Price Elasticity

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Contents

Introduction

In this study, we follow the ideas in a recent blog on price elasticity modeling. We will use R to build a regression model to estimate the price elasticity.

Data Analysis

Data Preparation

```
library(tidyverse)
library(gridExtra)
library(lubridate)
library(broom)
```

The data set of this analysis can be downloaded from here.

```
df <- read_csv("beef.csv")
df
```

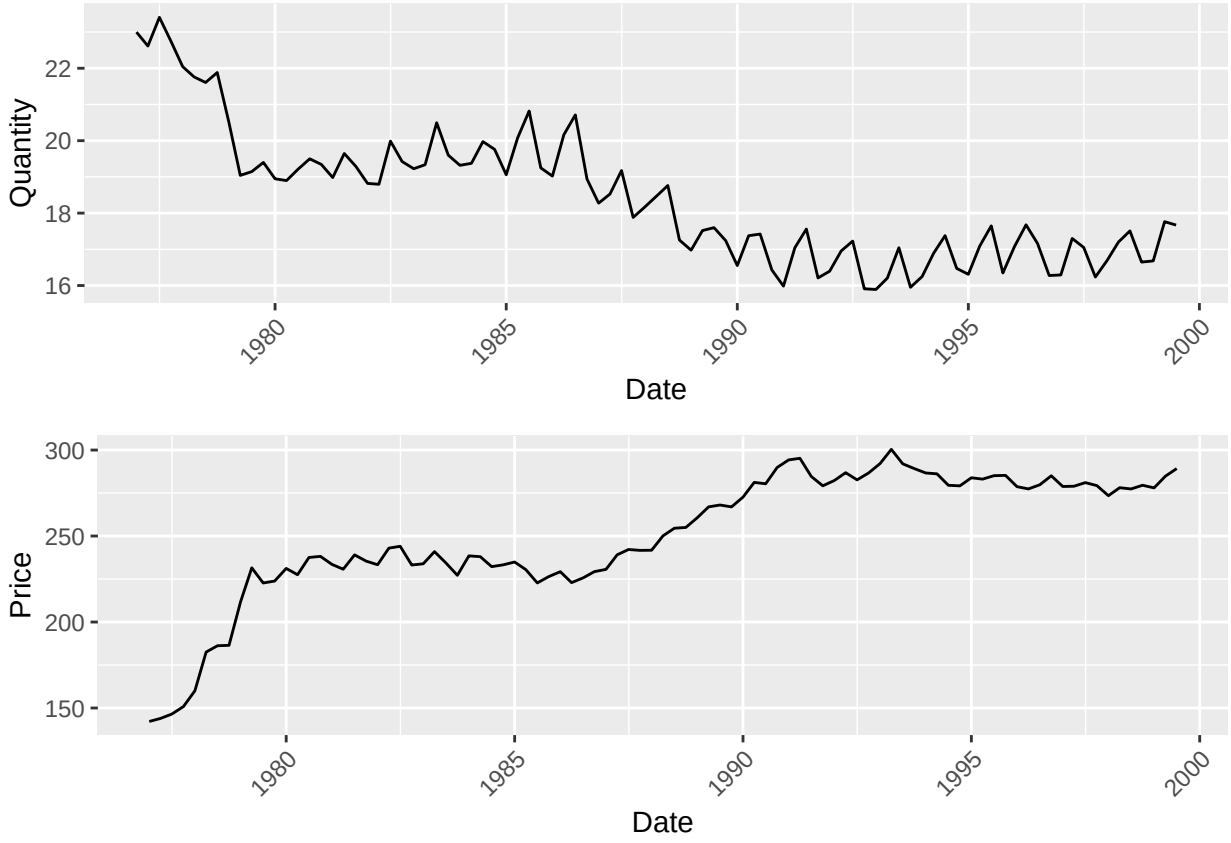
```
## # A tibble: 91 x 4
##     Year Quarter Quantity Price
##    <int>   <int>    <dbl> <dbl>
##  1  1977       1     23.0  142.
##  2  1977       2     22.6  144.
##  3  1977       3     23.4  146.
##  4  1977       4     22.7  151.
##  5  1978       1     22.0  160
##  6  1978       2     21.8  183.
##  7  1978       3     21.6  186.
##  8  1978       4     21.9  186.
##  9  1979       1     20.5  212.
## 10  1979       2     19.0  232.
## # ... with 81 more rows
```

The data set is the quarterly beef sale and price from 1Q1977 to 3Q1999. Therefore, let's visualize the trend.

```
df %>%
  mutate(date=make_date(Year, (Quarter-1)*3+1, 1)) %>%
  ggplot(aes(x=date, y=Quantity)) +
  geom_line() +
  labs(x="Date",y="Quantity") +
  theme(axis.text.x=element_text(angle=45,hjust=1)) -> p1

df %>%
  mutate(date=make_date(Year, (Quarter-1)*3+1, 1)) %>%
  ggplot(aes(x=date, y=Price)) +
  geom_line() +
  labs(x="Date",y="Price") +
  theme(axis.text.x=element_text(angle=45,hjust=1)) -> p2

grid.arrange(p1,p2,ncol=1)
```



We can see that the price and quantity do change in opposite directions. For example, quantity sharply decreased from 1977 to 1980 as price increased rapidly in the same time.

