IS 609 Week 13 Homework

Ben Arancibia

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B-13

4) Discuss how you might go about validating the nuclear arms race model. What data would you collect? Is it possible to obtain the data?

One way that we go about validating the nuclear arms race model is to look at historical records. There are tables out there with inventories, but it is difficult to determine how accurate these numbers are and usually records are not up to date. The National Resources Defense Council has table of 1945 - 2002 for nuclear weapons inventories: http://www.nrdc.org/nuclear/nudb/datab19.asp and the Bullentin of Atomic Scientists also has a table of inventories from 1945- 2010: http://bos.sagepub.com/content/66/4/77.full.pdf+html. With this data you could then estimate the survivability of each country's missle silos. Once you have this data you can then create standard deviations and moving averages to give a range of what the inventories might be for each country.

B-17

1) Build a numercial solution to Equations (15.8)

yn+1 = 120 + 1/2 * xn

xn+1 = 60 + 1/3 * yn

with

[x_0=100]

[y_0=200]

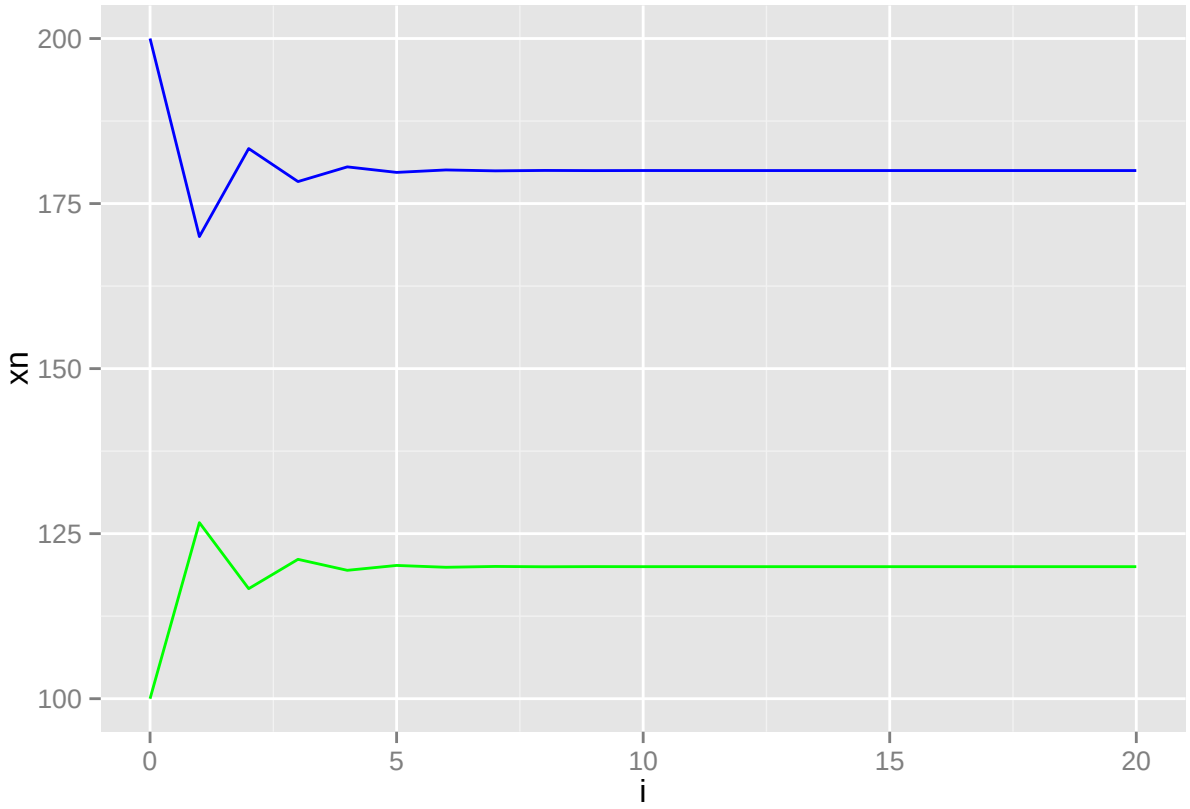
a) Graph your results

```
library(ggplot2)
```

```
## Warning: package 'ggplot2' was built under R version 3.1.3
```

```
model <- function(x.naught, y.naught)
{
  xn <- x.naught
  yn <- y.naught
  model.results <- data.frame(i=0,xn=c(xn), yn=c(yn))
  for(i in 1:20)
  {
    yn1 <- 120 + (1/2 * xn)
    xn1 <- 60 + (1/3 * yn)

    xn <- xn1
    yn <- yn1
```

```
    model.results <- rbind(model.results, cbind(i=i, xn=xn, yn=yn))
  }

  return (model.results)
}

nuke.race<- model(100, 200)

g1 <- ggplot(data=nuke.race) + geom_line(aes(x=i, y=xn), colour="green") +
  geom_line(aes(x=i, y=yn), colour="blue")

g1
```

