

Cournot Nash Equilibrium

Industrial Organization and Competition Policy

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Cournot Market Structure

This is a simple code for representing the Cournot equilibrium for a duopoly when market demand is $Q(P) = 200 - P$. Each firm's cost function is $C(q_i) = 20q_i$, where $i = 1, 2$.

- ▶ In this case the Cournot model corresponds to two firms with symmetric costs.
- ▶ Each firm's goal is to choose the level of output that maximizes profits, given the output of the other firm.
- ▶ Firm i 's payoffs are profits $\pi_i(q_i, q_j) = (p - c)q_i$

Create data frame with output values for each firm

The first step consist on creating a data frame with two columns. On column for the output for firm 1 and another column with the output for firm 2.

Next, we create some value with the parameters of the demand and costs functions.

```
rm(list=ls())

# Create output q and define the range of values
cournotdata <- data.frame(output_firm1 = seq(0, 180, by = 10),
                           output_firm2 = seq(0, 180, by = 10))

# Create values with parameters of the functions
a <- 200
c <- 20
b <- 1
```

Nash equilibrium

At the Nash equilibrium, recall that each firm must behave optimally assuming that its rival behaves optimally. That is, firm i maximizes profits, believing that firm j maximizes its profits. Another way of saying this is that each firm calculates its best response or reply to the expected best-reply behavior of the other firm

$$q_1 = \frac{a - c - bq_2}{2b}$$

$$q_2 = \frac{a - c - bq_1}{2b}$$

Compute best responses

```
# Compute best responses
cournotdata <- cournotdata %>%
  mutate( bestresp_Firm1 = (a-c-b*output_firm2)*((2*b)^-1),
           bestresp_Firm2 = (a-c-b*output_firm1)*((2*b)^-1)
)

ggplot() +
  geom_line(data = cournotdata, aes(x = output_firm1, y = b
  geom_line(data = cournotdata, aes(x = bestresp_Firm1, y = b
  labs(title = "Best Responses", x = "Output Firm 1", y = "
  scale_x_continuous(breaks = seq(0, max(cournotdata$output
  scale_y_continuous(breaks = seq(0, max(cournotdata$output
  theme_minimal()
```



Compute equilibrium

Solving simultaneously for q_1 and q_2 we get

$$q_1 = \frac{a-c}{3b}$$

$$q_2 = \frac{a-c}{3b}$$

Compute best responses

```
# Compute best responses
```

```
nashoutput_firm1= (a-c)*((3*b)^-1)
```

```
nashoutput_firm2= (a-c)*((3*b)^-1)
```

```
ggplot() +
```

```
  geom_line(data = cournotdata, aes(x = output_firm1, y = b
```

```
  geom_line(data = cournotdata, aes(x = bestresp_Firm1, y =
```

```
  labs(title = "Best Responses", x = "Output Firm 1", y = "
```

```
  geom_point(aes(x = nashoutput_firm1, y = nashoutput_firm2
```

```
  scale_x_continuous(breaks = seq(0, max(cournotdata$output
```

```
  scale_y_continuous(breaks = seq(0, max(cournotdata$output
```

```
  theme_minimal())
```