Cost Benefit Analysis - Assignment 2

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1. (12 points) Draw a conceptual model of the welfare impacts of removing the TRQ.

A. (4 points) Draw a set of linear supply and demand curves to represent the U.S. domestic market for raw sugar. Price, the vertical axis, should be in cents per pound, and quantity, on the horizontal axis, should be in thousands of short tons of raw sugar. Draw that graph here and include labels for the current price and quantity variables.

i) Assume that the international supply of raw sugar is perfectly elastic and that the world price for raw sugar, Pw, is constant at some price below the intersection of domestic supply and demand. Label your graph with a line representing the world price of sugar.

ii) Assume that the existence of the TRQ in the U.S. increases the price of imported raw sugar to PUS, but that the now higher sugar price in the U.S. is still below the intersection of domestic supply and demand. Label your graph with a line representing this domestic price, PUS.

iii) Label your graph with the quantity that would be produced domestically with the TRQ Q(S,TRQ), and the amount that would be consumed domestically with the TRQ Q(D,TRQ).

B. (2 points) With the TRQ in place, how much raw sugar is imported, Qimp,TRQ?

The amount of imported quantity with TRQ equals to what domestic producers are willing to produce. For example, the profit function is equal to revenue function subtracted by cost function. The profit function is replaced by P(US) so that quantity can be found through intersection method. That is, the imported quantity is equal to P(US) through this domestic supply function.

C. (2 points) How much does the U.S. government collect in tariff revenue with the TRQ?

The United States government revenue amounts up to E, which can be found in area between curves. However, mathematically, the integral is one of preferred ways to estimate government revenue. For example, the lower bound is Q(S,TRQ) and the upper bound is Q(D,TRQ). There are two integrals where P(US) horizontal line is subtracted by P(w) horizontal line. This is how the area between curves can be found.

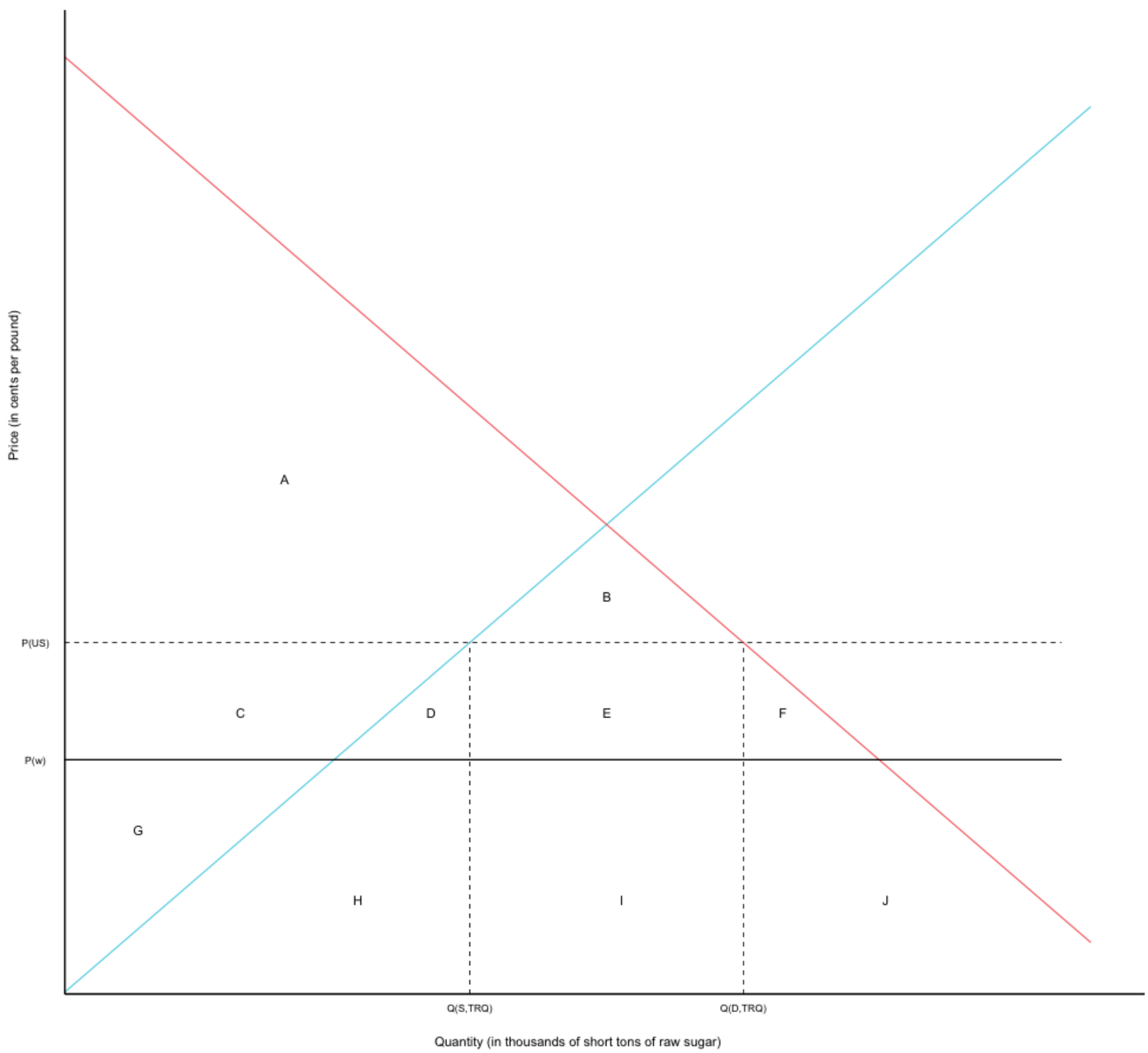
D. Label the areas in your sugar market graph with letters for easier reference.

```r
library(ggplot2)
demand <- function(q) 2.7*q+.04
supply <- function(q) -2.7*q+20
datad<-as.data.frame(x=c(1,7),y=c(1,50))
png(filename="RPlot.png",width=1000,height=1000)
ggplot(datad,aes(x=c(1,7),y=c(1,50)))+
  stat_function(fun=demand,col="#58D3E6",xlim=c(0,7))+
  stat_function(fun=supply,col="#F96767",xlim=c(0,7))+
  theme_void()+
  theme(axis.text.x=element_blank(),axis.text.y=element_blank())+
  geom_segment(aes(x=0,xend=6.8,y=5,yend=5))+
  geom_segment(aes(x=0,xend=6.8,y=7.5,yend=7.5),linetype="dashed",size=.3)+
  annotate(geom="text",x=-0.2,y=5,label="P(w)",size=3)+
```

```r
  annotate(geom="text",x=-0.2,y=7.5,label="P(US)",size=3)+
  geom_segment(aes(x=2.763,y=0,xend=2.763,yend=7.5),linetype="dashed",size=.3)+
  geom_segment(aes(x=4.63,y=0,xend=4.63,yend=7.5),linetype="dashed",size=.3)+
  annotate(geom="text",x=2.763,y=-0.3,label="Q(S,TRQ)",size=3)+
  annotate(geom="text",x=4.63,y=-0.3,label="Q(D,TRQ)",size=3)+
  geom_segment(x=8,xend=0,y=0,yend=0)+
  geom_segment(x=0,xend=0,y=21,yend=0)+
  annotate(geom="text",x=3.5,y=-1,
  label="Quantity (in thousands of short tons of raw sugar)")+
  annotate(geom="text",x=-.35,y=13,angle=90,
  label="Price (in cents per pound)")+
  annotate(geom="text",x=3.5,y=22,
  label="Conceptual Model of the Welfare Impact of Removing TRQ",size=5)+
  annotate(geom="text",x=c(1.5,3.7,1.2,2.5,3.7,4.9,.5,2,3.8,5.6),y=c(11,8.5,6,6,6,6,3.5,2,2,2),
  label=c("A","B","C","D","E","F","G","H","I","J"))
dev.off()
```

```
## pdf
##   2
```

Conceptual Model of the Welfare Impact of Removing TRQ



E. (4 points) Suppose the U.S. government were to eliminate the TRQ (both the quota and the loan price support program). Complete the Benefit-Cost Analysis Tableau below with the appropriate letters from a policy that would eliminate the TRQ. Note that you are not entering dollar figures here, only indicating which areas represent gains and losses.

