EDS241: Assignment 04 - Price Elasticity

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```
# load packages
packages = c("stargazer",
             "here",
             "tidyverse",
             "stringr",
             "janitor",
             "cowplot",
             "tinytex",
             "datasets",
             "tibble",
             "rio",
             "car",
             "readxl",
             "estimatr",
             "patchwork",
             "kableExtra",
             "huxtable",
             "lfe",
             "lmtest",
             "AER")

for (i in packages) {
  if (require(i,character.only=TRUE)==FALSE) {
    install.packages(i,repos='http://cran.us.r-project.org')
  }
  else {
    require(i,character.only=TRUE)
  }
}

options(scipen=999) # not scientific notation
```

1 EDS241 Environmental Policy Evaluation Assignment 04

This statistical analysis was completed as an assignment for the course, Environmental Data Science 241: Environmental Policy Evaluation.

We were tasked with estimating the price elasticity of demand for fresh sardines across 56 ports located in 4 European countries with monthly data from 2013 to 2019.

1.1 Data description

Each row in the data file is a combination of port location (where the fish is landed and sold) in a given year and month. The sample is not balanced due to the fact that the number of monthly observations varies across ports.

Variables include:

- `country`
- `port`: where the fish is landed and sold
- `year`
- `month`
- `price_euro_kg`: price per kg in Euros
- `volume_sold_kg`: quantity of sardines sold in kg
- `wind_m_s`

```r
# read in eu_sardines data
sardines <- read_csv(here("hw04/data/eu_sardines.csv"))

# clean the data
sardines_df <- sardines %>%
  clean_names() %>%
  mutate(year = as.factor(year),
         month = as.factor(month),
         price_euro_kg = as.numeric(price_euro_kg),
         volume_sold_kg = as.numeric(volume_sold_kg),
         wind_m_s = as.numeric(wind_m_s))
```

2 Homework Questions

2.1 Question 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.

```r
# transform variables to generate columns for log values
sardines_log <- sardines_df %>%
  mutate(log_volume_sold_kg = log(volume_sold_kg),
         log_price_euro_kg = log(price_euro_kg))
```

```r
# linear regression on log data
pe_mod01 <- lm_robust(log_volume_sold_kg ~ log_price_euro_kg, data = sardines_log)

summary(pe_mod01)
```

```
##
## Call:
## lm_robust(formula = log_volume_sold_kg ~ log_price_euro_kg, data = sardines_log)
##
## Standard error type:  HC2
##
## Coefficients:
##                   Estimate Std. Error t value
## (Intercept)          7.759    0.04302  180.34
## log_price_euro_kg   -1.545    0.07813  -19.78
##                                                                                                     Pr
## (Intercept)       0.0000000000000000000000000000000000000000000000000000000000000000000000000000000000
```

```
## log_price_euro_kg 0.00000000000000000000000000000000000000000000000000000000000000000000000000000000
##                   CI Lower CI Upper   DF
## (Intercept)          7.675    7.843 3986
## log_price_euro_kg   -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: < 0.00000000000000022
```

```r
elasticity <- round(pe_mod01$coefficients[[2]], 2)
```

```r
# pe_mod_table <- tidy(pe_mod01)
#
# pe_mod_table %>%
#   select(term, estimate, std.error, p.value, conf.low, conf.high) %>%
#   kable()
```

```r
pe_mod02 <- linearHypothesis(pe_mod01, c("log_price_euro_kg = -1"), white.adjust = "hc2")

pe_mod02
```

Res.Df	Df	Chisq	Pr(>Chisq)
3.99e+03			
3.99e+03	1	48.7	2.95e-12

2.1.1 Answers

The price elasticity of demand for sardines is estimated to be -1.55. With 95% confidence, the price elasticity coefficient is contained by the range -1.7 to -1.39. The null hypothesis that price elasticity is equal to -1 can be rejected as it is not within the coefficient range and when using the linear hypothesis testing, the p-value is statistically significant.

2.2 Question 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.

