

# Differentiated demand, logit exercise

## 1 Import & clean data, produce descriptive statistics

### Import data

First, import the data into a data frame, called 'cameras\_raw', and use the 'dim', 'str' and 'head' functions to describe the dataset:

```
library(haven)
cameras_raw <- read_dta("differentiated.dta")
```

### create population variable

Next, create the population variable, and save a new dataframe, 'cameras':

```
##
## Attaching package: 'dplyr'

## The following objects are masked from 'package:stats':
##
##   filter, lag

## The following objects are masked from 'package:base':
##
##   intersect, setdiff, setequal, union
```

### Tabulating sales by brand and country

```
library(flextable)
```

```
## Warning: package 'flextable' was built under R version 4.1.3
```

```
cameras %>%
  group_by(Country) %>%
  summarise(Sales = sum(salesunits),
            "Average price" = mean(priceur)) %>%
  ungroup() %>%
  flextable()
```

```
## Warning: Warning: fonts used in `flextable` are ignored because the `pdflatex`
## engine is used and not `xelatex` or `lualatex`. You can avoid this warning
## by using the `set_flextable_defaults(fonts_ignore=TRUE)` command or use a
## compatible engine by defining `latex_engine: xelatex` in the YAML header of the
## R Markdown document.
```

Country	Sales	Average price
AUSTRIA	1,101,194	209.6870
BELGIUM	1,223,913	202.6413

Country	Sales	Average price
BULGARIA	417,846	197.2080
CZECH REPUBLIC	875,386	212.2629
DENMARK	209,555	219.3733
FINLAND	693,962	199.9442
FRANCE	6,759,932	189.4914
GERMANY	8,858,038	196.0870
GREAT BRITAIN	4,895,820	200.5453
GREECE	746,282	221.1610
HUNGARY	633,865	185.4585
IRELAND	339,530	221.5719
ITALY	5,433,166	201.8071
NETHERLANDS	2,971,100	193.8815
POLAND	2,819,531	191.9818
PORTUGAL	777,945	198.2813
ROMANIA	511,348	178.8839
SLOVAKIA	269,521	212.5301
SLOVENIA	139,104	216.8658
SPAIN	4,355,039	183.6925
SWEDEN	1,175,259	210.6018

```
cameras %>%
  group_by(Brand) %>%
  summarise("Sales" = sum(salesunits),
            "Average price" = mean(priceur)) %>%
  ungroup() %>%
  flextable()
```

```
## Warning: Warning: fonts used in `flextable` are ignored because the `pdflatex`
## engine is used and not `xelatex` or `lualatex`. You can avoid this warning
## by using the `set_flextable_defaults(fonts_ignore=TRUE)` command or use a
## compatible engine by defining `latex_engine: xelatex` in the YAML header of the
## R Markdown document.
```

Brand	Sales	Average price
CANON	8,490,789	237.5031
FUJIFILM	3,716,289	173.1475

Brand	Sales	Average price
KODAK	3,336,791	140.7080
NIKON	6,057,270	210.7910
OLYMPUS	4,503,724	209.2909
PANASONIC	6,318,556	234.0199
SAMSUNG	4,456,985	150.2476
SONY	7,626,932	223.4952

```
cameras %>%
  group_by(Brand, Country) %>%
  summarise("Sales" = sum(salesunits),
            "Average price" = mean(priceur)) %>%
  ungroup() %>%
  flextable()
```

## `summarise()` has grouped output by 'Brand'. You can override using the  
## `.groups` argument.

## Warning: Warning: fonts used in `flextable` are ignored because the `pdflatex`  
## engine is used and not `xelatex` or `lualatex`. You can avoid this warning  
## by using the `set\_flextable\_defaults(fonts\_ignore=TRUE)` command or use a  
## compatible engine by defining `latex\_engine: xelatex` in the YAML header of the  
## R Markdown document.

Brand	Country	Sales	Average price
CANON	AUSTRIA	211,220	231.1914
CANON	BELGIUM	249,613	229.6580
CANON	BULGARIA	79,667	266.4482
CANON	CZECH REPUBLIC	127,995	255.3067
CANON	DENMARK	67,506	240.7552
CANON	FINLAND	297,403	231.7409
CANON	FRANCE	775,721	222.6589
CANON	GERMANY	2,329,072	238.6050
CANON	GREAT BRITAIN	994,524	233.3832
CANON	GREECE	93,557	261.3203
CANON	HUNGARY	58,991	240.1400
CANON	IRELAND	78,408	235.6451
CANON	ITALY	919,883	236.9684

Brand	Country	Sales	Average price
CANON	NETHERLANDS	\$23,041	221.4279
CANON	POLAND	482,233	235.5589
CANON	PORTUGAL	109,540	225.7256
CANON	ROMANIA	87,883	220.8295
CANON	SLOVAKIA	25,346	260.8822
CANON	SLOVENIA	36,121	240.9965
CANON	SPAIN	648,059	218.9744
CANON	SWEDEN	295,006	254.3579
FUJIFILM	AUSTRIA	13,875	184.0456
FUJIFILM	BELGIUM	39,599	163.5199
FUJIFILM	BULGARIA	5,946	135.4585
FUJIFILM	CZECH REPUBLIC	27,557	191.1430
FUJIFILM	DENMARK	4,270	192.3585
FUJIFILM	FINLAND	3,971	187.9040
FUJIFILM	FRANCE	662,865	164.4882
FUJIFILM	GERMANY	539,425	166.7971
FUJIFILM	GREAT BRITAIN	949,033	154.7094
FUJIFILM	GREECE	7,758	201.7238
FUJIFILM	HUNGARY	120,757	165.8724
FUJIFILM	IRELAND	94,984	170.1092
FUJIFILM	ITALY	363,234	177.5493
FUJIFILM	NETHERLANDS	\$14,682	167.0045
FUJIFILM	POLAND	132,737	166.4487
FUJIFILM	PORTUGAL	74,442	166.0316
FUJIFILM	ROMANIA	66,318	148.4643
FUJIFILM	SLOVAKIA	11,535	209.6302
FUJIFILM	SLOVENIA	3,400	214.8366
FUJIFILM	SPAIN	415,440	143.8975
FUJIFILM	SWEDEN	64,461	184.8196
KODAK	AUSTRIA	89,431	135.5998
KODAK	BELGIUM	91,685	152.0717
KODAK	BULGARIA	13,252	135.7844