	Benefit	Cost	Net Benefit
Consumer	C+D+E+F	–	C+D+E+F
Producer	–	C	-C
Government	–	E	-E
Total	C+D+E+F	C+E	D+F

2. (10 points) Obtain the U.S. and world price of sugar with the TRQ in place.

A. Go to the USDA's Sugar and Sweeteners Yearbook Tables at http://www.ers.usda.gov/dataproducts/sugar-and-sweeteners-yearbook-tables.aspx and familiarize yourself with the webpage. Create a data series to compare the U.S. price of raw sugar with the world price for fiscal years 1975 to 2019. (A fiscal year is the last quarter of the previous year and three quarters in the year listed.)

i) For the U.S. price, obtain the dataset "U.S. raw sugar price, duty fee paid, New York, monthly, quarterly, and by calendar and fiscal year" and use the price in the "Fiscal" column.

```
library(readxl)
Table04 <- read_excel("Table04.xls", col_types = c("numeric", "numeric", "numeric",
  "numeric", "numeric",  "numeric", "numeric", "numeric", "numeric", "numeric",
  "numeric", "numeric", "numeric", "numeric", "numeric", "numeric", "numeric",
  "numeric", "numeric"))
```

```
## Warning in read_fun(path = enc2native(normalizePath(path)), sheet_i = sheet, :
## Expecting numeric in S2 / R2C19: got 'NA'
```

```
names(Table04)[1]<-"Year (cents per pound)"
```

ii) For the world price, you will have to use two datasets: "World raw sugar price, spot, monthly, quarterly, and by calendar and fiscal year" and "World raw sugar price, ICE Contract 11 nearby futures price, monthly, quarterly, and by calendar and fiscal year." Create a full price series for 1975 to 2019 by combining the data from the two datasets. In both cases, use the price in the "Fiscal" column. Where the two datasets overlap, use the data from the data from the "World raw sugar price, ICE Contact 11 nearby futures price" dataset.

```
library(readxl)
table03b <- read_excel("table03b.xls", col_types = c("numeric",
  "numeric", "numeric", "numeric", "numeric", "numeric", "numeric",
  "numeric", "numeric", "numeric", "numeric", "numeric", "numeric",
  "numeric", "numeric", "numeric", "numeric", "numeric", "numeric"))
```

```
## Warning in read_fun(path = enc2native(normalizePath(path)), sheet_i = sheet, :
## Expecting numeric in S2 / R2C19: got 'NA'
```

```
TABLE03a <- read_excel("TABLE03a.xls", col_types = c("text", "numeric",
  "numeric", "numeric", "numeric", "numeric", "numeric", "numeric", "numeric",
  "numeric", "numeric", "numeric", "numeric", "numeric", "numeric", "numeric",
  "numeric", "numeric", "numeric"))
```

Report your data here

```
library(dplyr)
```

```
##
## Attaching package: 'dplyr'

## The following objects are masked from 'package:stats':
##
##     filter, lag

## The following objects are masked from 'package:base':
##
##     intersect, setdiff, setequal, union
```

```
select(TABLE03a,`Year (cents per pound)`,Fiscal)->a
slice(a,16:30)->a
select(table03b,`Year (cents per pound)`,Fiscal)->b
```

```r
slice(b,2:31)->b
rbind(a,b)->world

select(Table04,`Year (cents per pound)`,Fiscal)%>%slice(16:60)->US

as.numeric(world$`Year (cents per pound)`)->world$`Year (cents per pound)`
```

```r
png(filename="RPlot1.png",width=800,height=800)

library(ggplot2)
ggplot()+geom_area(data = US,aes(x=`Year (cents per pound)`,
  y=Fiscal),color="#58D3E6",fill="#58D3E6")+geom_area(data=world,
  aes(x=`Year (cents per pound)`,y=Fiscal),color="#F96767",
  fill="#F96767")+theme_minimal()+
  labs(title="Time Series of the U.S. Pirce of Raw Sugar and the World Price of Raw Sugar from 1975 to 2
  annotate(geom="text",x=1997,y=5,label="International",size=5,
  color="white",fontface="bold")+annotate(geom="text",x=1997,y=15,
  label="United States",size=5,color="white",fontface="bold")

dev.off()
```

```
## pdf
##   2
```

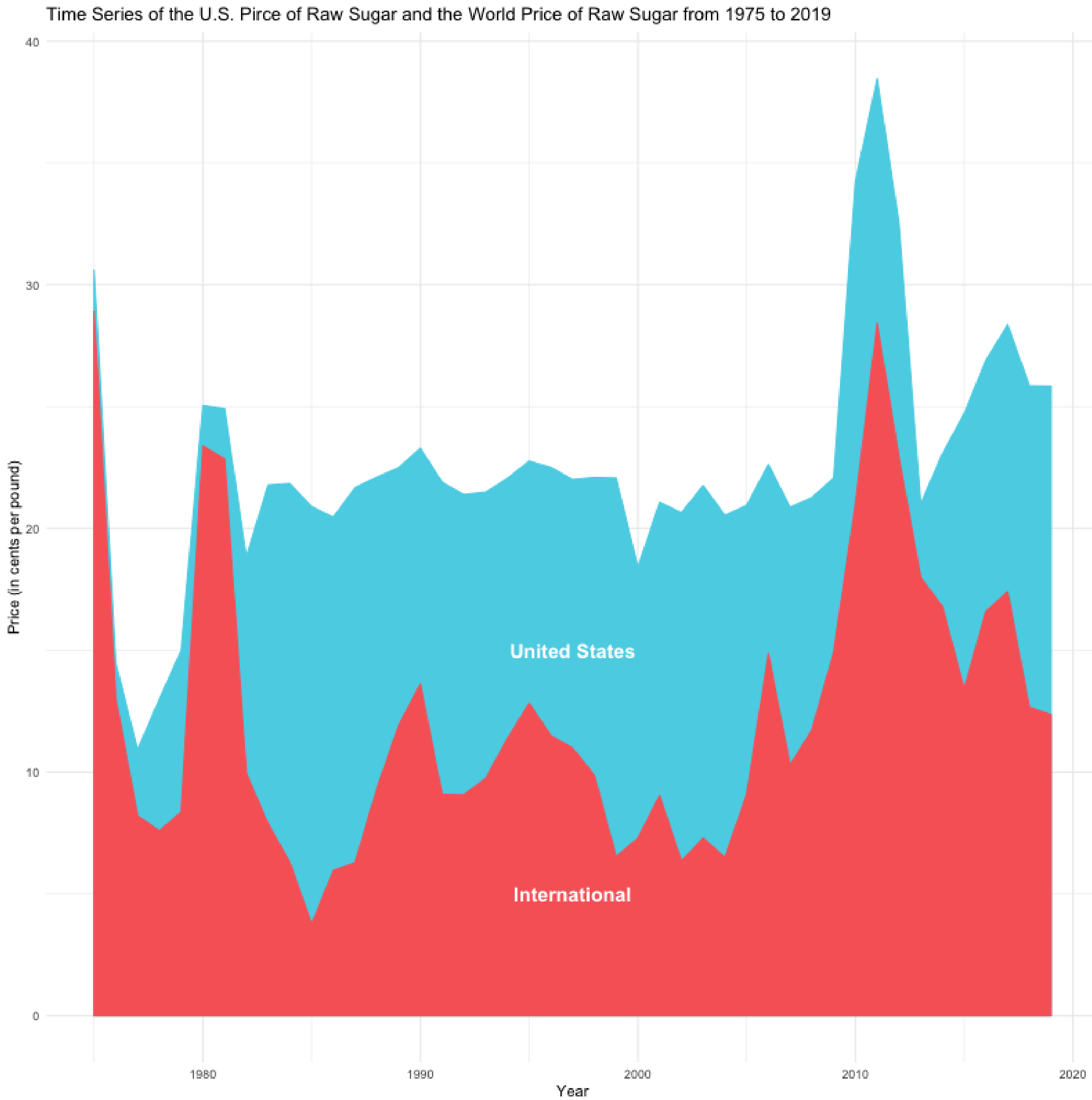
```r
library(knitr)
cbind(world,US$Fiscal)->here
names(here)<-c("Year (cents per pound)","International Price","US Price")
sapply(here[2:3],round)->here[2:3]
kable(here,caption="the comparative price between United States and International over time")
```