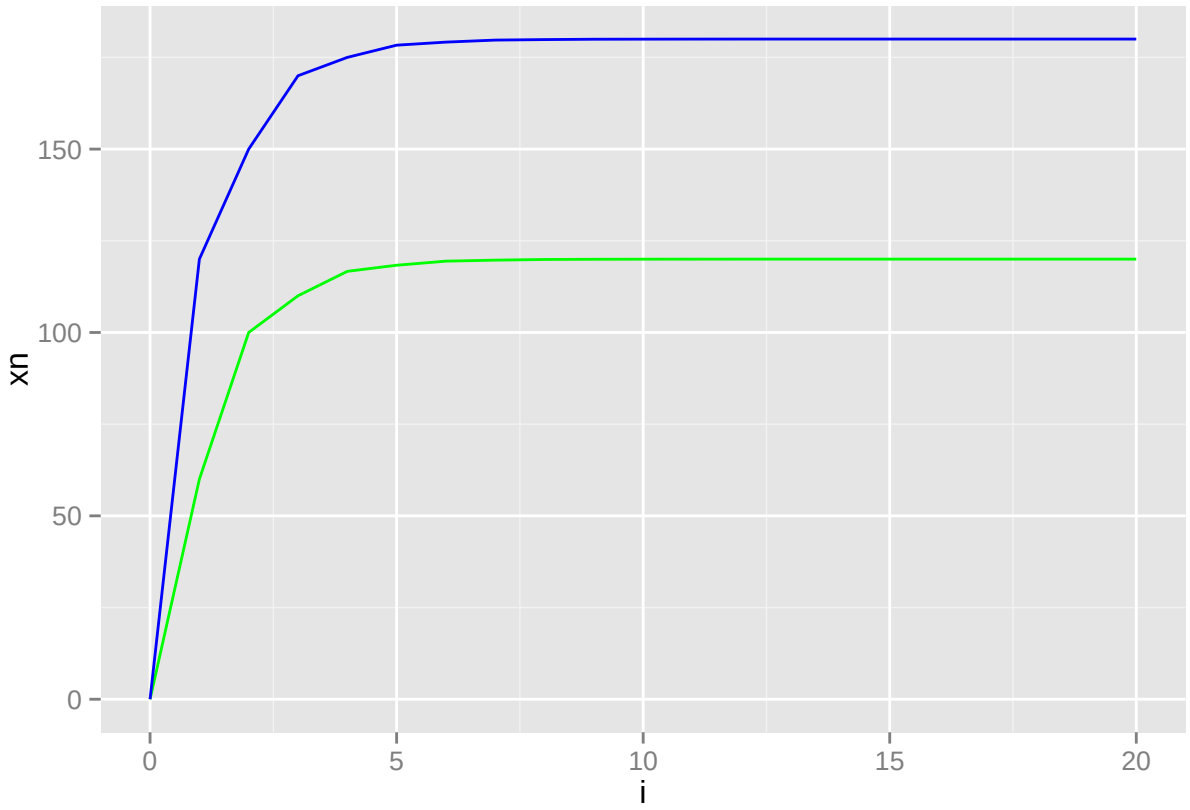


b) Is an equilibrium value reached

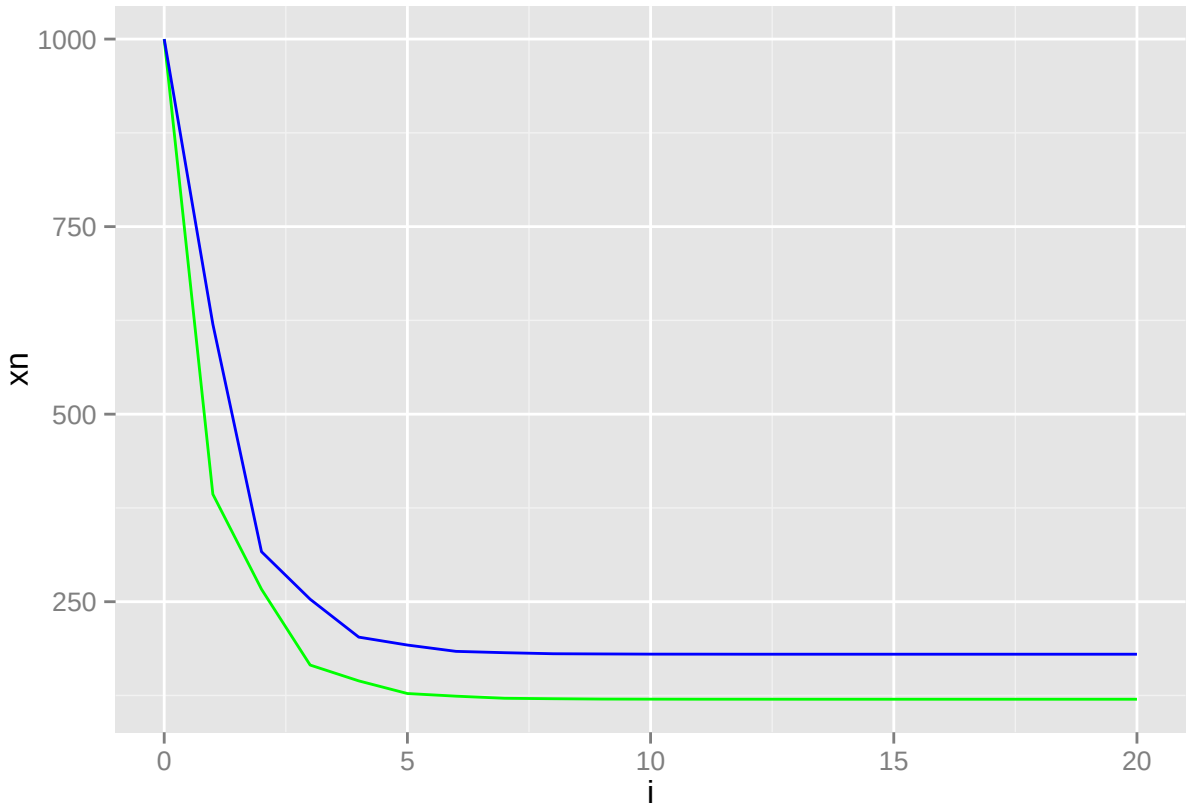
Yes equilibirum is reached.

c) Try other starting values. Do you think the equlibrium is stable

```
nuke.race<- model(0, 0)

g1 <- ggplot(data=nuke.race) + geom_line(aes(x=i, y=xn), colour="green") +
  geom_line(aes(x=i, y=yn), colour="blue")

g1
```