Brand	Country	Sales	Average price
KODAK	CZECH REPUBLIC	40,863	172.1085
KODAK	DENMARK	3,312	151.7840
KODAK	FINLAND	4,509	129.7855
KODAK	FRANCE	561,956	124.4658
KODAK	GERMANY	821,198	135.0296
KODAK	GREAT BRITAIN	302,808	106.3479
KODAK	GREECE	100,507	152.8551
KODAK	HUNGARY	28,122	130.2150
KODAK	IRELAND	34,095	172.2894
KODAK	ITALY	505,977	145.5662
KODAK	NETHERLANDS	84,925	135.9732
KODAK	POLAND	171,756	149.6712
KODAK	PORTUGAL	28,102	130.2086
KODAK	ROMANIA	13,406	121.1608
KODAK	SLOVAKIA	5,436	138.6715
KODAK	SLOVENIA	2,395	125.3422
KODAK	SPAIN	398,560	137.3284
KODAK	SWEDEN	34,496	137.4772
NIKON	AUSTRIA	218,161	202.5136
NIKON	BELGIUM	179,047	211.8690
NIKON	BULGARIA	37,909	190.3969
NIKON	CZECH REPUBLIC	96,625	224.0427
NIKON	DENMARK	23,361	222.5201
NIKON	FINLAND	94,508	201.4803
NIKON	FRANCE	1,055,875	201.0088
NIKON	GERMANY	766,403	211.9318
NIKON	GREAT BRITAIN	507,826	222.4430
NIKON	GREECE	107,828	239.4054
NIKON	HUNGARY	50,886	216.2224
NIKON	IRELAND	28,405	274.7472

Brand	Country	Sales	Average price
NIKON	ITALY	1,187,411	218.7502
NIKON	NETHERLANDS	183,694	206.9077
NIKON	POLAND	380,903	197.6195
NIKON	PORTUGAL	99,792	203.0006
NIKON	ROMANIA	40,518	214.9043
NIKON	SLOVAKIA	18,938	224.4866
NIKON	SLOVENIA	28,693	205.4579
NIKON	SPAIN	701,472	182.6330
NIKON	SWEDEN	249,015	215.1701
OLYMPUS	AUSTRIA	165,933	218.7932
OLYMPUS	BELGIUM	52,347	216.1536
OLYMPUS	BULGARIA	73,196	207.7792
OLYMPUS	CZECH REPUBLIC	242,661	215.0414
OLYMPUS	DENMARK	28,123	233.6691
OLYMPUS	FINLAND	139,312	200.5418
OLYMPUS	FRANCE	451,909	195.4279
OLYMPUS	GERMANY	532,639	201.4663
OLYMPUS	GREAT BRITAIN	293,499	206.9754
OLYMPUS	GREECE	160,644	239.7304
OLYMPUS	HUNGARY	77,231	183.4573
OLYMPUS	IRELAND	18,375	230.7006
OLYMPUS	ITALY	384,774	202.8236
OLYMPUS	NETHERLANDS	136,031	203.3057
OLYMPUS	POLAND	333,470	198.7953
OLYMPUS	PORTUGAL	111,006	211.7248
OLYMPUS	ROMANIA	37,792	177.6404
OLYMPUS	SLOVAKIA	99,163	213.3580
OLYMPUS	SLOVENIA	26,015	237.6391
OLYMPUS	SPAIN	882,100	192.5415
OLYMPUS	SWEDEN	157,504	221.2374
PANASONIC	AUSTRIA	125,437	263.7892
PANASONIC	BELGIUM	221,083	237.9450

Brand	Country	Sales	Average price
PANASONIC	BULGARIA	33,972	211.7955
PANASONIC	CZECH REPUBLIC	180,726	230.0310
PANASONIC	DENMARK	9,165	251.8852
PANASONIC	FINLAND	37,487	228.2088
PANASONIC	FRANCE	1,429,660	240.5862
PANASONIC	GERMANY	1,631,134	237.1616
PANASONIC	GREAT BRITAIN	636,175	233.2259
PANASONIC	GREECE	37,950	236.5457
PANASONIC	HUNGARY	120,990	210.8702
PANASONIC	IRELAND	19,814	239.8613
PANASONIC	ITALY	526,637	243.4110
PANASONIC	NETHERLANDS	289,290	244.1546
PANASONIC	POLAND	399,663	214.1940
PANASONIC	PORTUGAL	39,622	226.8622
PANASONIC	ROMANIA	95,557	177.7384
PANASONIC	SLOVAKIA	42,529	246.1175
PANASONIC	SLOVENIA	3,305	259.7814
PANASONIC	SPAIN	341,054	216.8700
PANASONIC	SWEDEN	97,306	257.6717
SAMSUNG	AUSTRIA	57,168	148.8931
SAMSUNG	BELGIUM	116,965	151.7087
SAMSUNG	BULGARIA	83,398	136.9069
SAMSUNG	CZECH REPUBLIC	78,974	161.3491
SAMSUNG	DENMARK	19,138	163.8280
SAMSUNG	FINLAND	58,946	148.1406
SAMSUNG	FRANCE	649,151	144.2941
SAMSUNG	GERMANY	1,014,235	147.8974
SAMSUNG	GREAT BRITAIN	284,969	161.1665
SAMSUNG	GREECE	26,443	156.2837
SAMSUNG	HUNGARY	103,279	139.9744

