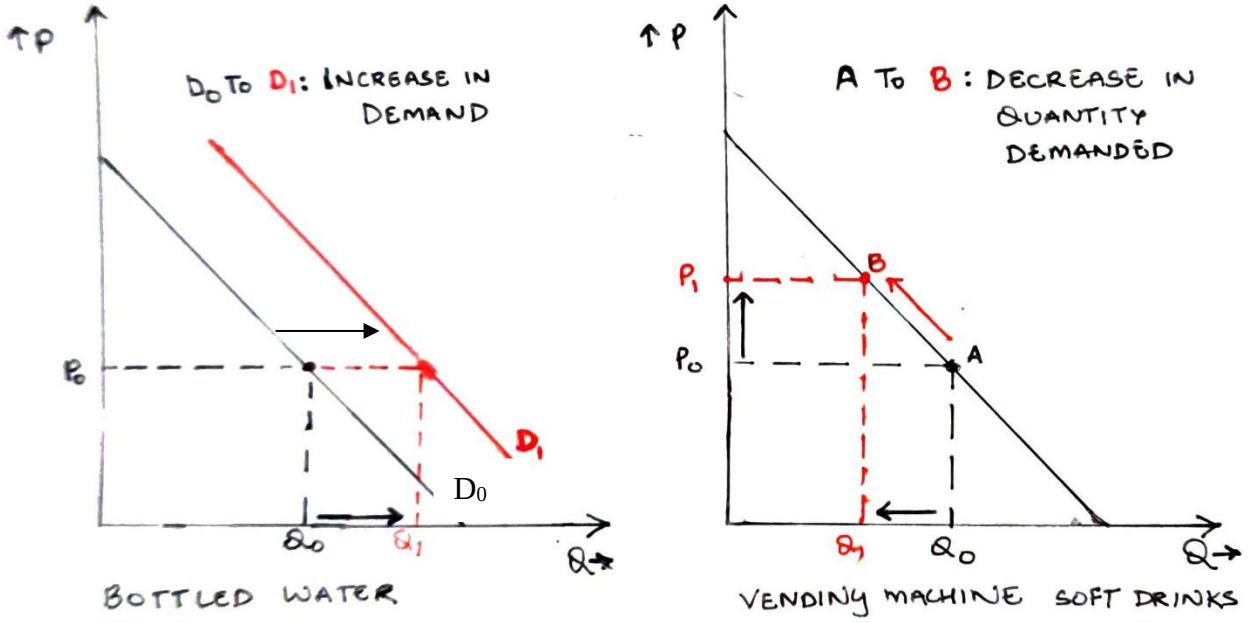
	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	14.29153	19.08438	0.74886	0.454637	-23.293	51.87601	-23.293	51.87601
Pbw00	391.1787	7.724768	50.63955	2E-134	375.9657	406.3918	375.9657	406.3918
Pgas	-69.6692	3.017724	-23.0867	3.22E-64	-75.6123	-63.7262	-75.6123	-63.7262

   b. (2pts) Write out the supply equation using the estimated coefficients "betas."

Supply: $\boldsymbol{Q_{BW} = 14.29 + 391.18\, P_{BW} - 69.67\, P_{Gas}}$

5. (9pts) Use graphs to explain the impact from a change in one of the slope coefficients. For this section, P is on the vertical axis and Q is on the horizontal axis. Also, distinguish between a change in demand vs a change in quantity demanded and a change in supply vs a change in quantity supplied.
   a. (3pts) Use the framework below to answer the following questions:

      i. (0.5pts) Label each axis and draw one Demand curve for the bottled water market and one Demand curve for the vending machine soft drink market (do not draw supply curves). [Again, you are free drawing here – your demand curves should be typical – that is not too steep or too flat.] Pick some random point on each demand curve and label it Q_0,P_0.



      ii. (0.5pts) What does the positive sign of B2 from question 3 tell you about the relationship between bottled water and the competitor's vending machine soft drinks?