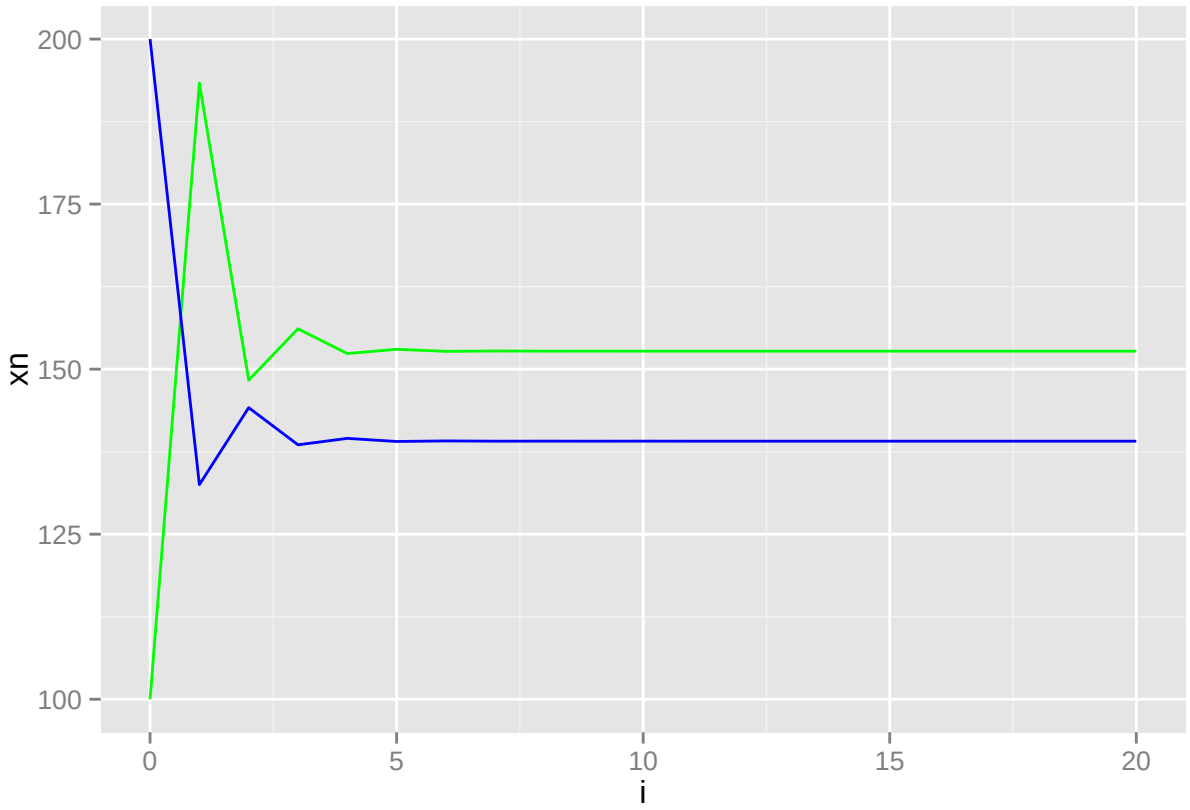



```
nuke.race<- model(1000, 1000)

g1 <- ggplot(data=nuke.race) + geom_line(aes(x=i, y=xn), colour="green") +
  geom_line(aes(x=i, y=yn), colour="blue")

g1
```



Yes equilibrium is stable d) Explore other values for survival coefficients of Countries X and Y. Describe your results.

```
model <- function(x.naught, y.naught)
{
  xn <- x.naught
  yn <- y.naught
  model.results <- data.frame(i=0,xn=c(xn), yn=c(yn))
  for(i in 1:20)
  {
    yn1 <- 120 + (1/8 * xn)
    xn1 <- 60 + (2/3 * yn)

    xn <- xn1
    yn <- yn1

    model.results <- rbind(model.results, cbind(i=i, xn=xn, yn=yn))
  }

  return (model.results)
}
# Run the model and get the resulting cycle data
nuke.race<- model(100, 200)

g1 <- ggplot(data=nuke.race) + geom_line(aes(x=i, y=xn), colour="green") +
  geom_line(aes(x=i, y=yn), colour="blue")

g1
```