Brand	Country	Sales	Average price
SAMSUNG	IRELAND	14,589	172.2848
SAMSUNG	ITALY	814,707	149.7212
SAMSUNG	NETHERLANDS	11,986	138.4327
SAMSUNG	POLAND	281,558	155.5146
SAMSUNG	PORTUGAL	108,661	158.9786
SAMSUNG	ROMANIA	46,997	124.5697
SAMSUNG	SLOVAKIA	29,183	160.0487
SAMSUNG	SLOVENIA	8,486	161.4359
SAMSUNG	SPAIN	211,233	146.6340
SAMSUNG	SWEDEN	136,919	160.8835
SONY	AUSTRIA	219,969	253.0449
SONY	BELGIUM	273,574	225.1449
SONY	BULGARIA	90,506	227.9362
SONY	CZECH REPUBLIC	79,985	242.0845
SONY	DENMARK	54,680	243.8224
SONY	FINLAND	57,826	208.9328
SONY	FRANCE	1,172,795	214.6412
SONY	GERMANY	1,223,932	224.3878
SONY	GREAT BRITAIN	926,986	215.6697
SONY	GREECE	211,595	235.1503
SONY	HUNGARY	73,609	201.4761
SONY	IRELAND	50,860	242.4478
SONY	ITALY	730,543	229.9932
SONY	NETHERLANDS	27,451	213.5029
SONY	POLAND	637,211	210.3651
SONY	PORTUGAL	206,780	233.3311
SONY	ROMANIA	122,877	204.0890
SONY	SLOVAKIA	37,391	227.7275
SONY	SLOVENIA	30,689	225.0618
SONY	SPAIN	757,121	209.2638
SONY	SWEDEN	140,552	223.8042



## Create country dummies

```
## Warning: package 'sjmisc' was built under R version 4.1.3
## Learn more about sjmisc with 'browseVignettes("sjmisc")'.
```

## Create logs of prices and quantities

Basic plot of tea price against time:

## Hedonic price regression

```
modell1_data <- cameras %>%
  select(lsalesunits, lpriceur, Country_BELGIUM, Country_BULGARIA, `Country_CZECH REPUBLIC`, Country_DENMARK,
        `Country_GREAT BRITAIN`, `Country_GREECE`, Country_HUNGARY, Country_IRELAND, Country_ITALY,
        Country_ROMANIA, Country_SLOVAKIA, Country_SLOVENIA, Country_SPAIN, Country_SWEDEN, type)

colnames(cameras)

## [1] "Country_AUSTRIA"      "Country_BELGIUM"      "Country_BULGARIA"
## [4] "Country_CZECH REPUBLIC" "Country_DENMARK"      "Country_FINLAND"
## [7] "Country_FRANCE"       "Country_GERMANY"      "Country_GREAT BRITAIN"
## [10] "Country_GREECE"       "Country_HUNGARY"      "Country_IRELAND"
## [13] "Country_ITALY"        "Country_NETHERLANDS"  "Country_POLAND"
## [16] "Country_PORTUGAL"     "Country_ROMANIA"      "Country_SLOVAKIA"
## [19] "Country_SLOVENIA"     "Country_SPAIN"        "Country_SWEDEN"
## [22] "category"            "period"               "Brand"
## [25] "model"               "salesunits"           "Country"
## [28] "priceur"             "type"                 "slr"
## [31] "elect"               "optical"              "pixeltot"
## [34] "population"          "lpriceur"             "lsalesunits"

hedonic1 <- lm(lpriceur ~ . -lsalesunits -type -slr -elect -optical -pixeltot, data = modell1_data)
summary(hedonic1)

##
## Call:
## lm(formula = lpriceur ~ . - lsalesunits - type - slr - elect -
##     optical - pixeltot, data = modell1_data)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -1.21923 -0.35417 -0.02418  0.34768  1.28651
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)      5.22250     0.02400  217.580 < 2e-16 ***
## Country_BELGIUM   -0.02439     0.03276   -0.745  0.456466
## Country_BULGARIA  -0.06126     0.03628  -1.688  0.091373 .
## `Country_CZECH REPUBLIC`  0.02218     0.03294    0.673  0.500675
## Country_DENMARK    0.05311     0.03443    1.542  0.123044
## Country_FINLAND   -0.03648     0.03384   -1.078  0.281002
## Country_FRANCE    -0.08747     0.03218   -2.718  0.006576 **
## Country_GERMANY    -0.05733     0.03292   -1.741  0.081679 .
## `Country_GREAT BRITAIN` -0.04601     0.04399   -1.046  0.295616
## Country_GREECE     0.07023     0.03315    2.119  0.034144 *
```

```

## Country_HUNGARY      -0.11254    0.03331   -3.378 0.000732 ***
## Country_IRELAND      0.08145    0.05351    1.522 0.128004
## Country_ITALY        -0.03743    0.03174   -1.179 0.238269
## Country_NETHERLANDS -0.07019    0.03264   -2.150 0.031572 *
## Country_POLAND       -0.07237    0.03249   -2.228 0.025938 *
## Country_PORTUGAL     -0.06228    0.03317   -1.878 0.060423 .
## Country_ROMANIA      -0.16070    0.03549   -4.528 6.04e-06 ***
## Country_SLOVAKIA     0.02713    0.03432    0.791 0.429166
## Country_SLOVENIA     0.04345    0.03516    1.236 0.216545
## Country_SPAIN        -0.14775    0.03145   -4.697 2.68e-06 ***
## Country_SWEDEN       0.02123    0.03370    0.630 0.528696
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.4807 on 8475 degrees of freedom
## Multiple R-squared:  0.01737,    Adjusted R-squared:  0.01505
## F-statistic: 7.489 on 20 and 8475 DF,  p-value: < 2.2e-16

hedonic2 <- lm(lsalesunits ~ . -type -slr -elect -optical -pixeltot, data = modell_data)
summary(hedonic2)

##
## Call:
## lm(formula = lsalesunits ~ . - type - slr - elect - optical -
##     pixeltot, data = modell_data)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -4.9836 -1.8157 -0.0275  1.6824  6.0035
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)      6.15539    0.27401   22.464 < 2e-16 ***
## lpriceur          0.00658    0.04832    0.136 0.891692
## Country_BELGIUM   -0.25998    0.14572   -1.784 0.074434 .
## Country_BULGARIA  -0.77148    0.16144   -4.779 1.79e-06 ***
## `Country_CZECH REPUBLIC` -0.42186    0.14653   -2.879 0.004000 **
## Country_DENMARK   -2.00453    0.15320  -13.085 < 2e-16 ***
## Country_FINLAND   -1.03402    0.15054   -6.869 6.94e-12 ***
## Country_FRANCE     1.54916    0.14320   10.818 < 2e-16 ***
## Country_GERMANY    1.92471    0.14648   13.140 < 2e-16 ***
## `Country_GREAT BRITAIN` 3.02044    0.19570   15.434 < 2e-16 ***
## Country_GREECE     -0.74387    0.14749   -5.043 4.67e-07 ***
## Country_HUNGARY    -0.92711    0.14828   -6.252 4.24e-10 ***
## Country_IRELAND    0.58313    0.23807    2.449 0.014332 *
## Country_ITALY      1.12454    0.14118    7.965 1.86e-15 ***
## Country_NETHERLANDS 0.32715    0.14525    2.252 0.024325 *
## Country_POLAND     0.50558    0.14456    3.497 0.000472 ***
## Country_PORTUGAL   -0.75135    0.14757   -5.092 3.63e-07 ***
## Country_ROMANIA    -0.83468    0.15807   -5.280 1.32e-07 ***
## Country_SLOVAKIA   -1.36862    0.15267   -8.965 < 2e-16 ***
## Country_SLOVENIA   -2.08285    0.15642  -13.316 < 2e-16 ***
## Country_SPAIN       0.79328    0.14011    5.662 1.54e-08 ***
## Country_SWEDEN     -0.19683    0.14990   -1.313 0.189202
## ---