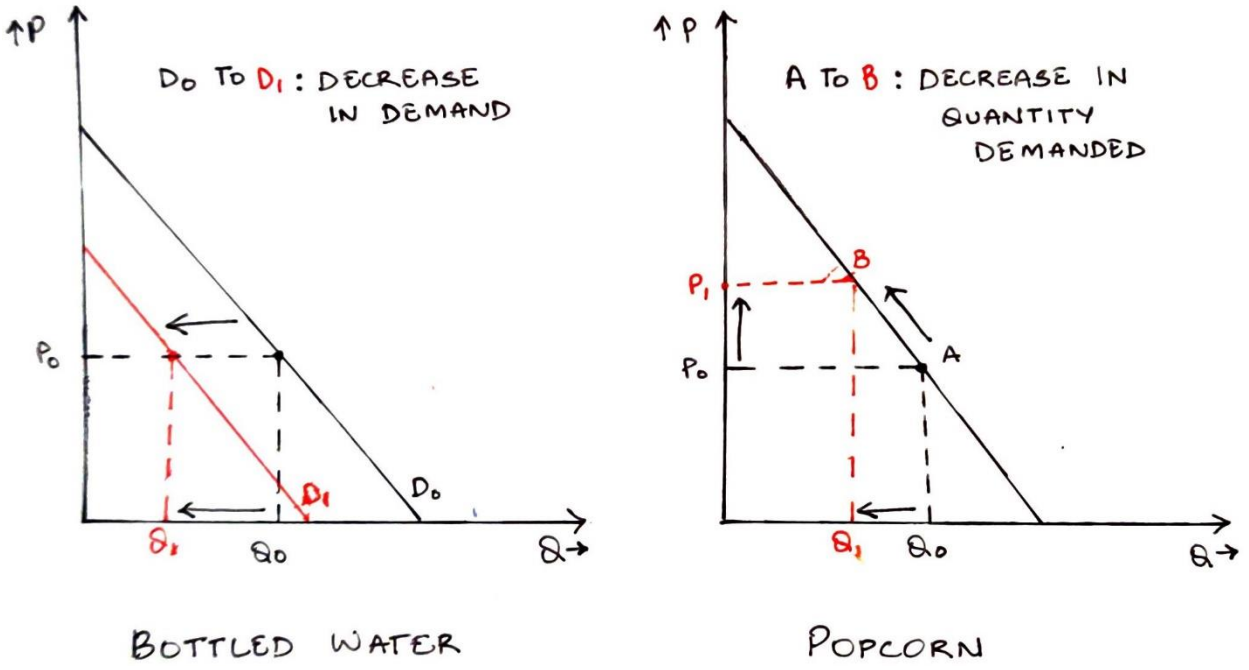
The positive sign of B2 (coefficient of $P_{Machine}$) indicates that the price of competitor's soft drinks is directly proportional to demand for bottled water, i.e., $P_{Machine} \propto Demand_{BW}$. Therefore, as the price of vending machine soft drinks increase, demand for bottled water is going to increase, and vice-versa. Thus, vending machine soft drink is a **substitute** of bottled water.

iii. (2pts) Suppose that the price of vending machine soft drinks increases. How does this affect each demand curve? Demonstrate this change on each demand curve in the graphs above. Explain your logic.

If the price of vending machine soft drinks increases from P_0 to P_1, by law of demand we know that there will a decrease in the quantity for vending machine soft drinks. Thus, there is a **decrease in quantity demanded** for Vending Machine Soft Drinks.
Now, we concluded in the previous part that vending machine soft drink is a substitute for bottled water and that $P_{Machine} \propto Demand_{BW}$. Thus, as the price of vending machine soft drink increases, **demand for bottled water increases**.

b. (3pts) Use the framework below to answer the following questions:

i. (0.5pts) Label each axis and draw one typical Demand curve for the bottled water market and one Demand curve for the popcorn market (do not draw supply curves). Pick some random point on each demand curve and label it Q_0,P_0.



ii. (0.5pts) What does the negative sign of B3 from question 3 tell you about the relationship between bottled water and popcorn?