Analysis

Based on definition of economics, the elasticity is

$$elasticity = \frac{\partial \log(d)}{\partial \log(P)}$$

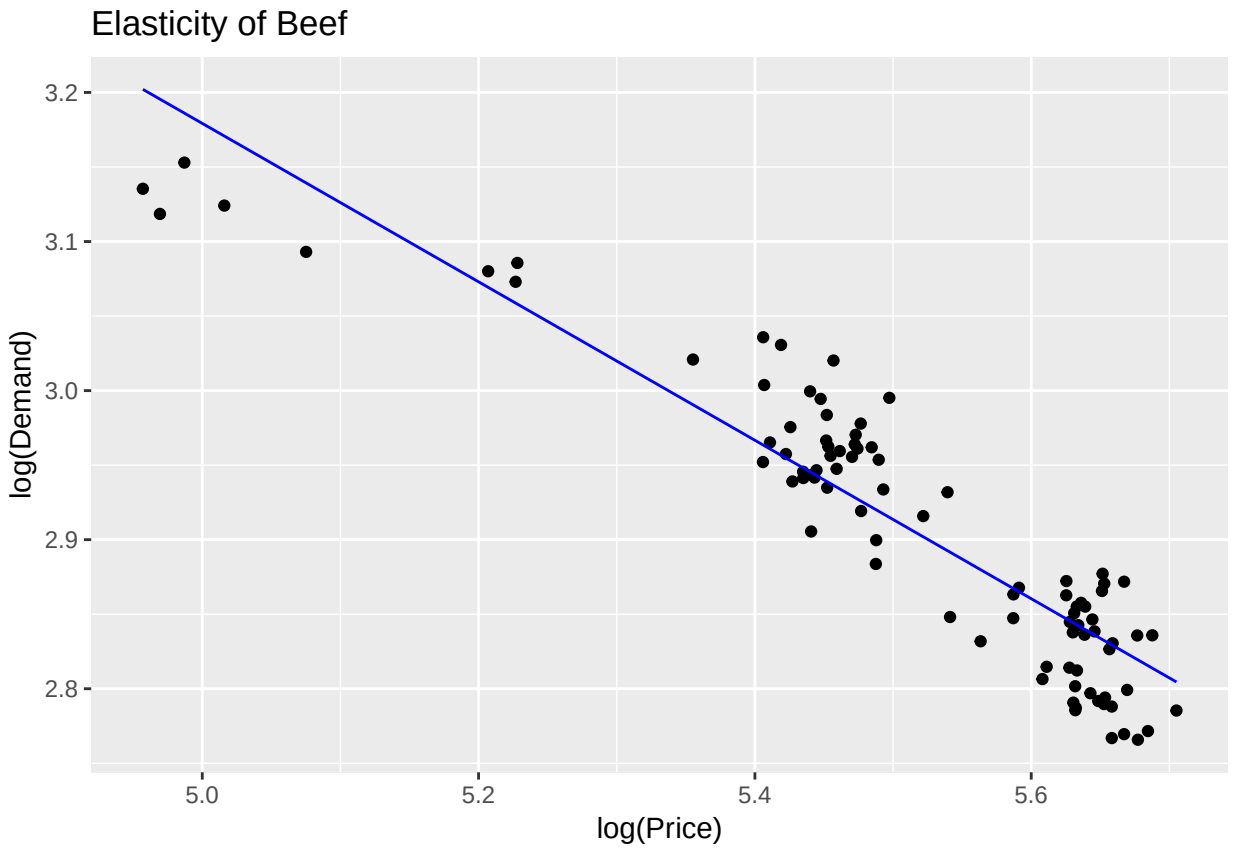
where d is the demand and P is the price. Therefore, we will produce a linear regression model on $\log(d)$ vs. $\log(P)$.

```
elast_lm <- lm(log(Quantity) ~ log(Price), data=df)
summary(elast_lm)
```

```
##
## Call:
## lm(formula = log(Quantity) ~ log(Price), data = df)
##
## Residuals:
##       Min        1Q    Median        3Q       Max
## -0.077011 -0.034805  0.002406  0.025817  0.083739
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept)  5.83637    0.12941   45.10   <2e-16 ***
## log(Price)  -0.53142    0.02347  -22.64   <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.0371 on 89 degrees of freedom
## Multiple R-squared:  0.8521, Adjusted R-squared:  0.8504
## F-statistic: 512.6 on 1 and 89 DF,  p-value: < 2.2e-16
```

```
elast_val <- unlist(tidy(elast_lm)["2","estimate"])

elast_lm %>% augment() %>%
  ggplot(aes(x=log.Price.)) +
  geom_point(aes(y=log.Quantity.), color="black") +
  geom_line(aes(y=.fitted), color="blue") +
  labs(x="log(Price)", y="log(Demand)") +
  guides(color=guide_legend(title="Key")) +
  ggtitle("Elasticity of Beef")
```

