EDS241: Assignment 4

Charles Hendrickson

03/10/2022

1 Data

```r
# Load the data
EU_sardines_data <- data.frame(read.csv("EU_sardines.csv"))
```

```r
# Take the log of volume_sold and price_euro_kg and create new columns for them
EU_sardines_data <- EU_sardines_data %>%
  mutate(log_volume_sold_kg = log(volume_sold_kg)) %>%
  mutate(log_price_euro_kg = log(price_euro_kg))
```

2 Question (a)

(a) Estimate a bivariate regression of log(volume_sold_kg) on log(price euro_kg). What is the price elasticity of demand for sardines? Test the null hypothesis that the price elasticity is equal to -1.

The price elasticity of demand for sardines is -1.545

We reject the null hypothesis that the price elasticity is equal to -1 because our linear hypothesis test tells us that the p-value is less than 0.001 and is statistically significant.

```r
# Bivariate regression of log(volume_sold_kg) on log(price euro_kg)
model_1 <- lm_robust(log_volume_sold_kg ~ log_price_euro_kg, data = EU_sardines_data)

# Get summary of the model
summary(model_1)
```

```
##
## Call:
## lm_robust(formula = log_volume_sold_kg ~ log_price_euro_kg, data = EU_sardines_data)
##
## Standard error type:  HC2
##
## Coefficients:
##                   Estimate Std. Error t value  Pr(>|t|) CI Lower CI Upper   DF
## (Intercept)          7.759    0.04302  180.34 0.000e+00    7.675    7.843 3986
## log_price_euro_kg   -1.545    0.07813  -19.78 3.805e-83   -1.699   -1.392 3986
##
## Multiple R-squared:  0.1044 ,    Adjusted R-squared:  0.1042
## F-statistic: 391.3 on 1 and 3986 DF,  p-value: < 2.2e-16
```

```r
# Linear hypothesis test
linearHypothesis(model_1, c("log_price_euro_kg = -1"), white.adjust = "hc2")
```

```
## Linear hypothesis test
```

```
##
## Hypothesis:
## log_price_euro_kg = - 1
##
## Model 1: restricted model
## Model 2: log_volume_sold_kg ~ log_price_euro_kg
##
##   Res.Df Df  Chisq        Pr(>Chisq)
## 1   3987
## 2   3986  1 48.724 0.000000000002946 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

3 Question (b)

(b) Like in Lecture 8 (see the IV.R script), we will use wind_m_s as an instrument for log(price_euro_kg). To begin, estimate the first-stage regression relating log(price_euro_kg) to wind_m_s. Interpret the estimated coefficient on wind speed. Does it have the expected sign? Also test for the relevance of the instrument and whether it is a "weak" instrument by reporting the proper F-statistic.

The estimated coefficient on wind speed is 0.06735. This means that for every additional meter per second increase in wind speed, there is a 0.06735 percent increase in the log price of sardines. It does have the expected sign (positive) because increased wind speeds would make fishing effort more difficult, thus there should be a positive increase in the log price of sardines.

The F-statistic is 144.65, which means the wind_m_s instrument is relevant and non-weak (Lecture 9, slide 14).

```r
# Regress log(price_euro_kg) on wind_m_s
model_2 <- lm_robust(log_price_euro_kg ~ wind_m_s, data = EU_sardines_data)

# Get summary table of the regression coefficients
summary(model_2)
```

```
##
## Call:
## lm_robust(formula = log_price_euro_kg ~ wind_m_s, data = EU_sardines_data)
##
## Standard error type:  HC2
##
## Coefficients:
##             Estimate Std. Error t value  Pr(>|t|) CI Lower CI Upper   DF
## (Intercept) -0.30489   0.027309  -11.16 1.609e-28 -0.35843 -0.25135 3986
## wind_m_s     0.06735   0.005599   12.03 9.379e-33  0.05637  0.07832 3986
##
## Multiple R-squared:  0.0379 ,    Adjusted R-squared:  0.03766
## F-statistic: 144.7 on 1 and 3986 DF,  p-value: < 2.2e-16
```

```r
# F-test for non-weak and relevant instruments
linearHypothesis(model_2, c("wind_m_s = 0"), white.adjust = "hc2")
```

```
## Linear hypothesis test
##
## Hypothesis:
## wind_m_s = 0
##
```

```
## Model 1: restricted model
## Model 2: log_price_euro_kg ~ wind_m_s
##
##   Res.Df Df  Chisq Pr(>Chisq)
## 1   3987
## 2   3986  1 144.65  < 2.2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

4 Question (c)

(c) Estimate the TSLS estimator of the price elasticity of demand for sardines using wind_m_s as an instrument for log(price_euro_kg). What is the estimated price elasticity of demand for sardines?