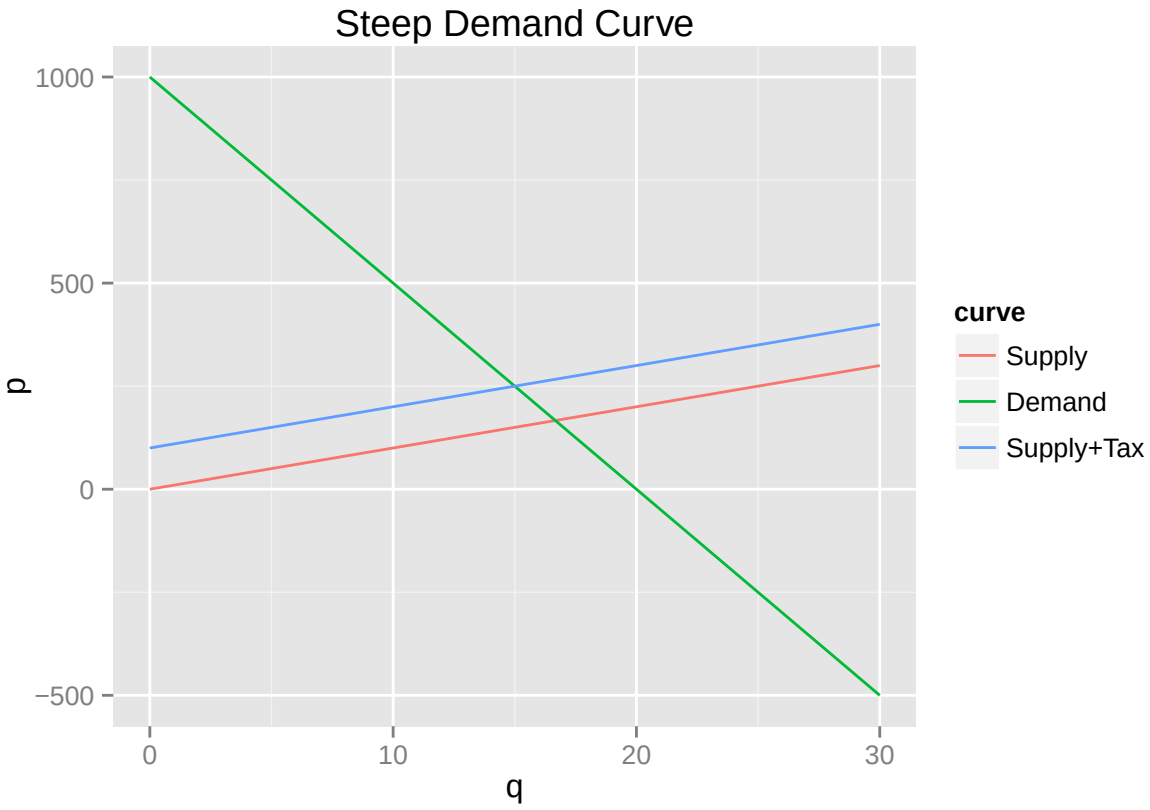


Changing survival coeffcients changes which nation will end up with largest inventory of nuclear weapons.

B-25

1) Show that when the demand curve is very steep, a tax added to each item sold will fall primarily on consumers. Now show that when the demand curve is more nearly horizontal, the tax is paid mostly by the industry. What if the supply curve is very steep? What if the supply curve is nearly horizontal?

```
f1 <- ggplot(data=dfCurves) +
  geom_line(aes(x=q, y=p, color=curve)) +
  labs(title="Steep Demand Curve")
f1
```

