Econ HW 2

Maddie Berger & Sara Orofino

4/25/2019

1. Aggregate Demand, Supply, and Surplus

High income demand curve:
$Price = (23.3914418) - (1.2966378 \times 10^{-4})Q$

Low income demand curve:
$Price = (21.9908534) - (1.3551741 \times 10^{-4})Q$

a. Find aggregate demand

Aggregate demand curve:
$Price = (22.7066059) - (6.6262994 \times 10^{-5})Q$

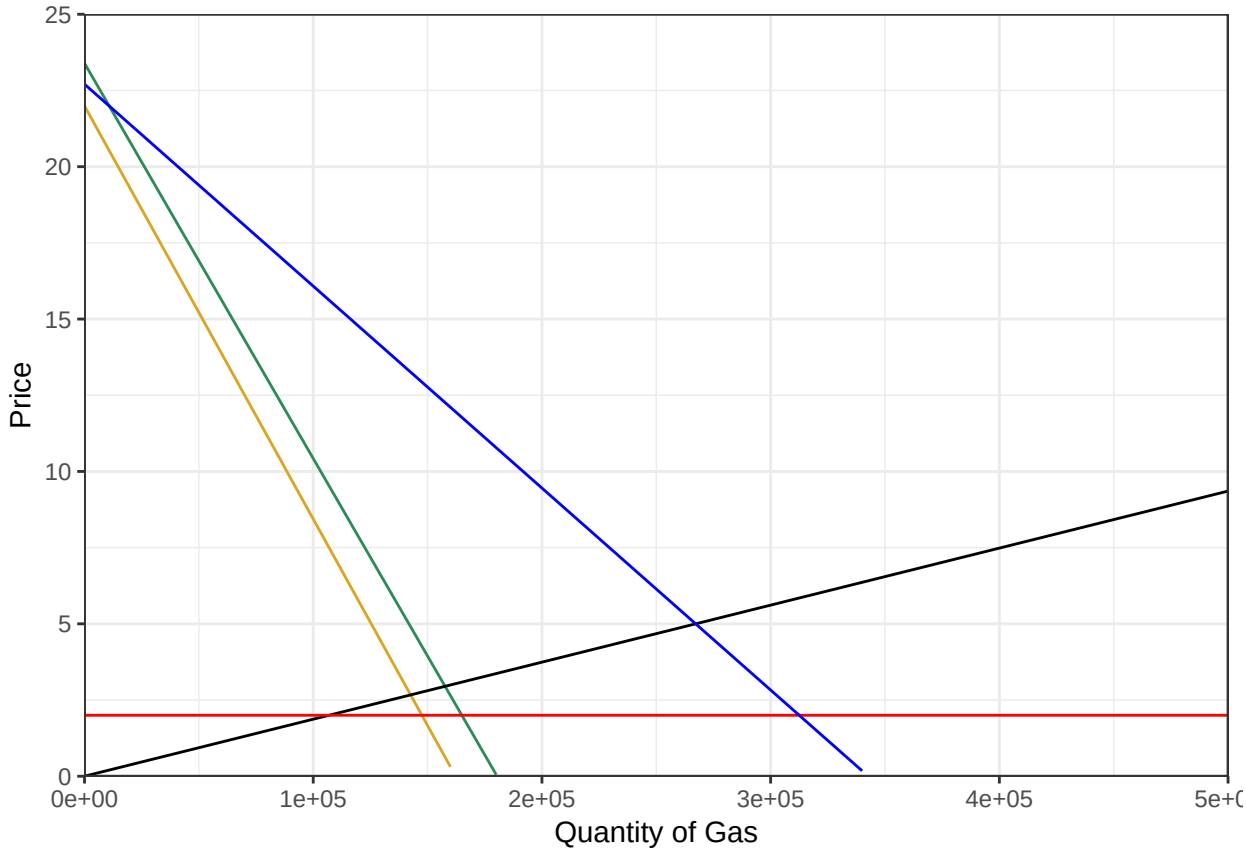
b. Find the supply curve

Supply curve:
$Price = (1.8711376 \times 10^{-5}) * Q$

```
## Warning: Removed 64 rows containing missing values (geom_path).
```

```
## Warning: Removed 68 rows containing missing values (geom_path).
```

```
## Warning: Removed 32 rows containing missing values (geom_path).
```



c. Surplus under the status quo

Consumers:
$CS = (2.3694528 \times 10^6)$

Producers:
$PS = (6.6804279 \times 10^5)$

d. Environmental Cost under the Status Quo

$Environmental\ Cost = (5.3443423 \times 10^5)$

2. Division of Consumer Benefit

Consumer Surplus for High Income
$CS_{High} = (1.3043162 \times 10^6)$

Consumer Surplus for Low Income
$CS_{Low} = (1.0651366 \times 10^6)$

3. Implement a Gas Tax of $0.50/gallon

a. New quantity of gasoline

```r
# Suppose the tax is placed on producers and the supply curve shifts left (new intercept 0.50)

# New equation for MPC with tax:

mpc_tax0.5 <- function(q) {
  0.50 + mpc_slope*q
}

# Find quantity where the MPC and aggregate demand intersect
q_tax0.5 <- ((agg_int/agg_slope)-0.50)/((1/agg_slope)+mpc_slope)
```

$Q_{Tax} = (2.6133299 \times 10^5)$

b. New price of gasoline

```r
# Price from aggregate demand with the new quantity

p_tax0.5 <- d_agg(q_tax0.5)
```

$P_{Tax} = (5.3898999)$

c. Surplus to high income consumers

```r
# CS for high demand = area under curve from 0 to quantity at new price - (new quantity*new price)
q_high_tax0.5 <- d_highq(p_tax0.5)
area_high_tax0.5 <- integrate(d_high, lower = 0, upper = q_high_tax0.5)
cost_high_tax0.5 <- q_high_tax0.5 * p_tax0.5
cs_high_tax0.5 <- area_high_tax0.5$value - cost_high_tax0.5
```