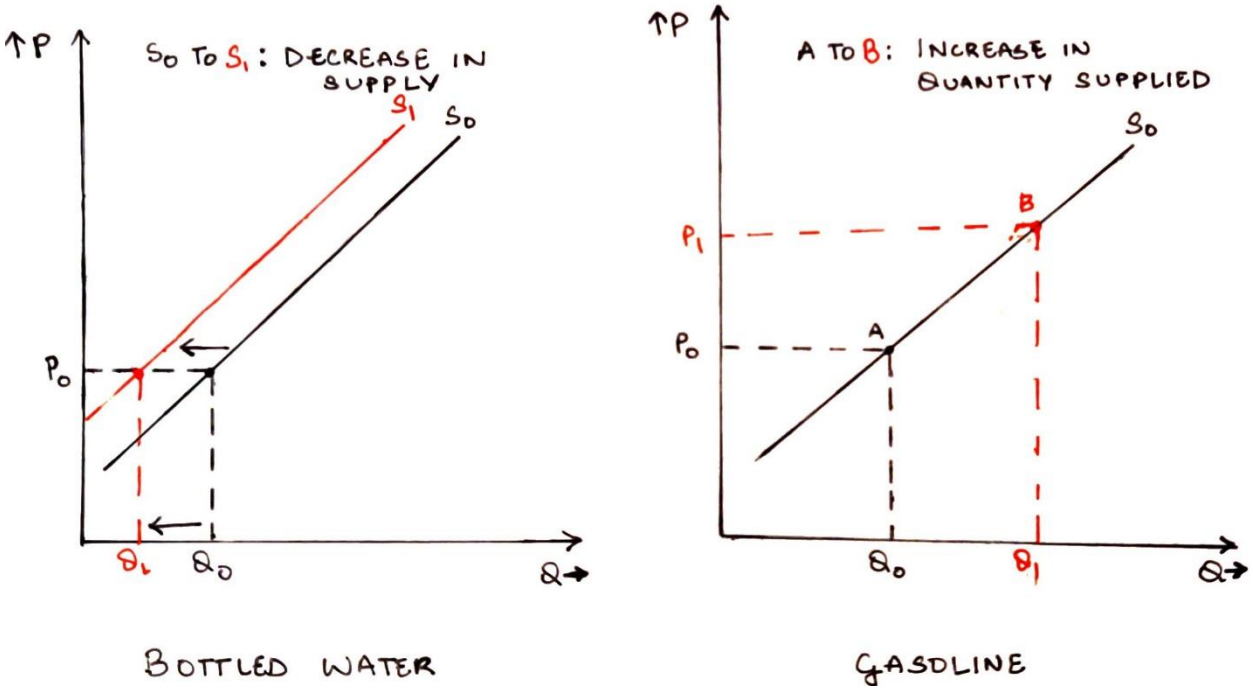
The negative sign of B3 (coefficient of $P_{Popcorn}$) indicates that the price of popcorn is inversely proportional to demand for bottled water, i.e., $P_{Popcorn} \propto \frac{1}{Demand_{BW}}$. Therefore, as the price of popcorn increase, demand for bottled water is going to decrease, and vice-versa. Thus, popcorn is a **complementary good** of bottled water.

iii. (2pts) Suppose the price of popcorn increases. Demonstrate this change on the demand curves in the graphs above. Explain your logic.

If the price of popcorn increases from P_0 to P_1, by law of demand we know that there will a decrease in the quantity for popcorn. Thus, there is a **decrease in quantity demanded** for Popcorn.
Now, we concluded in the previous part that popcorn is a complementary good for bottled water and that $P_{Popcorn} \propto \frac{1}{Demand_{BW}}$.. Thus, as the price of popcorn increases, **demand for bottled water decreases**.

c. (3pts) Use the framework below to answer the following questions:

i. (0.5pts) Label each axis and draw one Supply curve for the bottled water market and one Supply curve for the gasoline market (do not draw demand curves). Pick some random point on each supply curve and label it Q_0,P_0.



ii. (0.5pts) What does the negative sign of C2 from question 4 tell you about the relationship between bottled water and gasoline?

The negative sign of C2 (coefficient of P_{Gas}) indicates that the price of gasoline is inversely proportional to supply for bottled water, i.e., $P_{Gas} \propto \frac{1}{Supply_{BW}}$. Therefore, as the price of gasoline increase, supply for bottled water is going to decrease, and vice-versa. Thus, gasoline is an **input** in production and delivery of bottled water.

iii. (2pts) Suppose the price of gasoline increases. Demonstrate this change on the supply curves in the graphs above. Explain your logic.

If the price of gasoline increases from P_0 to P_1, by law of supply we know that there will an increase in the quantity for gasoline. Thus, there is an **increase in quantity supplied** for gasoline.
Now, we concluded in the previous part that gasoline is an input for bottled water and that $P_{Gas} \propto \frac{1}{Supply_{BW}}$. Thus, as the price of gasoline increases, **supply for bottled water decreases**.

6. (6pts) Recall the demand equations estimated from question #3. Use the following values for the prices of related goods and income to calculate simplified demand curves for summer (Q1) and winter (Q2). Thus, Q1 will represent summer quantity demanded and Q2 will represent winter quantity demanded when the following facts are true:
   - Pmachine = $2
   - Ppopcorn = $1
   - Income = $35

   a. (2pts) Use the regression equation for summer demand in question #3c and plug in the values above. Compute the new constant for the simplified summer demand equation. **Show your work**.