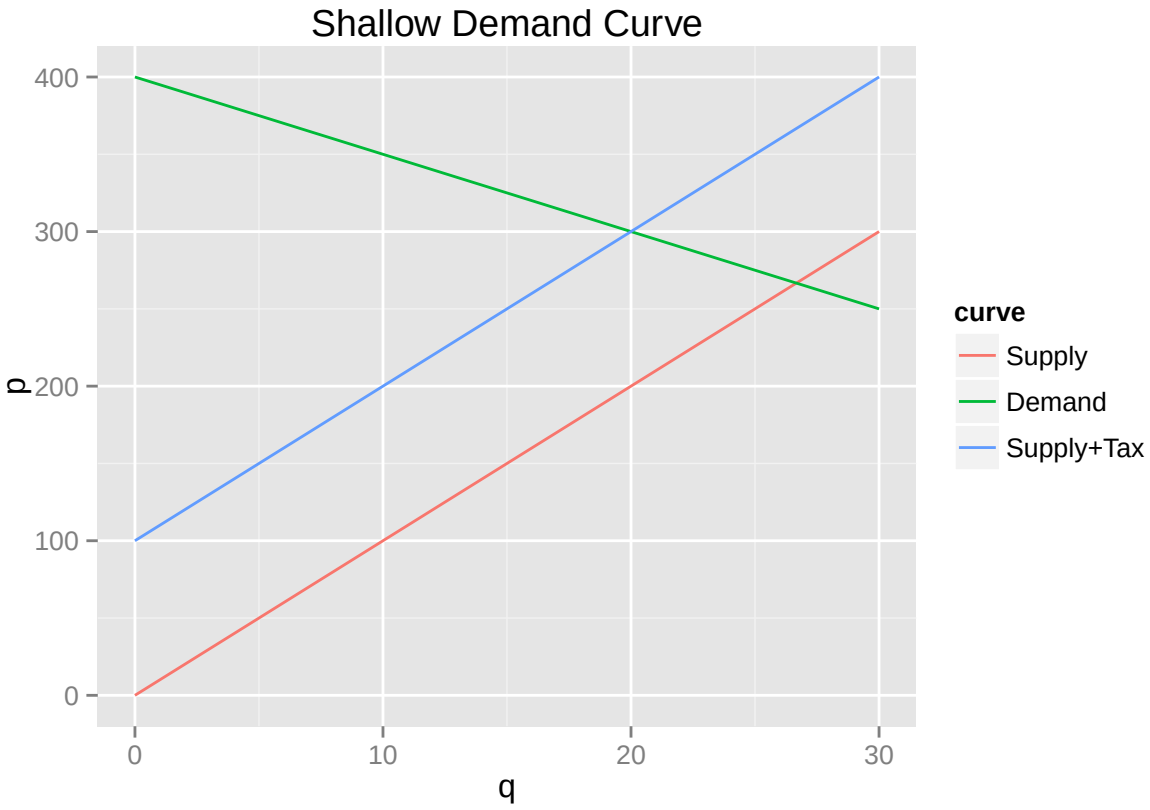


Pre-tax equilibrium is at p=166.67 and q=16.67.

$100 tax is added, equilibrium changes to p=250 and 1=15.

The consumer will pay $83.33 of the tax, and the supplier will pay the balance $16.67.

```
q <- seq(0, 30)
tax <- 100
dfCurves <- data.frame(q = q, p = supplyCurve(q, 10), curve = rep("Supply",
    length(q)))
dfCurves <- rbind(dfCurves, data.frame(q = q, p = demandCurve(q, 5, 400), curve = rep("Demand",
    length(q))))
dfCurves <- rbind(dfCurves, data.frame(q = q, p = supplyCurve(q, 10) + tax,
    curve = rep("Supply+Tax", length(q))))

g1 <- ggplot(data = dfCurves) + geom_line(aes(x = q, y = p, color = curve)) +
    labs(title = "Shallow Demand Curve")
g1
```