Table 2: the comparative price between United States and International over time

Year (cents per pound)	International Price	US Price
1975	29	31
1976	13	14
1977	8	11
1978	8	13
1979	8	15
1980	23	25
1981	23	25
1982	10	19
1983	8	22
1984	6	22
1985	4	21
1986	6	20
1987	6	22
1988	9	22
1989	12	22
1990	14	23
1991	9	22
1992	9	21
1993	10	21
1994	11	22

Year (cents per pound)	International Price	US Price
1995	13	23
1996	11	23
1997	11	22
1998	10	22
1999	7	22
2000	7	18
2001	9	21
2002	6	21
2003	7	22
2004	7	21
2005	9	21
2006	15	23
2007	10	21
2008	12	21
2009	15	22
2010	21	34
2011	28	38
2012	23	33
2013	18	21
2014	17	23
2015	13	25
2016	17	27
2017	17	28
2018	13	26
2019	12	26

B. (2 points) Graph the time series of the U.S. price of raw sugar and the world price of raw sugar from 1975 to 2019 with years on the horizontal axis and price, in cents per pound, on the vertical axis. Include that graph here.



C. (2 points) Calculate the ratio of the U.S. price to the world price. For the period from 1982 to 2019, when the TRQ was in effect, report the average ratio of U.S. price of raw sugar to world price.

```
sapply(US[8:45,2],mean)/sapply(world[8:45,2],mean)->ratio
paste("The average ratio is",round(unname(ratio),digits=0),"cents.",sep=" ")
```

```
## [1] "The average ratio is 2 cents."
```

D. (2 points) Report the U.S. price and the world price of raw sugar for the fiscal year 2019

```
paste("In 2019, the U.S. price is",
  round(unname(US[45,2]),digits=0),"cents",
  "while the international price is equal to",
  round(unname(world[45,2])),"cents.",sep=" ")
```

```
## [1] "In 2019, the U.S. price is 26 cents while the international price is equal to 12 cents."
```

E. (2 points) From the USDA website, obtain the dataset for the "U.S. sugar: supply and use (including Puerto Rico), fiscal years" (Be careful to get the data set with quantity reported in 1,000 short tons, not the one reporting quantity in metric tons.) Report the following for fiscal year 2018/19:

i) Quantity supplied = Beginning stocks + Total production

```
Table24a <- read_excel("Table24a.xls")

t(Table24a[5,2:21])%>%as.data.frame()->Bstock
as.numeric(levels(Bstock$V1))[Bstock$V1]->Bstock$V1

t(Table24a[7,2:21])%>%as.data.frame()->Tproduction
as.numeric(levels(Tproduction$V1))[Tproduction$V1]->Tproduction$V1

cbind(names(Table24a)[2:21],Bstock$V1,Tproduction$V1)%>%as.data.frame()->Supplied
names(Supplied)<-c("V1","V2","V3")
as.numeric(levels(Supplied$V2))[Supplied$V2]->Supplied$V2
as.numeric(levels(Supplied$V3))[Supplied$V3]->Supplied$V3
group_by(Supplied)%>%mutate("Quantity Supplied"=V2+V3)->Supplied
names(Supplied)<-c("Date","Beginning Stock","Total Production","Quantity Supplied")

kable(Supplied, caption="Quantity supplied = Beginning stocks + Total production")
```

Table 3: Quantity supplied = Beginning stocks + Total production

Date	Beginning Stock	Total Production	Quantity Supplied
2000/01	2216.119	8768.888	10985.007
2001/02	2179.678	7900.067	10079.745
2002/03	1527.782	8425.677	9953.459
2003/04	1670.000	8649.168	10319.168
2004/05	1897.330	7875.988	9773.318
2005/06	1331.648	7398.829	8730.477
2006/07	1697.526	8445.401	10142.927
2007/08	1799.000	8152.155	9951.155
2008/09	1664.172	7530.929	9195.101
2009/10	1534.102	7962.638	9496.740
2010/11	1498.150	7830.683	9328.833
2011/12	1378.013	8488.073	9866.086
2012/13	1979.281	8981.476	10960.757
2013/14	2158.439	8461.726	10620.165
2014/15	1809.719	8656.114	10465.833
2015/16	1815.236	8988.873	10804.109
2016/17	2053.930	8969.595	11023.525
2017/18	1875.992	9292.500	11168.492
2018/19	2007.903	8998.589	11006.492
2019/20	1782.550	8157.668	9940.218

ii) Total imports

```
t(Table24a[16,2:21])%>%as.data.frame()->Timports
as.numeric(levels(Timports$V1))[Timports$V1]->Timports$V1

cbind(names(Table24a[2:21]),Timports$V1)%>%as.data.frame()->Timports
as.numeric(levels(Timports$V2))[Timports$V2]->Timports$V2

names(Timports)<-c("Date","Total Imports")

kable(Timports,caption="Total Imports")
```

Table 4: Total Imports

Date	Total Imports
2000/01	1590.435
2001/02	1535.245
2002/03	1730.367
2003/04	1750.487
2004/05	2100.000
2005/06	3443.400
2006/07	2079.581
2007/08	2620.000
2008/09	3082.000
2009/10	3319.914
2010/11	3738.290
2011/12	3632.064
2012/13	3224.336
2013/14	3741.753
2014/15	3553.213
2015/16	3340.830
2016/17	3243.738
2017/18	3276.995
2018/19	3070.256
2019/20	3841.006

iii) Quantity demanded = Total Use + Ending stocks

```
t(Table24a[41,2:21])%>%as.data.frame()->Tuse
as.numeric(levels(Tuse$V1))[Tuse$V1]->Tuse$V1
t(Table24a[43,2:21])%>%as.data.frame()->Estock
as.numeric(levels(Estock$V1))[Estock$V1]->Estock$V1
names(Estock)<-"V2"

cbind(names(Table24a[2:21]),Tuse,Estock)%>%as.data.frame()->Demanded
group_by(Demanded)%>%mutate(V1+V2)->Demanded
names(Demanded)<-c("Date","Total Use","Ending Stocks","Quantity Demanded")

kable(Demanded,caption="Quantity demanded = Total Use + Ending stocks")
```