```

```
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 2.138 on 8474 degrees of freedom
## Multiple R-squared:  0.2246, Adjusted R-squared:  0.2227
## F-statistic: 116.9 on 21 and 8474 DF,  p-value: < 2.2e-16
hedonic3 <- lm(lpriceur ~ . -lsalesunits, data = modell_data)
summary(hedonic3)

##
## Call:
## lm(formula = lpriceur ~ . - lsalesunits, data = modell_data)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -1.15443 -0.25838 -0.01506  0.23035  1.68187
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)      4.4021427   0.0332443  132.418 < 2e-16 ***
## Country_BELGIUM      0.0227963   0.0250412   0.910  0.36266
## Country_BULGARIA     -0.0251796   0.0277451  -0.908  0.36415
## `Country_CZECH REPUBLIC` 0.0774824   0.0251879   3.076  0.00210 **
## Country_DENMARK      0.0759773   0.0263166   2.887  0.00390 **
## Country_FINLAND      0.0005723   0.0258654   0.022  0.98235
## Country_FRANCE       -0.0393490   0.0246013  -1.599  0.10975
## Country_GERMANY       -0.0518728   0.0251576  -2.062  0.03925 *
## `Country_GREAT BRITAIN` -0.1644535   0.0336592  -4.886 1.05e-06 ***
## Country_GREECE       0.1329802   0.0253540   5.245 1.60e-07 ***
## Country_HUNGARY      -0.0920925   0.0254594  -3.617  0.00030 ***
## Country_IRELAND      0.0158458   0.0409050   0.387  0.69848
## Country_ITALY        0.0411819   0.0242900   1.695  0.09003 .
## Country_NETHERLANDS  -0.0436543   0.0249485  -1.750  0.08019 .
## Country_POLAND       -0.0231889   0.0248461  -0.933  0.35069
## Country_PORTUGAL     -0.0111022   0.0253580  -0.438  0.66153
## Country_ROMANIA      -0.1100873   0.0271446  -4.056 5.05e-05 ***
## Country_SLOVAKIA     0.0734162   0.0262432   2.798  0.00516 **
## Country_SLOVENIA     0.0482719   0.0268721   1.796  0.07247 .
## Country_SPAIN        -0.0713319   0.0240916  -2.961  0.00308 **
## Country_SWEDEN       0.0353790   0.0257511   1.374  0.16951
## type                0.0879195   0.0203051   4.330 1.51e-05 ***
## slr                 0.8094621   0.0208372  38.847 < 2e-16 ***
## elect              -0.1232446   0.0118733 -10.380 < 2e-16 ***
## optical            0.2722848   0.0105606  25.783 < 2e-16 ***
## pixeltot          0.0692517   0.0020931  33.086 < 2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.3673 on 8470 degrees of freedom
## Multiple R-squared:  0.4266, Adjusted R-squared:  0.4249
## F-statistic: 252.1 on 25 and 8470 DF,  p-value: < 2.2e-16
hedonic4 <- lm(lsalesunits ~ ., data = modell_data)
summary(hedonic4)
```

```
##
## Call:
## lm(formula = lsalesunits ~ ., data = model1_data)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -5.7377 -1.4544 -0.0791  1.3942  6.0520
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)      6.53027    0.30557  21.371 < 2e-16 ***
## lpriceur         -1.07961    0.05700 -18.941 < 2e-16 ***
## Country_BELGIUM   -0.13872    0.13137  -1.056 0.291030
## Country_BULGARIA  -0.79799    0.14555  -5.482 4.32e-08 ***
## `Country_CZECH REPUBLIC` -0.21751    0.13221  -1.645 0.099957 .
## Country_DENMARK   -1.89614    0.13812 -13.728 < 2e-16 ***
## Country_FINLAND   -0.96208    0.13569  -7.091 1.44e-12 ***
## Country_FRANCE     1.63920    0.12907  12.700 < 2e-16 ***
## Country_GERMANY    1.89846    0.13201  14.382 < 2e-16 ***
## `Country_GREAT BRITAIN` 2.51453    0.17682  14.221 < 2e-16 ***
## Country_GREECE     -0.44011    0.13322  -3.304 0.000958 ***
## Country_HUNGARY    -1.00165    0.13366  -7.494 7.35e-14 ***
## Country_IRELAND     0.37201    0.21458   1.734 0.083020 .
## Country_ITALY      1.38179    0.12744  10.842 < 2e-16 ***
## Country_NETHERLANDS 0.37277    0.13090   2.848 0.004413 **
## Country_POLAND      0.57417    0.13035   4.405 1.07e-05 ***
## Country_PORTUGAL    -0.67299    0.13303  -5.059 4.30e-07 ***
## Country_ROMANIA     -0.91100    0.14253  -6.391 1.73e-10 ***
## Country_SLOVAKIA    -1.27894    0.13773  -9.286 < 2e-16 ***
## Country_SLOVENIA    -2.07456    0.14099 -14.714 < 2e-16 ***
## Country_SPAIN        0.97123    0.12645   7.681 1.75e-14 ***
## Country_SWEDEN      -0.17061    0.13510  -1.263 0.206696
## type                2.30353    0.10663  21.602 < 2e-16 ***
## slr                 1.43862    0.11865  12.125 < 2e-16 ***
## elect               1.09923    0.06268  17.537 < 2e-16 ***
## optical             1.17657    0.05753  20.451 < 2e-16 ***
## pixeltot            0.26452    0.01167  22.670 < 2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 1.927 on 8469 degrees of freedom
## Multiple R-squared:  0.3708, Adjusted R-squared:  0.3689
## F-statistic: 192 on 26 and 8469 DF, p-value: < 2.2e-16
```