The two stage least squares (TSLS) regression of the price elasticity of demand for sardines using wind_m_s as an instrument for log(price_euro_kg) shows us that -1.08802 is the estimated price elasticity of demand for sardines.

```r
# Two stage least squares regression
tsls1 <- ivreg(log_volume_sold_kg ~ log_price_euro_kg | wind_m_s, data = EU_sardines_data)

# Summary of TSLS
summary(tsls1)
```

```
##
## Call:
## ivreg(formula = log_volume_sold_kg ~ log_price_euro_kg | wind_m_s,
##     data = EU_sardines_data)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -8.8626 -1.9790 -0.2333  2.0950  6.2354
##
## Coefficients:
##                   Estimate Std. Error t value Pr(>|t|)
## (Intercept)        7.75534    0.04331  179.08   <2e-16 ***
## log_price_euro_kg -1.08802    0.37003   -2.94   0.0033 **
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 2.728 on 3986 degrees of freedom
## Multiple R-Squared: 0.09529, Adjusted R-squared: 0.09506
## Wald test: 8.646 on 1 and 3986 DF,  p-value: 0.003297
```

5 Question (d)

(d) Repeat the exercise in (c), but include fixed effects for each year, month, and country. [Hint: you can use the command "as.factor(country) + as.factor(year) +as.factor(month)" to the ivreg function in R]. Report the estimated price elasticity of demand and the F-statistic testing for relevant and non-weak instruments.

The estimated price elasticity of demand for sardines with fixed effects for each year, month, and country is -1.25004

```r
# Completes two stage least regression with fixed effects for each year, month, and country
tsls2 <- ivreg(log_volume_sold_kg ~ log_price_euro_kg +
               as.factor(country) + as.factor(year) + as.factor(month) |
               wind_m_s + as.factor(country) + as.factor(year) + as.factor(month),
               data = EU_sardines_data)

# Get summary table of TSLS
summary(tsls2)
```

```
##
## Call:
## ivreg(formula = log_volume_sold_kg ~ log_price_euro_kg + as.factor(country) +
##     as.factor(year) + as.factor(month) | wind_m_s + as.factor(country) +
##     as.factor(year) + as.factor(month), data = EU_sardines_data)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -9.2940 -1.8317 -0.1353  1.9969  6.2894
##
## Coefficients:
##                                  Estimate Std. Error t value        Pr(>|t|)
## (Intercept)                       7.33742    0.20781  35.309         < 2e-16
## log_price_euro_kg                -1.25004    0.46393  -2.694         0.00708
## as.factor(country)Italy          -0.68925    0.12970  -5.314 0.0000001129314
## as.factor(country)Portugal        1.71563    0.34614   4.957 0.0000007476568
## as.factor(country)United Kingdom -0.07422    0.31428  -0.236         0.81332
## as.factor(year)2014               0.14610    0.15281   0.956         0.33909
## as.factor(year)2015               0.18487    0.15221   1.215         0.22461
## as.factor(year)2016               0.21335    0.15320   1.393         0.16382
## as.factor(year)2017               0.07400    0.15224   0.486         0.62692
## as.factor(year)2018              -0.09137    0.15508  -0.589         0.55580
## as.factor(year)2019               0.03602    0.19688   0.183         0.85483
## as.factor(month)2                 0.06866    0.20972   0.327         0.74339
## as.factor(month)3                 0.51583    0.20489   2.518         0.01185
## as.factor(month)4                 0.91433    0.20297   4.505 0.0000068372477
## as.factor(month)5                 1.14887    0.20370   5.640 0.0000000181902
## as.factor(month)6                 1.14474    0.20164   5.677 0.0000000146801
## as.factor(month)7                 1.40047    0.21047   6.654 0.0000000000324
## as.factor(month)8                 1.26382    0.21692   5.826 0.0000000061221
## as.factor(month)9                 1.31072    0.21298   6.154 0.0000000008287
## as.factor(month)10                0.72059    0.22958   3.139         0.00171
## as.factor(month)11                0.48128    0.22575   2.132         0.03308
## as.factor(month)12                0.06683    0.21920   0.305         0.76049
##
## (Intercept)                      ***
## log_price_euro_kg                **
## as.factor(country)Italy          ***
## as.factor(country)Portugal       ***
## as.factor(country)United Kingdom
## as.factor(year)2014
## as.factor(year)2015
## as.factor(year)2016
## as.factor(year)2017
## as.factor(year)2018
```

```
## as.factor(year)2019
## as.factor(month)2
## as.factor(month)3                *
## as.factor(month)4                ***
## as.factor(month)5                ***
## as.factor(month)6                ***
## as.factor(month)7                ***
## as.factor(month)8                ***
## as.factor(month)9                ***
## as.factor(month)10               **
## as.factor(month)11               *
## as.factor(month)12
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 2.648 on 3966 degrees of freedom
## Multiple R-Squared: 0.1522,  Adjusted R-squared: 0.1477
## Wald test: 9.963 on 21 and 3966 DF,  p-value: < 2.2e-16
```

The F-statistic is 77.658, which means the instruments are relevant and non-weak (Lecture 9, slide 14).

```r
# Can't get the f-statistic from ivreg
model_3 <- lm_robust(log_price_euro_kg ~ wind_m_s + as.factor(country) + as.factor(year) + as.factor(mon

# F-test for non-weak and relevant instruments (Lecture 9, slides 13-14)
linear_hypoth_model_3 <- linearHypothesis(model_3, c("wind_m_s = 0"), white.adjust = "hc2")

linear_hypoth_model_3
```

```
## Linear hypothesis test
##
## Hypothesis:
## wind_m_s = 0
##
## Model 1: restricted model
## Model 2: log_price_euro_kg ~ wind_m_s + as.factor(country) + as.factor(year) +
##     as.factor(month)
##
##   Res.Df Df  Chisq Pr(>Chisq)
## 1   3967
## 2   3966  1 77.658  < 2.2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```