   $Q_{BW} = 267.77 - 24.56P_{BW} + 21.39P_{Machine} - 57.24P_{Popcorn} + 19.29\ I$
   Substituting the given values in the above equation:

   $Q_{BW} = 267.77 - 24.56P_{BW} + 21.39\ (2) - 57.24(1) + 19.29\ (35)$
   $Q_{BW} = 267.77 - 24.56P_{BW} + 42.78 - 57.24 + 675.15$
   $Q_{BW} = 928.46 - 24.56P_{BW}$

   b. (1pt) Write the simplified demand equation for summer:

   Q1 = $\mathbf{928.46 - 24.56\ P}$

   c. (2pts) Use the regression equation for winter demand in question #3c and plug in the values above. Compute the new constant for the simplified winter demand equation. **Show your work**.

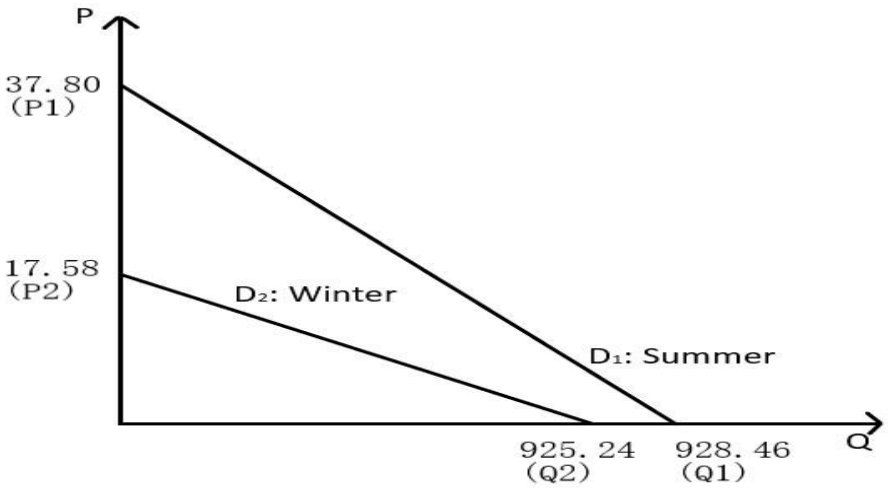
   $Q_{BW} = 219.27 - 52.62\ P_{BW} + 17.56\ P_{Machine} - 30.90\ P_{Popcorn} + 20.05\ I$
   Substituting the given values in the above equation:

   $Q_{BW} = 219.27 - 52.62\ P_{BW} + 17.56\ (2) - 30.90\ (1) + 20.05\ (35)$
   $Q_{BW} = 219.27 - 52.62\ P_{BW} + 35.12 - 30.90 + 701.75$
   $Q_{BW} = 925.24 - 52.62\ P_{BW}$

   d. (1pt) Write the simplified demand equation for winter:

   Q2 = $\mathbf{925.24 - 52.62\ P}$

7. (13pts) Graph the simplified demand curves created in question 6. Organize your thinking by sketching a hand-drawn graph that shows both demand equations using the equations in Q6. I've already drawn the summer line for you.



a. (2pts) Think about this graph carefully.
   - This is the graph that economists draw frequently: P is on the vertical axis.
   - Look at your demand equation for Q1. This is the type of equation that economists generally use to estimate demand. BUT – notice – P is not on the left-hand side.
   - (1pt) We need to think carefully about the constant term. When P = 0, **Q1 = 928.46**. Label that point on the graph.
   - (1pt) When Q1 = 0, **P = 37.80**. Label that point on the graph.

b. (3pts) What do you expect to happen to demand during the winter period?
   - (1pt) When P = 0, **Q2 = 925.24**. Show that point on the graph.
   - (1pt) When Q2 = 0, **P = 17.58**. Show that point on the graph.
   - (1pt) Show the winter demand line on the graph above.

c. (1pt) Did you just illustrate a movement along a demand curve or a shift in demand? Briefly explain.

From the graph shown above, we see that **there is a shift in demand**. This is because the slopes of both the demand lines are different. This shift in demand may be due to change in season. And moreover, a movement along a demand curve is shown by change in price of bottled water. Since we do not see any change in prices, this is a shift in demand.

d. Use Excel to create a graph showing the two demand lines.
   a. First, create 2 new columns in Excel, labeled Q1 and Q2 and put the simplified equations from question #6 into Excel for Q1 and Q2.