Table 5: Quantity demanded = Total Use + Ending stocks

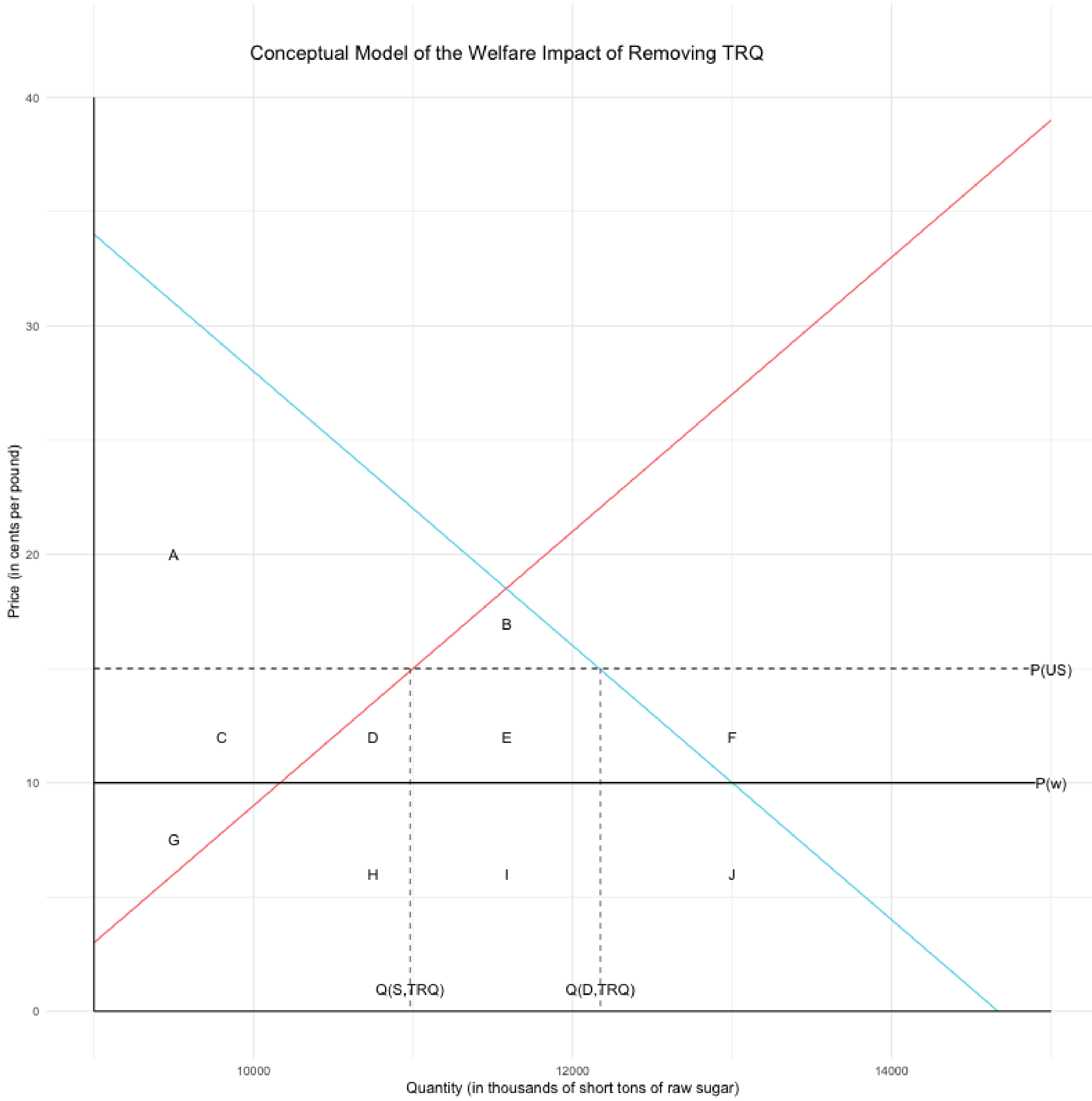
Date	Total Use	Ending Stocks	Quantity Demanded
2000/01	10395.76	2179.678	12575.44

Date	Total Use	Ending Stocks	Quantity Demanded
2001/02	10087.21	1527.782	11614.99
2002/03	10013.83	1670.000	11683.83
2003/04	10172.32	1897.330	12069.65
2004/05	10541.67	1331.648	11873.32
2005/06	10475.98	1697.892	12173.87
2006/07	10424.01	1798.500	12222.51
2007/08	10906.98	1664.172	12571.15
2008/09	10743.00	1534.102	12277.10
2009/10	11318.50	1498.150	12816.65
2010/11	11689.11	1378.013	13067.12
2011/12	11518.87	1979.281	13498.15
2012/13	12026.65	2158.439	14185.09
2013/14	12552.17	1809.745	14361.92
2014/15	12203.81	1815.236	14019.05
2015/16	12091.04	2053.930	14144.97
2016/17	12391.27	1875.992	14267.26
2017/18	12437.58	2007.903	14445.48
2018/19	12294.20	1782.550	14076.75
2019/20	12265.00	1516.224	13781.22

F. (2 points) Redraw your graph from part 1.e, substituting in the values that you reported in parts 2.e and 2.f for the appropriate variables on your graph.

```r
png(filename="RPlot2.png",width=800,height=800)
demand <- function(q) -0.006*q+88
supply <- function(q) 0.006*q-51
`Quantity (in thousands of short tons of raw sugar)` <-c(min(Supplied$`Quantity Supplied`),
  max(Demanded$`Quantity Demanded`))
`Price (in cents per pound)` <- c(min(here$`International`),
  max(here$`US Price`))
datad<-as.data.frame(y=`Price (in cents per pound)`,
  x=`Quantity (in thousands of short tons of raw sugar)`)
ggplot(datad,aes(y=`Price (in cents per pound)`,
  x=`Quantity (in thousands of short tons of raw sugar)`))+
  stat_function(fun=demand,col="#58D3E6",xlim=c(9000,14666.67))+
  stat_function(fun=supply,col="#F96767",xlim=c(9000,15000))+
  theme_minimal()+
  geom_segment(aes(x=c(9000,9000),xend=c(15000,9000),y=c(0,0),yend=c(0,40)))+
  geom_segment(aes(x=9000,xend=14900,y=10,yend=10))+
  geom_segment(aes(x=9000,xend=14900,y=15,yend=15),linetype="dashed",size=.3)+
  geom_segment(aes(x=c(10981,12173.3),xend=c(10981,12173.3),y=c(15,15),
  yend=c(0,0)),linetype="dashed",size=.3)+
  annotate(geom="text",y=c(10,15),x=c(15000,15000),label=c("P(w)","P(US)"))+
  annotate(geom="text",x=c(9500,11587.98,9800,10750,11587.98,13000,9500,10750,11587.98,
  13000,10981,12173.3),y=c(20,17,12,12,12,12,7.5,6,6,6,1,1),
  label=c("A","B","C","D","E","F","G","H","I","J","Q(S,TRQ)","Q(D,TRQ)"))+
  annotate(geom="text",x=11587.98,y=42,
  label="Conceptual Model of the Welfare Impact of Removing TRQ",size=5)
dev.off()
```

```
## pdf
##   2
```



3. (16 points) Econometrically estimate the domestic supply and demand elasticities.