## Create a list of characteristics variables

```
characteristics <- c("variables", "type", "slr", "elect", "optical", "pixeltot")
```

## Check uniqueness of brand+model

```
cameras %>%
  group_by(product, Country) %>%
  summarise(count = n(),
```

```

      sum = sum(salesunits),
      mean = mean(salesunits)) %>%
ungroup()

## `summarise()` has grouped output by 'product'. You can override using the
## `.groups` argument.

## # A tibble: 8,496 x 5
##   product Country      count    sum  mean
##   <int> <chr>      <int> <dbl> <dbl>
## 1      1 AUSTRIA          1  1369  1369
## 2      1 BELGIUM          1   791   791
## 3      1 BULGARIA          1     4     4
## 4      1 CZECH REPUBLIC      1    67    67
## 5      1 DENMARK            1   183   183
## 6      1 FRANCE             1  5124  5124
## 7      1 GERMANY            1  3585  3585
## 8      1 GREAT BRITAIN       1  2527  2527
## 9      1 GREECE             1   601   601
## 10     1 HUNGARY            1   120   120
## # ... with 8,486 more rows

```

## Rescaling sales

```

cameras <- cameras %>%
  mutate(salesunits = salesunits / 1000,
         group = elect)

```

## Nesting variable - segment

Consider the price of coffee and wages:

Create variables: total sales, market size and dependent variable for MNL, nested logit

```

country_sales <- cameras %>%
  group_by(Country) %>%
  mutate(salesunits_t = sum(salesunits)) %>%
  ungroup()

cameras <- cameras %>%
  inner_join(country_sales) %>%
  mutate(MSIZE = 0.4 * population,
         share = salesunits / MSIZE,
         share0 = (MSIZE - salesunits_t)/MSIZE,
         ls=log(share/share0))

## Joining, by = c("Country_AUSTRIA", "Country_BELGIUM", "Country_BULGARIA",
## "Country_CZECH REPUBLIC", "Country_DENMARK", "Country_FINLAND",
## "Country_FRANCE", "Country_GERMANY", "Country_GREAT BRITAIN", "Country_GREECE",
## "Country_HUNGARY", "Country_IRELAND", "Country_ITALY", "Country_NETHERLANDS",
## "Country_POLAND", "Country_PORTUGAL", "Country_ROMANIA", "Country_SLOVAKIA",
## "Country_SLOVENIA", "Country_SPAIN", "Country_SWEDEN", "category", "period",

```

```
## "Brand", "model", "salesunits", "Country", "priceur", "type", "slr", "elect",
## "optical", "pixeltot", "population", "lpriceur", "lsalesunits", "product",
## "group")
```

## Nested logit - shares within a segment

```
country_nest <- cameras %>%
  group_by(Country, group) %>%
  mutate(salesunits_g = sum(salesunits)) %>%
  ungroup()

cameras <- cameras %>%
  inner_join(country_nest) %>%
  mutate(lsj_g = log(salesunits / salesunits_g)) %>%
  mutate(con = 1)
```

```
## Joining, by = c("Country_AUSTRIA", "Country_BELGIUM", "Country_BULGARIA",
## "Country_CZECH REPUBLIC", "Country_DENMARK", "Country_FINLAND",
## "Country_FRANCE", "Country_GERMANY", "Country_GREAT BRITAIN", "Country_GREECE",
## "Country_HUNGARY", "Country_IRELAND", "Country_ITALY", "Country_NETHERLANDS",
## "Country_POLAND", "Country_PORTUGAL", "Country_ROMANIA", "Country_SLOVAKIA",
## "Country_SLOVENIA", "Country_SPAIN", "Country_SWEDEN", "category", "period",
## "Brand", "model", "salesunits", "Country", "priceur", "type", "slr", "elect",
## "optical", "pixeltot", "population", "lpriceur", "lsalesunits", "product",
## "group", "salesunits_t", "MSIZE", "share", "share0", "ls")
```