Step-by-step:

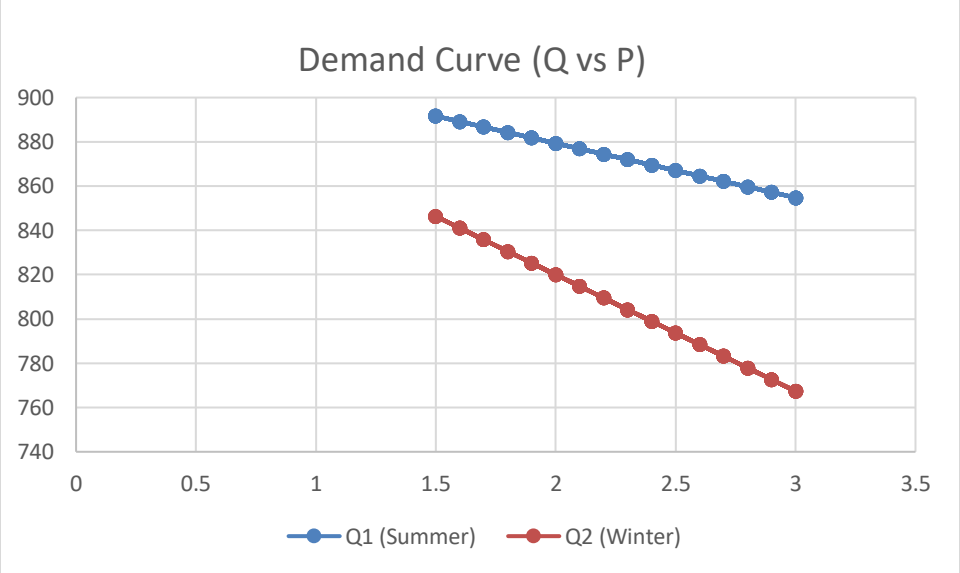
- Highlight columns L, M, N, and O in excel. Right click on the highlighted columns and choose "insert." This will insert 4 new columns between the demand and supply data.

- In cell M2, type Q1 and in cell N2, type Q2.
- In cell M3, type in your simplified demand equation for summer using the summer price column for Price (B3).) [So, your equation is =constant – slope*B3] (alternatively, you may type the equation directly into M3 beginning with =SUM)
- Copy and paste into the remaining cells in column M (click on M3, then click "home" on the top tool bar, then click "copy." The M3 cell will shimmer. Click on M4 and hold it as you scroll down to the end of the data. Then click paste. Excel will copy the formula into each cell. If you click down column M, you will see that the price from each row will appear in the formula.)
- Repeat this process in column N for Q2 (**note: use B3 for price – you must have the same data for price otherwise the graph will not work**).

b. (2pts) Graph Q1 and Q2 against price (P_{BW}).

Step-by-step:

- Copy and paste summer P_{BW} (column B) into column L. When creating graphs in excel, it is easiest to have all relevant variables next to each other.
- Starting with cell L2, highlight all of the data in the three columns: P_{BW}, Q1 and Q2.
- Click "Insert" on the top toolbar.
- In the "chart" section, select "scatter."
- From the drop-down menu, choose the scatter option with smooth lines and markers.
- Cut and paste your graph here:



e. (1pt) Looking at your graph, Excel put which variable on the vertical axis? **Quantity (Q)**

f. (1pt) Think about the equation for Q1. If the excel graph were extended, where would it cross the Q1 axis? (ie., what is the Q1 intercept) (write the number) **Q1 = 928.46**

g. (1pt) Think about the equation for Q2. If the excel graph were extended, where would it cross the Q2 axis? (ie., what is the Q2 intercept) (write the number) **Q2 = 925.24**

h. (2pts) How does the Excel graph compare with the graph you drew in part "a" above?

Both, hand-drawn and Excel **graphs, are same**. The only difference is **Excel graph has its axes inverted**.