```r
# first stage regression
pw_mod01 <- lm(log_price_euro_kg ~ wind_m_s, data = sardines_log)

#summary(pw_mod01)

huxreg("log_price_euro_kg" = pw_mod01)
```

```r
# generate F-statistic
pw_mod02 <- linearHypothesis(pw_mod01, c("wind_m_s=0"), white.adjust = "hc2")

summary(pw_mod02)
```

```
##      Res.Df           Df          F              Pr(>F)
##  Min.   :3986   Min.   :1   Min.   :144.7   Min.   :0
##  1st Qu.:3986   1st Qu.:1   1st Qu.:144.7   1st Qu.:0
```

	log_price_euro_kg
(Intercept)	-0.305 ***
	(0.027)
wind_m_s	0.067 ***
	(0.005)
N	3988
R2	0.038
logLik	-3542.393
AIC	7090.785

*** p < 0.001; ** p < 0.01; * p < 0.05.

```
##  Median :3986   Median :1   Median :144.7   Median :0
##  Mean   :3986   Mean   :1   Mean   :144.7   Mean   :0
##  3rd Qu.:3987   3rd Qu.:1   3rd Qu.:144.7   3rd Qu.:0
##  Max.   :3987   Max.   :1   Max.   :144.7   Max.   :0
##                 NA's   :1   NA's   :1       NA's   :1
```

2.2.1 Answers

A. For every 1 meter per second increase in wind speed there is a 0.067 increase in the log price of fish. The positive correlation is expected as wind speed is not anticipated to influnce the demand for fish in markets, but increased wind speeds can reduce the number of fish that can be caught.

B. The F-statistic,144.65, is greater than 10, which indicates that wind speed is not a weak instrument.

2.3 Question 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?

```
tsls_mod01 <- ivreg(log_volume_sold_kg ~ log_price_euro_kg | wind_m_s, data = sardines_log)

summary(tsls_mod01)
```

```
##
## Call:
## ivreg(formula = log_volume_sold_kg ~ log_price_euro_kg | wind_m_s,
##     data = sardines_log)
##
## 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 <0.0000000000000002 ***
```

```
## 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
```

2.3.1 Answers

The estimated price elasticity of demand for sardines is -1.0880152.

2.4 Question D:

Repeat the exercise in (c), but include fixed effects for each year, month, and country. Report the estimated price elasticity of demand and the F-statistic testing for relevant and non-weak instruments.

```
# Fit instrumental-variable regression by two-stage least squares
tsls_mod02 <- ivreg(log_volume_sold_kg ~ log_price_euro_kg +
                  country + year + month |
                  wind_m_s + country + year + month, data = sardines_log)

# summary(tsls_mod02)

tsls_mod02_table <- huxreg(tsls_mod02)
```

```
restack_across(tsls_mod02_table, 21)
```

```
pw_mod03 <- lm_robust(log_price_euro_kg ~ wind_m_s +
                    country + year + month, data = sardines_log)

pw_mod03_f <- linearHypothesis(pw_mod03, c("wind_m_s = 0"),
                               white.adjust = "hc2")
#summary(pw_mod03_f)

huxtable(pw_mod03_f)
```

2.4.1 Answers

The estimated price elasticity for demand of sardines using wind (meter per sec) as an instrument for log_price, including fixed effects for each year, month, and country is -1.25. The F-statistic for the wind speed is 77.66.

	(1)		(1)		(1)
(Intercept)	7.337 ***	year2019	0.036	month11	0.481 *
	(0.208)		(0.197)		(0.226)
log_price_euro_kg	-1.250 **	month2	0.069	month12	0.067
	(0.464)		(0.210)		(0.219)
countryItaly	-0.689 ***	month3	0.516 *	N	3988
	(0.130)		(0.205)	R2	0.152
countryPortugal	1.716 ***	month4	0.914 ***	*** p < 0.001; ** p < 0.01; * p < 0.05.	
	(0.346)		(0.203)		
countryUnited Kingdom	-0.074	month5	1.149 ***		
	(0.314)		(0.204)		
year2014	0.146	month6	1.145 ***		
	(0.153)		(0.202)		
year2015	0.185	month7	1.400 ***		
	(0.152)		(0.210)		
year2016	0.213	month8	1.264 ***		
	(0.153)		(0.217)		
year2017	0.074	month9	1.311 ***		
	(0.152)		(0.213)		
year2018	-0.091	month10	0.721 **		
	(0.155)		(0.230)		

Res.Df	Df	Chisq	Pr(>Chisq)
3.97e+03			
3.97e+03	1	77.7	1.23e-18