## define instrumental variables

### Create brand dummies

```
cameras <- cameras %>%
  mutate(i1_type = sum2_type - type,
         i2_type = sum1_type - sum2_type,
         i3_type = sum4_type - type,
         i4_type = sum3_type - sum4_type,
         i7_type = type^2
  )
```

```
cameras <- cameras %>%
  relocate(con, type, slr, elect, optical, pixeltot)
colnames(cameras) # find the cameras characteristics variables
```

```
## [1] "con"           "type"          "slr"
## [4] "elect"         "optical"       "pixeltot"
## [7] "Country_AUSTRIA" "Country_BELGIUM" "Country_BULGARIA"
## [10] "Country_CZECH REPUBLIC" "Country_DENMARK" "Country_FINLAND"
## [13] "Country_FRANCE" "Country_GERMANY" "Country_GREAT BRITAIN"
## [16] "Country_GREECE" "Country_HUNGARY" "Country_IRELAND"
## [19] "Country_ITALY" "Country_NETHERLANDS" "Country_POLAND"
## [22] "Country_PORTUGAL" "Country_ROMANIA" "Country_SLOVAKIA"
## [25] "Country_SLOVENIA" "Country_SPAIN" "Country_SWEDEN"
## [28] "category"      "period"        "Brand"
## [31] "model"         "salesunits"    "Country"
## [34] "priceur"       "population"    "lpriceur"
```

## [37] "lsalesunits"	"product"	"group"
## [40] "salesunits_t"	"MSIZE"	"share"
## [43] "share0"	"ls"	"salesunits_g"
## [46] "lsj_g"	"sum1_con"	"sum1_type"
## [49] "sum1_slr"	"sum1_elect"	"sum1_optical"
## [52] "sum1_pixeltot"	"sum2_con"	"sum2_type"
## [55] "sum2_slr"	"sum2_elect"	"sum2_optical"
## [58] "sum2_pixeltot"	"sum3_con"	"sum3_type"
## [61] "sum3_slr"	"sum3_elect"	"sum3_optical"
## [64] "sum3_pixeltot"	"sum4_con"	"sum4_type"
## [67] "sum4_slr"	"sum4_elect"	"sum4_optical"
## [70] "sum4_pixeltot"	"i1_type"	"i2_type"
## [73] "i3_type"	"i4_type"	"i7_type"

```
for (var in names(cameras[1:6])) { # loop over all of the variable names
  cameras %>%
    count(.data[[var]]) %>% print() # '.data' is a pronoun that calls the 'cameras' dataset
}
```

```
## # A tibble: 1 x 2
##   con      n
##   <dbl> <int>
## 1     1  8496
## # A tibble: 2 x 2
##   type      n
##   <dbl> <int>
## 1     0   373
## 2     1  8123
## # A tibble: 2 x 2
##   slr      n
##   <dbl> <int>
## 1     0  8151
## 2     1   345
## # A tibble: 2 x 2
##   elect      n
##   <dbl> <int>
## 1     0  6765
## 2     1  1731
## # A tibble: 2 x 2
##   optical      n
##   <dbl> <int>
## 1     0  4951
## 2     1  3545
## # A tibble: 75 x 2
##   pixeltot      n
##   <dbl> <int>
## 1  0.400      2
## 2  0.800      1
## 3     1      1
## 4  1.30      9
## 5  1.5       5
## 6     2      1
## 7  2.10     37
## 8  2.40      1
## 9  2.5       1
```

```
## 10      3.10      3
## # ... with 65 more rows
for (var in names(cameras[1:6])) {
  # create our summation variables dynamically from the variable name
  sumvar1 = paste0("sum1_",var) # paste0 is the same as paste but assumes 'sep = ""'
  sumvar2 = paste0("sum2_",var)
  sumvar3 = paste0("sum3_",var)
  sumvar4 = paste0("sum4_",var)
  # create our new characteristics instrument name dynamically from the variable name
  newvar1 = paste0("i1_",var)
  newvar2 = paste0("i2_",var)
  newvar3 = paste0("i3_",var)
  newvar4 = paste0("i4_",var)
  newvar5 = paste0("i7_",var)
  # create our instruments and assign our dynamic variable name
  cameras <- cameras %>%
    mutate(!newvar1 := .data[[sumvar2]] - .data[[var]], # the !! means use the dynamic variable name c
           !!newvar2 := .data[[sumvar1]] - .data[[sumvar2]],
           !!newvar3 := .data[[sumvar4]] - .data[[var]],
           !!newvar4 := .data[[sumvar3]] - .data[[sumvar4]],
           !!newvar5 := .data[[var]]^2
    )
}
```