A. (2 points) Obtain a time series of the quantity of sugar consumed in the U.S. from 1975-2019.

i. From the USDA's Sugar and Sweeteners Yearbook Tables at http://www.ers.usda.gov/data-products/sugar-and-sweeteners-yearbook-tables.aspx obtain the dataset "U.S. sugar deliveries for human consumption by type of user, calendar year" and use the "Total U.S." column. (Note: This quantity measure is different from the value you reported in part 2.f. The reason you need to use this dataset it because it gives you a full time series whereas the dataset for your quantity supplied, quantity demanded, and imports in part 2.f only reported 15 years.)

ii. Edit the data so that you have an annual time series from 1975-2019.

```
Table20a <- read_excel("Table20a.xls")
```

```
## New names:
## * `` -> ...2
```

```
## * `` -> ...3
## * `` -> ...4
## * `` -> ...5
## * `` -> ...6
## * ... and 9 more problems
```

```
Table20a[32:76,1:15]->Table20a
```

iii. Report the mean of the quantity of sugar deliveries in the U.S. from 1975-2019.

```
sapply(Table20a[2:15],na.omit)%>%as.data.frame()->crumb
sapply(crumb,function(x) as.numeric(as.character(x)))%>%as.data.frame()->crumb
names(crumb)<-c("Bakery, cereal, and allied products","Confectionery and related products","Ice Cream ar
sapply(crumb,mean)->result
as.data.frame(result)->result;names(result)<-"Mean"
kable(result,caption="the mean of the quantity of sugar deliveries in the U.S. from 1975-2019")
```

Table 6: the mean of the quantity of sugar deliveries in the U.S. from 1975-2019

	Mean
Bakery, cereal, and allied products	1919.93836
Confectionery and related products	1133.78984
Ice Cream and Diary Products	534.55107
Beverages	681.63062
Canned,Bottled, and Frozen Foods	410.18632
All Other Food Uses	671.80578
Non-Food Use	108.29182
Subtotal Industrial Use	5459.96906
Hotels,Restaurants, and Institutions	92.55547
Wholesale Grocers, Jobbers, and Sugar Dealers	2159.50756
Retail Grocers, and Chain Stores	1196.86946
All Other Deliveries	215.14128
Subtotal Non-Industrial Use	3664.18190
Total U.S.	9167.84346

B. (2 points) Obtain a time series of personal disposable income from 1975 to 2019 from the St. Louis Federal Reserve economic database, FRED.

iv. Go to the site at https://fred.stlouisfed.org/ search "Real Disposable Personal Income." Select "Real Disposable Personal Income: Per Capita." Click the "Edit Graph" button and change the frequency to "Annual" (with the aggregation method as "Average") and close the Edit window to return to the graph. Click the "Download" button and choose "Excel (data)" to obtain a spreadsheet with the data.

Done as instructed.

v. Edit the data so that you have an annual time series from 1975-2019.

```
A229RX0 <- read_excel("A229RX0.xls", col_types = c("date","numeric"))
```

```
## New names:
## * `` -> ...2
```

```
A229RX0[27:71,c(1,2)]->A229RX0
```

vi. Report the mean of the per capita real personal disposable income from 1975-2019.

```
paste("The average per capital real personal disposable income is",
  paste("$",formatC(round(mean(A229RX0$...2)),
  format="d", big.mark=","),".",sep=""),sep=" ")
```

```
## [1] "The average per capital real personal disposable income is $31,368."
```

C. (2 points) Obtain a time series of the drought conditions from 1975 to 2019 from the National Oceanic and Atmospheric Administration's National Centers for Environmental Information (NCEI).

vii. Go to the site at https://www.ncdc.noaa.gov/cag/time-series/us and familiarize yourself with the interface

viii. Create a monthly time series for the parameter "Palmer Hydrological Drought Index (PHDI)." Set the other options as follows: Time Scale = "All Months," Month = "December" Start Year = "1975," and End Year = "2019." (The Display Base Period in the Options box doesn't really matter, but you can set it to 1975-2015 just for consistency.) Click the Plot button to create a plot and table of the time series.

ix. You can either copy the data from the table or you can click the little Excel spreadsheet symbol just below the graph to download the data in CSV format.

```
library(readr)
NOAA <- read_csv("NOAA.csv");names(NOAA)[1:2]<-c("Date","Value")
```

```
## Parsed with column specification:
## cols(
##   `Contiguous U.S.` = col_character(),
##   `Palmer Hydrological Drought Index (PHDI)` = col_character()
## )
```

```
NOAA[3:542,]->NOAA;names(NOAA)<-c("Date","Value")
```

x. Edit the data to create an annual time series of the "Value" of the drought index (not the "Anomaly" or "Departure from the mean") from 1975-2019.

```
substr(NOAA$Date,1,nchar(NOAA$Date)-2)->NOAA$Date
as.numeric(NOAA$Value)->NOAA$Value
list<-c()
for(i in 1975:2019)
{filter(NOAA,Date==i)$Value%>%mean()->list[[i]]}
list[1975:2019]->list;cbind(1975:2019,list)->NOAA
as.data.frame(NOAA)->NOAA;names(NOAA)<-c("Date","Value")
```

xi. Report the mean of the drought index from 1975-2019.

```
kable(NOAA,caption="the mean of the drought index from 1975 to 2019")
```

Table 7: the mean of the drought index from 1975 to 2019

Date	Value
1975	3.7183333
1976	1.4033333
1977	-2.0341667
1978	1.3466667
1979	2.2266667
1980	0.1775000
1981	-3.0733333
1982	3.3658333
1983	5.0058333

Date	Value
1984	3.9491667
1985	1.8641667
1986	2.1366667
1987	0.7100000
1988	-3.4966667
1989	-1.2983333
1990	-0.0608333
1991	1.1541667
1992	1.1741667
1993	4.3708333
1994	2.1441667
1995	2.7958333
1996	2.7958333
1997	4.3016667
1998	3.3341667
1999	0.5725000
2000	-4.4383333
2001	-2.8700000
2002	-3.0300000
2003	0.3616667
2004	1.2133333
2005	2.4491667
2006	-2.2058333
2007	-1.6441667
2008	-0.2016667
2009	1.2516667
2010	3.0533333
2011	0.1708333
2012	-4.0025000
2013	-2.4116667
2014	1.2325000
2015	1.2925000
2016	1.4841667
2017	0.2050000
2018	-0.5058333
2019	4.7208333

D. (2 points) Enter the data necessary for the elasticity estimation into Stata, or some other statistical software i) Enter the 1975-2016 time series data for the year, the U.S. price of raw sugar, the world price of raw sugar, the quantity of sugar deliveries, the per capita real personal disposable income, and the drought index into a statistical software program like Stata.

```
cbind(here,Table20a$...15,A229RX0$...2,NOAA$Value)->estimation
names(estimation)<-c("Year","International Price","US Price","Quantity of Sugar Deliveries","Income Per
estimation[,c(1,3,2,4:6)]->estimation
as.numeric(as.character(estimation$`Quantity of Sugar Deliveries`))->estimation$`Quantity of Sugar Deli
```

ii) Take the natural logarithm of the U.S. price of sugar, the world price of sugar, the quantity of sugar deliveries, and the per capita, disposable income(You don't need the logarithm of the drought index.)

```
sapply(estimation[,2:5],log)->estimation[,2:5]
```

iii) Report the summary statistics for these variables here.

```
library(pastecs)
```

```
##
## Attaching package: 'pastecs'

## The following objects are masked from 'package:dplyr':
##
##     first, last
```

```
names(estimation)<-c("Year","logP(US)","logP(w)","logQuantity","logIncome","Drought Index")
stat.desc(estimation[2:6])->`Descriptive Statistics`
kable(`Descriptive Statistics`,caption="Summary Statistics")
```