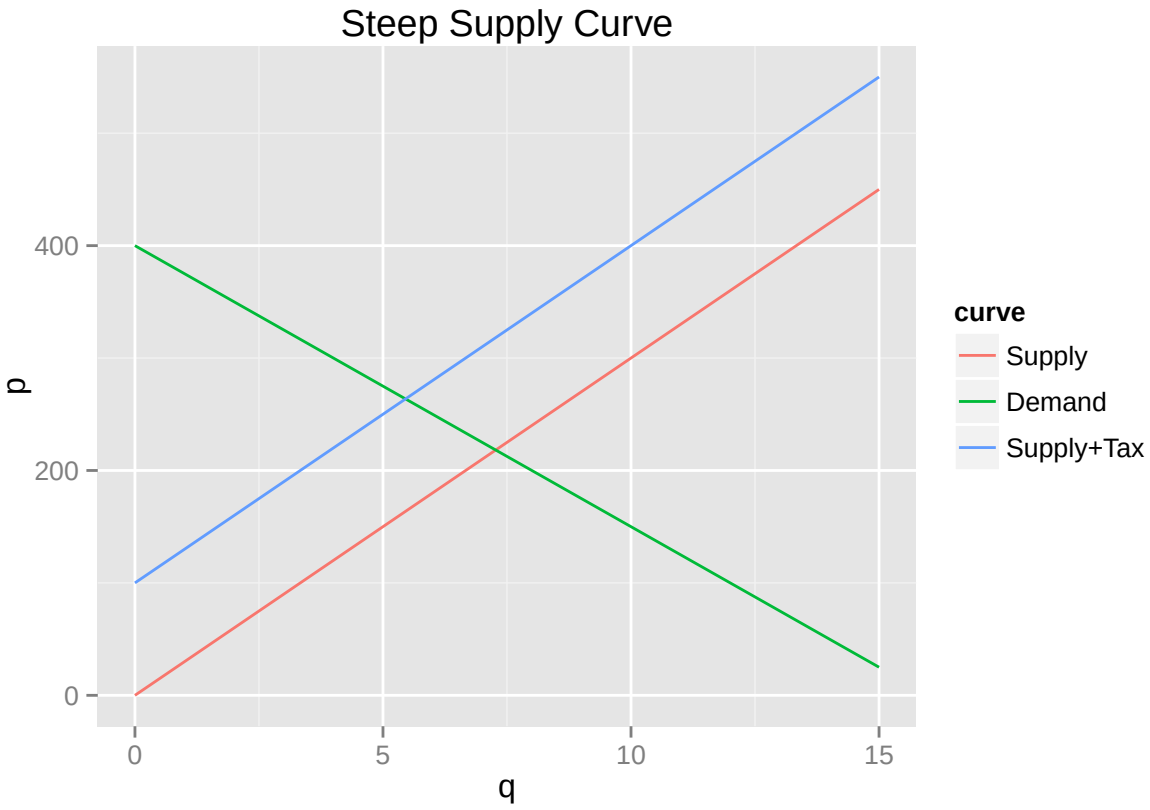


In a shallow demand curve scenario, pre-tax equilibrium is at p=266.67 and q=26.67.

$100 tax is added, the equilibrium shifts to p=300 and q=20.

The consumer pays $33.33 and the supplier pays the balance of the tax, $66.67

```
q <- seq(0, 15)
tax <- 100
sm <- 30
dfCurves <- data.frame(q = q, p = supplyCurve(q, sm), curve = rep("Supply",
    length(q)))
dfCurves <- rbind(dfCurves, data.frame(q = q, p = demandCurve(q, 25, 400), curve = rep("Demand",
    length(q))))
dfCurves <- rbind(dfCurves, data.frame(q = q, p = supplyCurve(q, sm) + tax,
    curve = rep("Supply+Tax", length(q))))
```