## Create brand dummies

```
cameras <- cameras %>%
  to_dummy(Brand, suffix = "label") %>%
  bind_cols(cameras)
```

## Logit regression

```
colnames(cameras)
```

## [1]	"Brand_CANON"	"Brand_FUJIFILM"	"Brand_KODAK"
## [4]	"Brand_NIKON"	"Brand_OLYMPUS"	"Brand_PANASONIC"
## [7]	"Brand_SAMSUNG"	"Brand_SONY"	"con"
## [10]	"type"	"slr"	"elect"
## [13]	"optical"	"pixeltot"	"Country_AUSTRIA"
## [16]	"Country_BELGIUM"	"Country_BULGARIA"	"Country_CZECH REPUBLIC"
## [19]	"Country_DENMARK"	"Country_FINLAND"	"Country_FRANCE"
## [22]	"Country_GERMANY"	"Country_GREAT BRITAIN"	"Country_GREECE"
## [25]	"Country_HUNGARY"	"Country_IRELAND"	"Country_ITALY"
## [28]	"Country_NETHERLANDS"	"Country_POLAND"	"Country_PORTUGAL"
## [31]	"Country_ROMANIA"	"Country_SLOVAKIA"	"Country_SLOVENIA"
## [34]	"Country_SPAIN"	"Country_SWEDEN"	"category"
## [37]	"period"	"Brand"	"model"
## [40]	"salesunits"	"Country"	"priceur"
## [43]	"population"	"lpriceur"	"lsalesunits"
## [46]	"product"	"group"	"salesunits_t"
## [49]	"MSIZE"	"share"	"share0"
## [52]	"ls"	"salesunits_g"	"lsj_g"
## [55]	"sum1_con"	"sum1_type"	"sum1_slr"



```
## [58] "sum1_elect"          "sum1_optical"          "sum1_pixeltot"
## [61] "sum2_con"            "sum2_type"             "sum2_slr"
## [64] "sum2_elect"          "sum2_optical"          "sum2_pixeltot"
## [67] "sum3_con"            "sum3_type"             "sum3_slr"
## [70] "sum3_elect"          "sum3_optical"          "sum3_pixeltot"
## [73] "sum4_con"            "sum4_type"             "sum4_slr"
## [76] "sum4_elect"          "sum4_optical"          "sum4_pixeltot"
## [79] "i1_type"             "i2_type"               "i3_type"
## [82] "i4_type"             "i7_type"               "i1_con"
## [85] "i2_con"              "i3_con"                "i4_con"
## [88] "i7_con"              "i1_slr"                "i2_slr"
## [91] "i3_slr"              "i4_slr"                "i7_slr"
## [94] "i1_elect"            "i2_elect"              "i3_elect"
## [97] "i4_elect"            "i7_elect"              "i1_optical"
## [100] "i2_optical"          "i3_optical"            "i4_optical"
## [103] "i7_optical"          "i1_pixeltot"           "i2_pixeltot"
## [106] "i3_pixeltot"         "i4_pixeltot"           "i7_pixeltot"
```

```
model2_data <- cameras %>%
```

```
  select(c("ls",
           starts_with("Brand_"),
           starts_with("Country_"),
           "priceur",
           "type", "slr", "elect", "optical", "pixeltot"))
```

```
logit1 <- lm(ls ~ . -Brand_CANON -Country_AUSTRIA, data = model2_data)
```

```
summary(logit1)
```

```
##
```

```
## Call:
```

```
## lm(formula = ls ~ . - Brand_CANON - Country_AUSTRIA, data = model2_data)
```

```
##
```

```
## Residuals:
```

```
##      Min       1Q   Median       3Q      Max
## -5.6102 -1.4047 -0.0473  1.3645  6.6360
```

```
##
```

```
## Coefficients:
```

```
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)   -1.205e+01  1.794e-01 -67.183 < 2e-16 ***
## Brand_FUJIFILM -7.285e-01  9.212e-02 -7.908 2.94e-15 ***
## Brand_KODAK    -1.313e+00  9.147e-02 -14.360 < 2e-16 ***
## Brand_NIKON    -5.880e-01  8.135e-02 -7.229 5.31e-13 ***
## Brand_OLYMPUS  -6.415e-01  7.681e-02 -8.351 < 2e-16 ***
## Brand_PANASONIC -4.640e-01  8.701e-02 -5.332 9.95e-08 ***
## Brand_SAMSUNG  -1.072e+00  8.366e-02 -12.808 < 2e-16 ***
## Brand_SONY     -1.958e-01  7.691e-02 -2.546 0.010912 *
## Country_BELGIUM -5.019e-01  1.293e-01 -3.880 0.000105 ***
## Country_BULGARIA -9.046e-01  1.434e-01 -6.309 2.95e-10 ***
## `Country_CZECH REPUBLIC` -5.701e-01  1.302e-01 -4.378 1.21e-05 ***
## Country_DENMARK -1.815e+00  1.360e-01 -13.344 < 2e-16 ***
## Country_FINLAND -5.988e-01  1.337e-01 -4.480 7.56e-06 ***
## Country_FRANCE  -5.193e-01  1.271e-01 -4.084 4.46e-05 ***
## Country_GERMANY  -4.244e-01  1.300e-01 -3.265 0.001100 **
## `Country_GREAT BRITAIN`  2.287e-01  1.744e-01  1.311 0.189864
## Country_GREECE   -9.010e-01  1.312e-01 -6.865 7.10e-12 ***
```

```
## Country_HUNGARY      -1.385e+00  1.316e-01 -10.521 < 2e-16 ***
## Country_IRELAND      6.844e-01  2.114e-01  3.237 0.001211 **
## Country_ITALY        -6.968e-01  1.255e-01 -5.551 2.93e-08 ***
## Country_NETHERLANDS -3.131e-01  1.289e-01 -2.429 0.015150 *
## Country_POLAND       -1.136e+00  1.283e-01 -8.851 < 2e-16 ***
## Country_PORTUGAL     -1.080e+00  1.310e-01 -8.244 < 2e-16 ***
## Country_ROMANIA      -2.153e+00  1.404e-01 -15.339 < 2e-16 ***
## Country_SLOVAKIA     -1.087e+00  1.356e-01 -8.019 1.21e-15 ***
## Country_SLOVENIA     -9.160e-01  1.389e-01 -6.596 4.48e-11 ***
## Country_SPAIN        -8.609e-01  1.245e-01 -6.914 5.05e-12 ***
## Country_SWEDEN       -3.345e-01  1.330e-01 -2.514 0.011939 *
## priceur              -6.377e-03  2.844e-04 -22.417 < 2e-16 ***
## type                 2.346e+00  1.056e-01 22.215 < 2e-16 ***
## slr                  1.794e+00  1.241e-01 14.464 < 2e-16 ***
## elect                1.264e+00  6.303e-02 20.058 < 2e-16 ***
## optical              1.021e+00  6.058e-02 16.856 < 2e-16 ***
## pixeltot             2.886e-01  1.173e-02 24.598 < 2e-16 ***
## ---
```

```
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
## Residual standard error: 1.897 on 8462 degrees of freedom
```

```
## Multiple R-squared:  0.2657, Adjusted R-squared:  0.2628
```

```
## F-statistic: 92.77 on 33 and 8462 DF,  p-value: < 2.2e-16
```

```
library("AER")
```

```
## Warning: package 'AER' was built under R version 4.1.3
```

```
## Loading required package: car
```

```
## Warning: package 'car' was built under R version 4.1.3
```

```
## Loading required package: carData
```

```
## Warning: package 'carData' was built under R version 4.1.3
```

```
##
```

```
## Attaching package: 'car'
```

```
## The following object is masked from 'package:dplyr':
```

```
##
```

```
##      recode
```

```
## Loading required package: lmtest
```

```
## Loading required package: zoo
```

```
##
```

```
## Attaching package: 'zoo'
```

```
## The following objects are masked from 'package:base':
```

```
##
```

```
##      as.Date, as.Date.numeric
```

```
## Loading required package: sandwich
```

```
## Loading required package: survival
```

```
model3_data <- cameras %>%
```

```
  select(c("ls",
           starts_with("Brand_"),
```

```

      starts_with("Country_"),
      "priceur",
      "type", "slr", "elect", "optical", "pixeltot",
      starts_with("i1"),
      starts_with("i2"),
      starts_with("i7"))
colnames(model3_data)