$CS_{High} = (1.2495992 \times 10^6)$

d. Surplus to low income consumers

```r
# CS for low demand = area under curve from 0 to quantity at new price - (new quantity*new price)
q_low_tax0.5 <- d_lowq(p_tax0.5)
area_low_tax0.5 <- integrate(d_low, lower = 0, upper = q_low_tax0.5)
cost_low_tax0.5 <- q_low_tax0.5 * p_tax0.5
cs_low_tax0.5 <- area_low_tax0.5$value - cost_low_tax0.5
```

$CS_{Low} = (1.0168127 \times 10^6)$

e. Producer surplus

```r
# PS = (new quantity*price at MPC) - area under curve through new quantity
mpc_area_tax0.5 <- integrate(mpc_tax0.5, lower = 0, upper = q_tax0.5)
cost_tax0.5 <- q_tax0.5 * p_tax0.5
ps_tax0.5 <- cost_tax0.5 - mpc_area_tax0.5$value
```

$PS_{Tax} = (6.3894607 \times 10^5)$

f. Environmental damage

```r
tec_tax0.5 <- 2*q_tax0.5
```

$TEC_{Tax} = (5.2266597 \times 10^5)$

g. Tax revenue

```
# Revenue from taxes = (quantity with tax) * (price of the tax)

# Calculate Revenue:
tax0.5_rev <- q_tax0.5 * 0.50
```

$Tax\ Revenue = (1.3066649 \times 10^5)$

4. Tax Revenues for Infrastructure Repairs

```
# If revenues are being used for infrastructure repairs that area becomes part of CS

# Part that goes to low income consumers is (Qlow)/(total Q with tax) * Rev

########## Generic functions for calculations assuming tax is placed on producers

# Amount of the tax - create a vector that will find tax amounts in increments $0.25 from $0.25-$5
amt_tax <- seq(0.25,5, by = 0.25)

#New MPC with the tax (intercept is equal to amount of the tax)
mpc_tax <- function(q) {
  amt_tax + mpc_slope*q
}

# Price at equilibrium (status quo)
p_sq <- 5

#Quantity with tax:
q_tax <- ((agg_int/agg_slope)-amt_tax)/((1/agg_slope)+mpc_slope)

#Price with tax:
p_tax <- d_agg(q_tax)

#Price of MPC with quantity of tax:
p_mpc_tax <- mpc(q_tax)

#Environmental cost of tax:
tec_tax <- 2*q_tax

# Total Revenue
rev_tax <- amt_tax * q_tax
```

a. Surplus to high income consumers

```
# CShigh = [(area under curve from 0 to quantity with tax) - (price with tax *quantity with tax)] + Rev

q_high_tax <- d_highq(p_tax)

# Revenue for High Income Consumers:
rev_highcon <- rev_tax * ((q_high_tax)/q_tax)

# Define the integration function:
```

```r
area_h <- function(q) {
  integrate(d_high, lower = 0, upper = q)$value
}

# Use sapply() to integrate to the quantity at each value of the tax:
high_areas <- sapply(q_high_tax, area_h)

# Cost:
cost_high_tax <- q_high_tax * p_tax

# Calculate CS:
cs_high_tax <- (high_areas - cost_high_tax) + rev_highcon
```

b. Surplus to low income consumers

```r
# CSlow = [(area under curve from 0 to quantity with tax) - (price with tax * quantity with tax)] + Rev

q_low_tax <- d_lowq(p_tax)

# Revenue for Low Incoming Consumers:
rev_lowcon <- rev_tax * ((q_low_tax)/q_tax)

# Define the integration function:

area_l <- function(q) {
  integrate(d_low, lower = 0, upper = q)$value
}

# Use sapply() to integrate to the quantity at each value of the tax:
low_areas <- sapply(q_low_tax, area_l)

# Cost:
cost_low_tax <- q_low_tax * p_tax

# Calculate CS:
cs_low_tax <- (low_areas - cost_low_tax) + rev_lowcon - tec_tax
```

c. Surplus to producers

```r
# PS = [(price with tax * quantity with tax) - area under curve of MPC+tax through quantity with tax]

# Define the integration function:

area_p <- function(q){
  integrate(mpc, lower = 0, upper = q)$value
}

# Use sapply() to integrate to the quantity at each value of the tax:
prod_areas <- sapply(q_tax, area_p)

# Cost using the original supply curve and price at MPC
cost_tax <- q_tax * p_mpc_tax
```

```r
#Calculate PS:
ps_tax <- cost_tax - prod_areas
```

```r
# Bind the baseline to the amount of tax, CS high, CS low, and PS into a dataframe:

tax_scenarios <- as.data.frame(cbind(amt_tax, cs_high_tax, cs_low_tax, ps_tax))


# Graph them:

taxes <- ggplot(tax_scenarios, aes(x = cs_high_tax, y = amt_tax)) +
  geom_line()+
  geom_line(aes(x=cs_low_tax, y = amt_tax)) +
  geom_line(aes(x=ps_tax, y = amt_tax)) +
  scale_x_continuous(limits = c(560000,1650000))

# Graph is bad.... try table instead


# Use percent change from the baseline
tax_table <- tax_scenarios %>%
  mutate(cs_high_change = (cs_high_tax-cs_high)/cs_high) %>%
  mutate(cs_low_change = (cs_low_tax-cs_low)/cs_low) %>%
  mutate(ps_change = (ps_tax-ps_total)/ps_total) %>%
  select(amt_tax, cs_low_change, cs_high_change, ps_change)
```