Table 8: Summary Statistics

	logP(US)	logP(w)	logQuantity	logIncome	Drought Index
nbr.val	45.0000000	45.0000000	45.0000000	45.0000000	45.0000000
nbr.null	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
nbr.na	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
min	2.3978953	1.3862944	8.8871804	9.8970209	-4.4383333
max	3.6375862	3.3672958	9.2858249	10.7272280	5.0058333
range	1.2396909	1.9810015	0.3986445	0.8302071	9.4441667
sum	139.2510034	108.3550804	410.3164964	464.5929167	34.7091667
median	3.0910425	2.3978953	9.1377500	10.3170614	1.2133333
mean	3.0944667	2.4078907	9.1181444	10.3242870	0.7713148
SE.mean	0.0332210	0.0674493	0.0156510	0.0368047	0.3685264
CI.mean.0.95	0.0669526	0.1359351	0.0315426	0.0741749	0.7427162
var	0.0496637	0.2047232	0.0110230	0.0609562	6.1115274
std.dev	0.2228535	0.4524635	0.1049904	0.2468932	2.4721503
coef.var	0.0720168	0.1879087	0.0115144	0.0239138	3.2051120

Table 8: The *nbr.val* stands for number of values while *nbr.null* stands for the number of null values and *nbr.na* stands for the number of missing values. The *SE.mean* represents the standard error on mean and *CI.mean.0.95* represents confidence interval of the mean. The *coef.var* refers to variation coefficient, which is the standard deviation divided by the mean.

E. (2 points) Estimate a constant elasticity of substitution demand curve for the U.S. sugar market by regressing the logarithm of the quantity of sugar deliveries on the logarithm of the U.S. price of sugar, the logarithm of per capita disposable income, and a time trend. Report the results of your regression here.

```
library(jtools)

cbind(estimation,1:length(estimation$Year))->estimation
names(estimation)[7]<-"Trend"
lm(logQuantity ~`logP(US)`+logIncome+Trend,estimation)->fit1

summ(fit1)
```

Observations	45
Dependent variable	logQuantity
Type	OLS linear regression

F(3,41)	12.82
R^2	0.48
Adj. R^2	0.45

	Est.	S.E.	t val.	p
(Intercept)	25.91	4.65	5.58	0.00
‘logP(US)‘	-0.20	0.06	-3.09	0.00
logIncome	-1.65	0.46	-3.55	0.00
Trend	0.04	0.01	4.12	0.00

Standard errors: OLS

F. (2 points) Report the point estimate of the own-price elasticity of demand from this regression. (We discussed in the Week 2 lecture.) Also report the lower 95% confidence interval (i.e., the most inelastic estimate) for this own-price elasticity of demand.

```
`dQ/dP`<-coef(fit1)[2]

`dQ/dP`->point_estimator1;summary(fit1)$coefficients[2,2]->se
length(estimation$Year)->n
qt(0.05/2,length(list)-1,lower.tail=F)->t

margin_of_error1<-t*se

min1<-point_estimator1-margin_of_error1
max1<-point_estimator1+margin_of_error1

naming <- c("Mean","Lower 95% Confidence Interval")
result<-c(unname(round(point_estimator1,digits=3)),unname(round(min1,digits=3)))
as.data.frame(cbind(naming,result))->set1
names(set1)<-c("","Measure of Elasticity")
```

```r
kable(set1,caption="the own-pricing elasticity of demand",align="rc")
```

Table 9: the own-pricing elasticity of demand

	Measure of Elasticity
Mean	-0.199
Lower 95% Confidence Interval	-0.328

G. (2 points) Estimate a constant elasticity of substitution supply curve for the U.S. sugar market by regressing the logarithm of the quantity of sugar deliveries on the logarithm of the World price of sugar, the drought index, and a time trend. Report the results of your regression here.

```r
lm(logQuantity ~`logP(w)`+`Drought Index`+Trend,estimation)->fit
summ(fit)
```

Observations	45
Dependent variable	logQuantity
Type	OLS linear regression

F(3,41)	8.06
R^2	0.37
Adj. R^2	0.32

	Est.	S.E.	t val.	p
(Intercept)	8.85	0.07	124.07	0.00
‘logP(w)‘	0.08	0.03	2.67	0.01
‘Drought Index‘	-0.00	0.01	-0.03	0.98
Trend	0.00	0.00	3.14	0.00

Standard errors: OLS

H. (2 points) Report the point estimate of the own-price elasticity of supply from this regression. Also report the upper 95% confidence interval (again, the most inelastic estimate) for this own-price elasticity of supply.

```r
`dQ/dP`<-coef(fit)[2]

`dQ/dP`->point_estimator;summary(fit)$coefficients[2,2]->se
qt(0.05/2,length(list)-1,lower.tail=F)->t

margin_of_error<-t*se

min<-point_estimator-margin_of_error
max<-point_estimator+margin_of_error

naming <- c("Mean","Upper 95% Confidence Interval")
result<-c(unname(round(point_estimator,digits=3)),unname(round(max,digits=3)))
as.data.frame(cbind(naming,result))->set
names(set)<-c("","Measure of Elasticity")

kable(set,caption="the own-pricing elasticity of supply",align="rc")
```

Table 10: the own-pricing elasticity of supply

	Measure of Elasticity
Mean	0.08
Upper 95% Confidence Interval	0.141

4. (14 points) Estimate a linear supply and demand curves for raw sugar and estimate the quantity of raw sugar that would have been produced domestically in 2015 and the total amount that would have been consumed domestically in 2019 if the TRQ had not been in place.

A. (3 points) Estimate a linear demand curve for U.S. domestic demand, QD, for raw sugar using the point estimate of the own-price elasticity of demand that you reported in part 3.f. The technique for doing this was also described at the end of Week 2. (Note: The reason you are estimating at linear demand curve is to make things easier to calculate the welfare effects in part 5 and because the quantity measure you used in part 3 is different from the quantity measures that you obtained in part 2.) Assume that this elasticity holds at the U.S. domestic price of sugar, PUS, in 2019 and the amount of sugar consumed domestically with the TRQ, QD,TRQ, in 2019, both of which you reported in part 2. (Do not use the quantity measures from part 3.) Report the equation for your linear demand curve here.

```
A1<-unname(round(Demanded$`Quantity Demanded`[20]-point_estimator1*exp(estimation$`logP(US)`[45])))

paste("The formula for demand curve is",
  paste(A1,round(point_estimator1,digits=3),"P",
  sep=""),sep=" ")
```

```
## [1] "The formula for demand curve is 13786-0.199P"
```

B. (3 points) Using this linear demand curve, estimate the quantity of sugar that would have been consumed domestically without the TRQ, assuming the U.S. price of sugar without the TRQ would have been the world price for raw sugar, Pw, in 2019.

```
df<-function(P){unname(round(A1+point_estimator1*P))}

cat(paste(paste(paste(paste("As indicated by calculation, if without TRQ, the consumers will use",
  df(exp(estimation$`logP(w)`[45])),sep=" "),"short tons instead of",sep="\n"),
  df(exp(estimation$`logP(US)`[45])),"short tons",sep=" "),".",sep=""))
```

```
## As indicated by calculation, if without TRQ, the consumers will use 13784
## short tons instead of 13781 short tons.
```

C. (3 points) Estimate a linear supply curve for U.S. domestic supply of raw sugar, QS, using the point estimate of the own-price elasticity of supply that you reported in part 3.h. The technique is analogous to what you did to estimate the domestic demand curve. Assume that this elasticity holds at the U.S. domestic price of sugar, PUS, in 2019 and the quantity of sugar produced domestically with the TRQ, QS,TRQ, in 2019, both of which you reported in part 2. Report you equation here

```
A<-unname(round(Supplied$`Quantity Supplied`[20]-point_estimator*exp(estimation$`logP(US)`[45])))

paste("The formula for supply curve is",paste(A,"+",round(point_estimator,digits=3),"P",sep=""),sep=" "
```

```
## [1] "The formula for supply curve is 9938+0.08P"
```

D. (3 points) Using this linear supply curve, estimate the quantity of sugar that would have been produced domestically without the TRQ, assuming the U.S. price of sugar without the TRQ would have been the world price for raw sugar, Pw, in 2019.