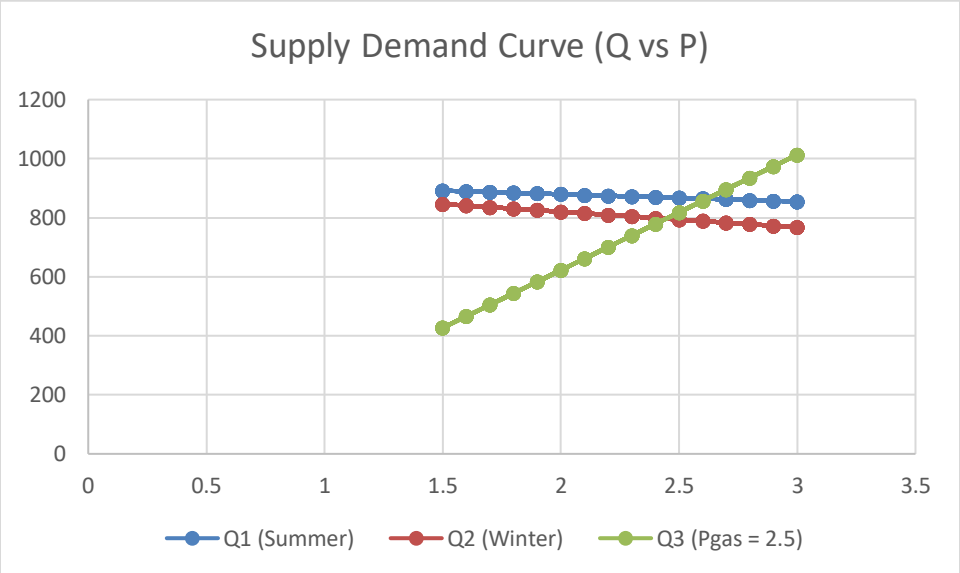
8. (8pts) Graph the simplified supply curve when gas prices are $2.50 per gallon (Q3).
   a. (2pts) Refer back to the supply curve you estimated in question #4. Plug in the value for the price of gas, calculate the new constant term and write out the simplified supply curve (Q3).
   $Q_{BW} = 14.29 + 391.18\ P_{BW} - 69.67\ P_{Gas}$
   Substituting the given value of gas in the equation above:

   $Q_{BW} = 14.29 + 391.18\ P_{BW} - 69.67\ (2.50)$
   $Q_{BW} = 14.29 + 391.18\ P_{BW} - 174.18$
   $Q_{BW} = 391.18\ P_{BW} - 159.89$

   Q3 = $\mathbf{391.18\ P - 159.89}$

   b. Follow the same Excel process as in question #7. Set up column O with Q3, using the simplified supply equation above. Use the same P (from column B) that you used for demand (so you will not use all of the supply data).

   c. (2pts) Create an Excel graph with supply and both demand curves:
   - Highlight P and Q1, Q2, Q3
   - Use the scatter plot with lines and markers
   - Insert your graph here:



d. (2pts) Now suppose the price of gas increases to $3 per gallon. Refer back to the supply curve you estimated in question #4. Plug in this new value for the price of gas, calculate the new constant term and write out the new simplified supply curve (Q4).

$Q_{BW} = 14.29 + 391.18\ P_{BW} - 69.67\ P_{Gas}$
Substituting the given value of gas in the equation above:

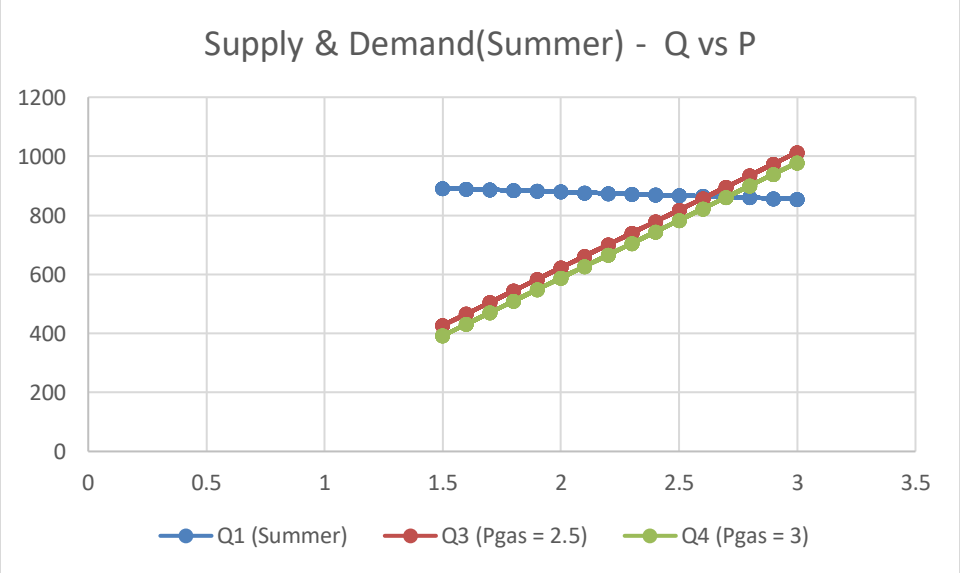
$Q_{BW} = 14.29 + 391.18\ P_{BW} - 69.67\ (3)$
$Q_{BW} = 14.29 + 391.18\ P_{BW} - 209.01$
$Q_{BW} = 391.18\ P_{BW} - 194.72$