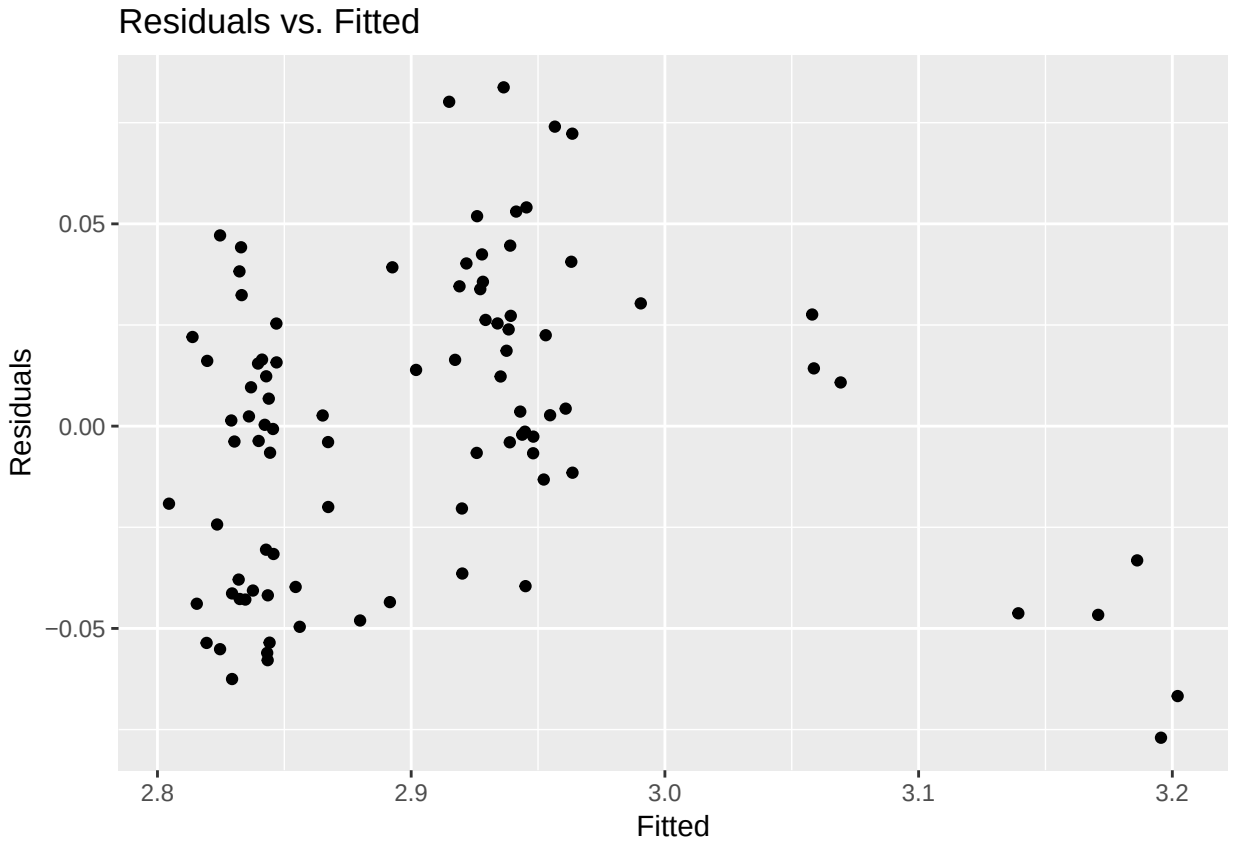



```
paste("Elasticity = ", round(elast_val, digits=3))
```

```
## [1] "Elasticity =  -0.531"
```

The regression model return very good R^2 and the elasticity is -0.531. Let's also review the residual graph to ensure the quality.

```
elast_lm %>% augment() %>%
  ggplot(aes(x=.fitted, y=.resid)) +
  geom_point() +
  labs(x="Fitted", y="Residuals") +
  ggtitle("Residuals vs. Fitted")
```



Overall, the points seem to distribute randomally, although there is clearly some inbalance between fitted value below and above 3.

Conclusions

Overall, the beef's demand is fairly inelastic with regard to price as demand decreases more slowly than price. This could be that beef is a major source of protein intake for the region and it is relatively difficult to substitute it with another food.