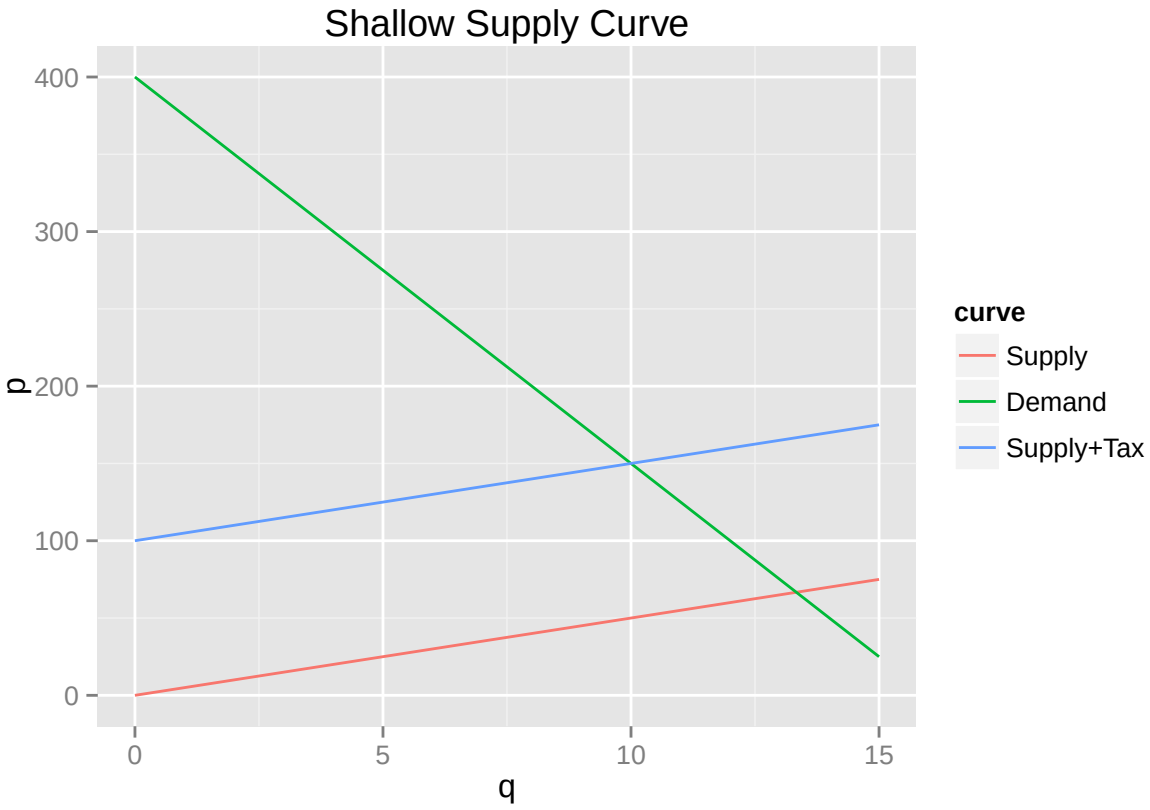
In a steep supply curve scenario, pre-tax equilibrium is at p=216.3 and q=7.21.

$100 tax is added, the equilibrium shifts to p=263.5 and q=5.45.

The consumer pays $47.20 and the supplier pays the balance of the tax, $52.80.

```
q <- seq(0, 15)
tax <- 100
sm <- 5
dfCurves <- data.frame(q = q, p = supplyCurve(q, sm), curve = rep("Supply",
    length(q)))
dfCurves <- rbind(dfCurves, data.frame(q = q, p = demandCurve(q, 25, 400), curve = rep("Demand",
    length(q))))
dfCurves <- rbind(dfCurves, data.frame(q = q, p = supplyCurve(q, sm) + tax,
    curve = rep("Supply+Tax", length(q))))
```

```
g1 <- ggplot(data=dfCurves) +
  geom_line(aes(x=q, y=p, color=curve)) +
  labs(title="Shallow Supply Curve")
g1
```



In a shallow supply curve scenario, pre-tax equilibrium is at p=66.65 and q=13.33).

When $100 tax is added, the equilibrium shifts to p=150 and q=10

The consumer pays $83.35 of the tax and the supplier pays the balance of the tax, $16.65.