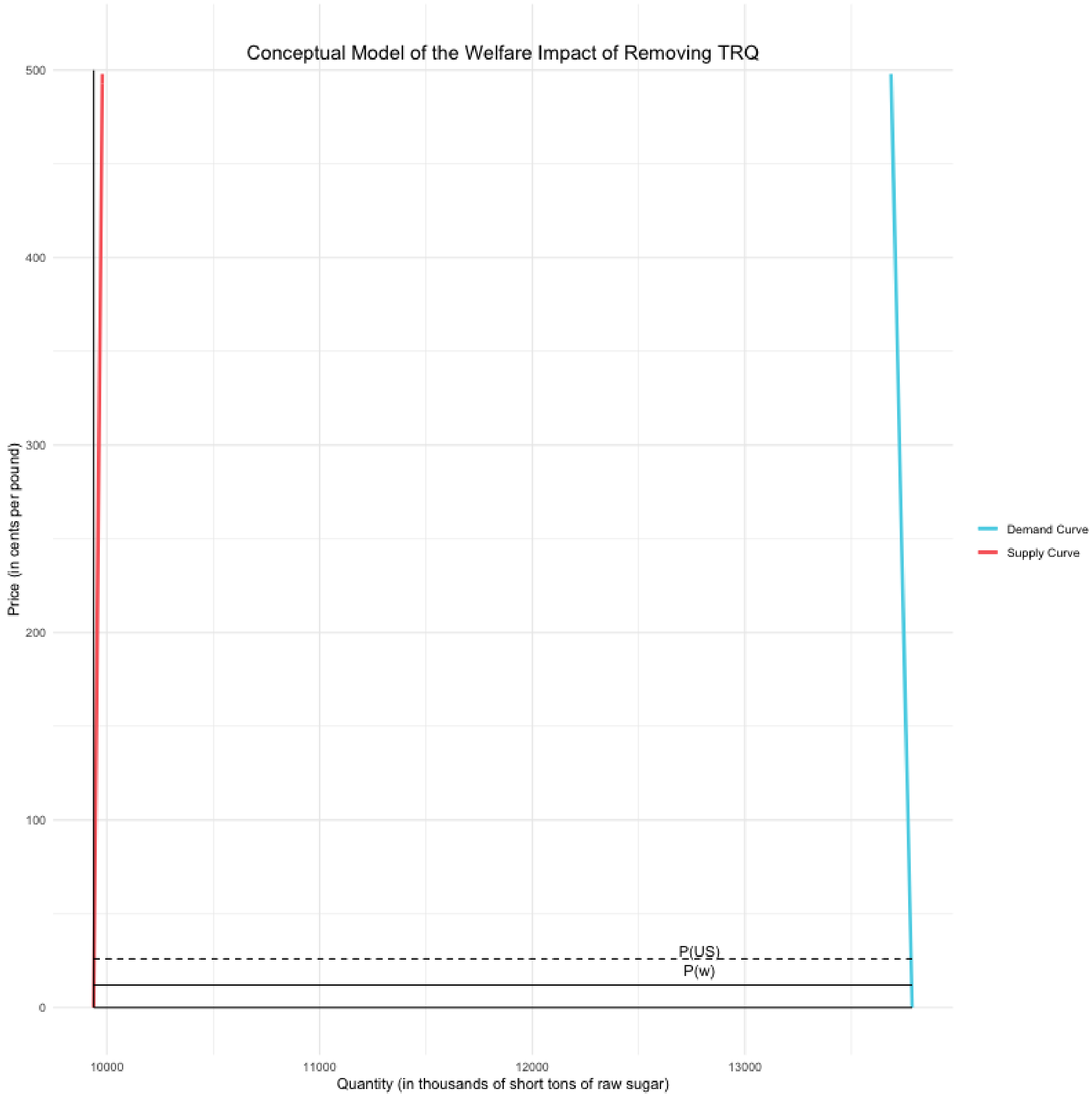
```r
sf<-function(P){unname(round(A+point_estimator*P))}

cat(paste(paste(paste(paste("As indicated by calculation, if without TRQ, the producers will make",
  sf(exp(estimation$`logP(w)`[45])),sep=" "),"short tons instead of",sep="\n"),
  sf(exp(estimation$`logP(US)`[45])),"short tons",sep=" "),".",sep=""))
```

```
## As indicated by calculation, if without TRQ, the producers will make 9939
## short tons instead of 9940 short tons.
```

E. (2 points) Redraw your graph from part 1, substituting in all of the values that you calculated in parts 2 and part 4.

```r
png(filename="RPlot3.png",width=800,height=800)
dqf<-function(Q)unname(round((Q-A1)/point_estimator1))
sqf<-function(Q)unname(round((Q-A)/point_estimator))
datad<-as.data.frame(cbind(c(sf(0),df(0)),c(0,60000)))
ggplot(datad,aes(y=datad$V2,x=datad$V1))+
  stat_function(fun=dqf,aes(col="#58D3E6"),xlim=c(df(500),df(0)),size=1.2)+
  stat_function(fun=sqf,aes(col="#F96767"),xlim=c(sf(0),sf(500)),size=1.2)+
  theme_minimal()+labs(y="Price (in cents per pound)",
  x="Quantity (in thousands of short tons of raw sugar)")+
  geom_segment(aes(x=c(sf(0),sf(0)),xend=c(df(0),sf(0)),y=c(0,0),yend=c(0,500)))+
  geom_segment(aes(x=sf(0),xend=df(0),y=exp(estimation$`logP(w)`[45]),
  yend=exp(estimation$`logP(w)`[45])))+
  geom_segment(aes(x=sf(0),xend=df(0),y=exp(estimation$`logP(US)`[45]),
  yend=exp(estimation$`logP(US)`[45])),linetype="dashed")+
  annotate(geom="text",y=c(exp(estimation$`logP(US)`[45])+4,
  exp(estimation$`logP(w)`[45]+.5)),x=c(df(0)-1000,df(0)-1000),label=c("P(US)","P(w)"))+
  annotate(geom="text",x=mean(c(df(0),sf(0))),y=510,
  label="Conceptual Model of the Welfare Impact of Removing TRQ",size=5)+
  scale_color_identity(name="",
  breaks = c("#58D3E6", "#F96767"),labels = c("Demand Curve","Supply Curve"),
  guide = "legend")
dev.off()
```

```
## pdf
##   2
```



5. (10 points) Calculate the welfare effects associated with removing the Sugar TRQ.