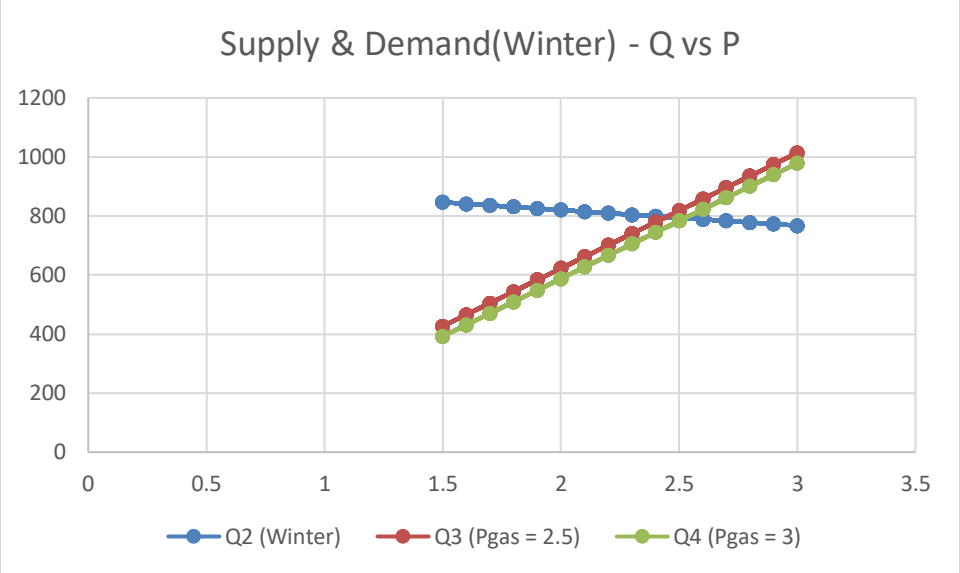
Q4 = $\mathbf{391.18\ P - 194.72}$

e. Follow the same Excel process as in question #7. Set up column P with Q4, using the simplified supply equation above. **Use the same P (from column B) that you used for demand** (thus you will not use all of the supply data).

f. (2pts) Create two Excel graphs
- The first graph will show two supply lines (Pgas = 2.5 and Pgas = 3), along with summer demand (Q1).
- The second graph will show two supply lines (Pgas = 2.5 and Pgas = 3), along with winter demand (Q2).

Note that you will have to move the columns around so that the P and the two Q's of interest are side by side. When you copy and paste, use "paste values" to avoid problems.
- Insert your graphs here:





9. (8pts) Use the equations for Q1, Q2, Q3, and Q4 to compare the impact of the gasoline price increase on P&Q in the two situations.
   a. Rewrite below the equations for Q1-Q4 so they are all in one place.

   Q1 = $\mathbf{928.46 - 24.56\,P}$
   Q2 = $\mathbf{925.24 - 52.62\,P}$
   Q3 = $\mathbf{391.18\,P - 159.89}$
   Q4 = $\mathbf{391.18\,P - 194.72}$

   b. (3pts) Use algebra to solve for the equilibrium P and Q for summer with gas prices at $2.5 and $3. **Show your work**.

   When gas price = $2.5, we solve Q1 & Q3.

   At Equilibrium, Q1 = Q3:
   928.46 – 24.56(P) = 391.18(P) – 159.89
   1088.35 = 415.74(P)
   P = $\frac{1088.35}{415.74}$

   Therefore, **P_E = $2.62**
   Substituting value of P_E in Q1,
   Q1 = 928.46 – 24.56 (2.62)
   Q1 = 864.11

   Therefore, **Q_E = 864.11**

When gas price = $3.0, we solve Q1 & Q4.

At Equilibrium, Q1 = Q4:
928.46 – 24.56(P) = 391.18(P) – 194.72
1123.18 = 415.74(P)
$P = \frac{1123.18}{415.74}$

Therefore, **P_E = $2.70**
Substituting value of P_E in Q1,
Q1 = 928.46 – 24.56 (2.7)
Q1 = 862.15

Therefore, **Q_E = 862.15**

c. (3pts) Use algebra to solve for the equilibrium P and Q for winter with gas prices at $2.5 and $3. **Show your work**.

When gas price = $2.5, we solve Q2 & Q3.