A. (5 points) Complete the Benefit-Cost Analysis Tableau with the dollar value of the welfare effect that would occur if the sugar TRQ was eliminated using values that obtained or estimated in parts 2 and 4.

i) Pay very careful attention to the units in your calculations. The price axis in your graph is in cents per pound. The quantity axis is in thousands of short tons.

ii) To make things easier to report, you may want to report the values in billions of dollars.

```
library(measurements)
conv_unit(1,"short_ton","lbs")->lbs

integralD<-function(lower,upper){unname((A1*upper +point_estimator1*.5*upper*upper) - (A1*lower + point_
integralS<-function(upper,lower){unname((A*upper + point_estimator*.5*upper*upper) - (A*lower - point_es
integralG<-function(upper,lower){(exp(estimation$`logP(US)`[45])*upper-exp(estimation$`logP(US)`[45])*lo
```

```r
integralD(exp(estimation$`logP(w)`[45]),exp(estimation$`logP(US)`[45]))/100*lbs->DemandBenefit
integralS(exp(estimation$`logP(w)`[45]),exp(estimation$`logP(US)`[45]))/100*lbs->SupplyCost
integralG(sf(exp(estimation$`logP(US)`[45])),df(exp(estimation$`logP(US)`[45])))/100*lbs->GovernmentCost

c("Consumer","Producer","Government","Total:")->a
c("",paste("$",formatC(-SupplyCost,digits=2,
  format="f", big.mark=","),sep=""),paste("$",formatC(-GovernmentCost,digits=2,
  format="f",big.mark=","),sep=""),paste("-","$",
  formatC(-(GovernmentCost+SupplyCost),digits=2,format="f", big.mark=",")))->b
c(paste("$",formatC(DemandBenefit,digits=2,format="f",big.mark = ","),sep=""),"","",
  paste("$",formatC(DemandBenefit,digits=2,format="f",big.mark=","),sep=""))->c
c("","","",paste("=",paste("$",formatC(SupplyCost+GovernmentCost+DemandBenefit,
  digits=2,format="f",big.mark=","),sep=""),sep=" "))->d
cbind(a,b,c,d)->tabled
as.data.frame(tabled)->tabled
names(tabled)<-c("","Cost","Benefit","")
kable(tabled)
```

	Cost	Benefit	
Consumer		$3,859,022.58	
Producer	$2,781,980.47		
Government	$1,075,479.86		
Total:	- $ 3,857,460.33	$3,859,022.58	= $1,562.25

B. (5 points) Conduct a sensitivity analysis by re-estimating you linear supply and demand equations from part 4 using the 95% confidence interval elasticities that you reported in part 3. To do so,

i) Re-estimate the linear demand curve like you did in part 4.a, but use the value for lower 95% confidence interval that you reported in 3.f.

```r
A2<-unname(round(Demanded$`Quantity Demanded`[20]-min1*exp(estimation$`logP(US)`[45])))

df1<-function(P){unname(round(A2+min1*P))}
```

ii) Using this new demand curve, re-calculate the quantity of sugar that would have been consumed domestically without the TRQ, like you did part 4.b.

```r
cat(paste(paste(paste(paste("As indicated by calculation, if without TRQ, the consumers will use",
  df1(exp(estimation$`logP(w)`[45])),sep=" "),"short tons instead of",sep="\n"),
  df1(exp(estimation$`logP(US)`[45])),"short tons",sep=" "),".",sep=""))
```

```
## As indicated by calculation, if without TRQ, the consumers will use 13786
## short tons instead of 13781 short tons.
```

iii) Re-estimate the linear supply curve like you did in part 4.c, but use the value for upper 95% confidence interval that you reported in 3.h.

```r
A3<-unname(round(Supplied$`Quantity Supplied`[20]-max*exp(estimation$`logP(US)`[45])))
sf1<-function(P){unname(round(A3+max*P))}
```

iv) Using this new supply curve, re-calculate the quantity of sugar that would have been consumed domestically without the TRQ, like you did part 4.d.

```r
cat(paste(paste(paste(paste("As indicated by calculation, if without TRQ, the producers will make",
  sf1(exp(estimation$`logP(w)`[45])),sep=" "),"short tons instead of",sep="\n"),
  sf1(exp(estimation$`logP(US)`[45])),"short tons",sep=" "),".",sep=""))
```

```
## As indicated by calculation, if without TRQ, the producers will make 9939
## short tons instead of 9941 short tons.
```

v) Using these new values, complete the Benefit-Cost Analysis Tableau with the dollar value of the welfare effect that would occur if the sugar TRQ was eliminated, like you did in part 5.a.

```r
library(measurements)
conv_unit(1,"short_ton","lbs")->lbs

integralD<-function(lower,upper){unname((A2*upper +min1*.5*upper*upper) - (A2*lower + min1*.5*lower*lowe
integralS<-function(upper,lower){unname((A3*upper + max*.5*upper*upper) - (A3*lower - max*.5*lower*lowe
integralG<-function(upper,lower){(exp(estimation$`logP(US)`[45])*upper-exp(estimation$`logP(US)`[45])*lo
integralD(exp(estimation$`logP(w)`[45]),exp(estimation$`logP(US)`[45]))/100*lbs->DemandBenefit
integralS(exp(estimation$`logP(w)`[45]),exp(estimation$`logP(US)`[45]))/100*lbs->SupplyCost
integralG(sf(exp(estimation$`logP(US)`[45])),df(exp(estimation$`logP(US)`[45])))/100*lbs->GovernmentCos

c("Consumer","Producer","Government","Total:")->a
c("",paste("$",formatC(-SupplyCost,digits=2,
  format="f", big.mark=","),sep=""),paste("$",formatC(-GovernmentCost,digits=2,
  format="f",big.mark=","),sep=""),paste("-","$",
  formatC(-(GovernmentCost+SupplyCost),digits=2,format="f", big.mark=",")))->b
c(paste("$",formatC(DemandBenefit,digits=2,format="f",big.mark = ","),sep=""),"","",
  paste("$",formatC(DemandBenefit,digits=2,format="f",big.mark=","),sep=""))->c
c("","","",paste("=",paste("$",formatC(SupplyCost+GovernmentCost+DemandBenefit,
  digits=2,format="f",big.mark=","),sep=""),sep=" "))->d
cbind(a,b,c,d)->tabled
as.data.frame(tabled)->tabled
names(tabled)<-c("","Cost","Benefit","")
kable(tabled)
```

	Cost	Benefit	
Consumer		$3,859,454.27	
Producer	$2,781,203.83		
Government	$1,075,479.86		
Total:	- $ 3,856,683.69	$3,859,454.27	= $2,770.57

6. (8 points) Write a summary of the results of you welfare analysis associated with removing the Sugar TRQ and offer a brief commentary. Would this be an economically efficient action? Does the sensitivity analysis alter this position? Why do you say this? Who would likely support such an action and who would likely oppose it? Are there reasons why this policy may or may not be a good idea?

If the Sugar Tariff Rate Quota (TRQ) system is entirely removed, the total welfare will increase by $1,562.25. According to the sensitivity analysis, if both supply and demand curves are inelastic, it will increase by $2,770.57. In this empirical study, this is an unequivocally zero-sum situation so that this policy is controversial. The producers and government both lost about $3.86 million while the consumer gains about $3.86 million. The consumers are more likely to favor removing TRQ policy. How efficient this policy might be is a fundamental question to be considered.

Thus, the econometric assessment needs to be evaluated. Although the logarithmic trend regressions for both supply and demand are statistically significant at 1% level, this assessment does not evaluate endogeneity and heteroskedasticity. Because the correlation between explanatory variables may take place, the Durbin-Wu-Hausman test is important to consider.

The point in discussing above is that some critical tools in econometrics need to include in order to ensure this policy considered efficient. If the omitted variable bias exists, there are some critical missing variables that need to be included. When both regressions change based on additional explanatory variables, the constant elasticity may change. The change is likely to have an impact on the total welfare analysis, so the sensitivity analysis is not sufficient to conclude.

There is another problem that is worth mentioning. For policy decisions, the precision for benefit transfer is highly demanded. The approach to estimate benefit should rely on Willingness to Pay (WTP) using the meta regression instead of benefit function transfer. Since the net benefit is small, there is no way to be certain that, from the economic perspective, this policy might be a good idea.