At Equilibrium, Q2 = Q3:
925.24 – 52.62(P) = 391.18(P) – 159.89
1085.13 = 443.8(P)
$P = \frac{1085.13}{443.80}$

Therefore, **P_E = $2.45**
Substituting value of P_E in Q2,
Q2 = 925.24 – 52.62 (2.45)
Q2 = 796.32

Therefore, **Q_E = 796.32**

When gas price = $3.0, we solve Q2 & Q4.

At Equilibrium, Q2 = Q4:
925.24 – 52.62(P) = 391.18(P) – 194.72
1119.96 = 443.8(P)
$P = \frac{1119.96}{443.80}$

Therefore, **P_E = $2.52**
Substituting value of P_E in Q2,
Q2 = 925.24 – 52.62 (2.52)
Q2 = 792.64

Therefore, **Q_E = 792.64**

d. (2pts) Fill in the table below for changes in values when the price of gas changes. Magnitude means the difference between original and new values.

	Summer	**winter**
Magnitude of the change in P (New - Original)	(2.70-2.62) **= 0.08**	(2.52-2.45) **= 0.07**
Magnitude of the change in Q (New - Original)	(862.15-864.11) **= -1.96**	(792.64-796.32) **= -3.68**

10. (8pts) Compute the elasticity of demand in the summer and in the winter when the price of gas is $2.50.

Remember that elasticity = $$\frac{\%changeQ}{\%changeP} = \frac{\frac{dQ}{Q}}{\frac{dP}{P}} = \frac{dQ}{dP} \times \frac{P}{Q}$$

The demand regression equations provide dQ/dP for summer and winter demand (these are the slope coefficients on P).

P/Q for summer and winter are the ratios of P and Q in the initial equilibrium for each season (when Pgas = 2.5).

a. (5pts) Use the information provided above to make the calculations necessary to fill in the following table (show calculations):

	C1	**C2**	**C3**	Elasticity of demand
	Regression equation coefficient of Pbw (this is dQ/dP)	Equilibrium P (when Pgas = $2.50)	Equilibrium Q (when Pgas = $2.50)	C1*(C2/C3)
Summer	**-24.56**	**2.62**	**864.11**	**|-0.07|**
Winter	**-52.62**	**2.45**	**796.32**	**|-0.16|**

Calculations:

Demand Equation for summer:
Q1 = 928.46 – 24.56(P)
Differentiating the equation:
dQ/dP = -24.56

Demand Equation for winter:
Q2 = 925.24 – 52.62(P)
Differentiating the equation:
dQ/dP = -52.62

For summer:
C1*(C2/C3) = (-24.56) * (2.62/864.11) = -0.07

For winter:
C1*(C2/C3) = (-52.62) * (2.45/796.32) = -0.16

b. (3pts) Now that you have used Excel to estimate the supply and demand curves and you have used this information to calculate the elasticity of demand for the summer and winter equilibria, are your Excel results consistent with the prediction from your hand-drawn graph in question #2? Explain.

Elasticity of demand for both summer & winter is less than one, i.e., $\mathbf{E_{Summer} < 1}$ & $\mathbf{E_{Winter} < 1.}$ Thus, we can conclude that both curves are **inelastic.** However, we notice that, relatively, elasticity of winter is greater than elasticity of summer, i.e., $\mathbf{E_{Winter} > E_{Summer}}$.

Now looking at our results from our calculation, we see that, $\Delta Q_{Winter} > \Delta Q_{Summer}$ and $\Delta P_{Winter} < \Delta P_{Summer}$. And, we know that Elasticity, $E_D = \frac{\%\Delta Q}{\%\Delta P}$.
Therefore, $\frac{\%\Delta Q_{Winter}}{\%\Delta P_{Winter}} > \frac{\%\Delta Q_{Summer}}{\%\Delta P_{Summer}}$, or $\frac{\boldsymbol{dQ(Winter)}}{\boldsymbol{dP}} > \frac{\boldsymbol{dQ(Summer)}}{\boldsymbol{dP}}$, thus $E_{Winter} > E_{Summer}$.

Earlier we had established that, greater the elasticity, flatter the slope. Thus, according to our prediction, Demand (Winter) should have a flatter slope than Demand (Summer). But if we look at our graphs from Excel, we see that slope for winter is steeper than slope for summer. However, remember that our axes in Excel are inverted.
Therefore, if we were to invert the Excel Axes such that P is on Y-Axis and Q on X-Axis, we will get that slope of winter is flatter than slope of summer, thus confirming our predictions that Winter is relatively elastic, and Summer is relatively inelastic.
Hence, we can safely say that **our predictions from hand-drawn graph in question 2 are consistent with Excel results.**