```

```

## [1] "ls" "Brand_CANON" "Brand_FUJIFILM"
## [4] "Brand_KODAK" "Brand_NIKON" "Brand_OLYMPUS"
## [7] "Brand_PANASONIC" "Brand_SAMSUNG" "Brand_SONY"
## [10] "Country_AUSTRIA" "Country_BELGIUM" "Country_BULGARIA"
## [13] "Country_CZECH REPUBLIC" "Country_DENMARK" "Country_FINLAND"
## [16] "Country_FRANCE" "Country_GERMANY" "Country_GREAT BRITAIN"
## [19] "Country_GREECE" "Country_HUNGARY" "Country_IRELAND"
## [22] "Country_ITALY" "Country_NETHERLANDS" "Country_POLAND"
## [25] "Country_PORTUGAL" "Country_ROMANIA" "Country_SLOVAKIA"
## [28] "Country_SLOVENIA" "Country_SPAIN" "Country_SWEDEN"
## [31] "priceur" "type" "slr"
## [34] "elect" "optical" "pixeltot"
## [37] "i1_type" "i1_con" "i1_slr"
## [40] "i1_elect" "i1_optical" "i1_pixeltot"
## [43] "i2_type" "i2_con" "i2_slr"
## [46] "i2_elect" "i2_optical" "i2_pixeltot"
## [49] "i7_type" "i7_con" "i7_slr"
## [52] "i7_elect" "i7_optical" "i7_pixeltot"

```

```

ivlogit1 <- ivreg(ls ~ Brand_FUJIFILM + Brand_KODAK + Brand_NIKON + Brand_OLYMPUS + Brand_PANASONIC + 
+ Country_BELGIUM + Country_BULGARIA + `Country_CZECH REPUBLIC` + Country_DENMARK + Coun
+ `Country_GREAT BRITAIN` + Country_GREECE + Country_HUNGARY + Country_IRELAND + Countr
+ Country_ROMANIA + Country_SLOVAKIA + Country_SLOVENIA + Country_SPAIN + Country_SWEDEN
Brand_FUJIFILM + Brand_KODAK + Brand_NIKON + Brand_OLYMPUS + Brand_PANASONIC + Brand_SAM
+ Country_BELGIUM + Country_BULGARIA + `Country_CZECH REPUBLIC` + Country_DENMARK + Coun
+ `Country_GREAT BRITAIN` + Country_GREECE + Country_HUNGARY + Country_IRELAND + Countr
+ Country_ROMANIA + Country_SLOVAKIA + Country_SLOVENIA + Country_SPAIN + Country_SWEDEN
#instruments start here
+ i1_con + i2_con + i7_con + i1_type + i2_type + i7_type + i1_slr + i2_slr + i7_slr + i
+ i1_optical + i2_optical + i7_optical + i1_pixeltot + i2_pixeltot + i7_pixeltot
, data = model3_data) # excluded Brand_CANON + Country_AUSTRIA

```

```
summary(ivlogit1)
```

```

##
## Call:
## ivreg(formula = ls ~ Brand_FUJIFILM + Brand_KODAK + Brand_NIKON +
## Brand_OLYMPUS + Brand_PANASONIC + Brand_SAMSUNG + Brand_SONY +
## Country_BELGIUM + Country_BULGARIA + `Country_CZECH REPUBLIC` +
## Country_DENMARK + Country_FINLAND + Country_FRANCE + Country_GERMANY +
## `Country_GREAT BRITAIN` + Country_GREECE + Country_HUNGARY +
## Country_IRELAND + Country_ITALY + Country_NETHERLANDS + Country_POLAND +
## Country_PORTUGAL + Country_ROMANIA + Country_SLOVAKIA + Country_SLOVENIA +
## Country_SPAIN + Country_SWEDEN + priceur + type + slr + elect +
## optical + pixeltot + priceur | Brand_FUJIFILM + Brand_KODAK +
## Brand_NIKON + Brand_OLYMPUS + Brand_PANASONIC + Brand_SAMSUNG +

```

```

## Brand_SONY + Country_BELGIUM + Country_BULGARIA + `Country_CZECH REPUBLIC` +
## Country_DENMARK + Country_FINLAND + Country_FRANCE + Country_GERMANY +
## `Country_GREAT BRITAIN` + Country_GREECE + Country_HUNGARY +
## Country_IRELAND + Country_ITALY + Country_NETHERLANDS + Country_POLAND +
## Country_PORTUGAL + Country_ROMANIA + Country_SLOVAKIA + Country_SLOVENIA +
## Country_SPAIN + Country_SWEDEN + type + slr + elect + optical +
## pixeltot + i1_con + i2_con + i7_con + i1_type + i2_type +
## i7_type + i1_slr + i2_slr + i7_slr + i1_elect + i2_elect +
## i7_elect + i1_optical + i2_optical + i7_optical + i1_pixeltot +
## i2_pixeltot, data = model3_data)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -13.1631  -2.1144  -0.1944   1.8370  17.8589
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)    -9.283172   0.393721  -23.578 < 2e-16 ***
## Brand_FUJIFILM  -1.799490   0.185051   -9.724 < 2e-16 ***
## Brand_KODAK     -3.730176   0.263424  -14.160 < 2e-16 ***
## Brand_NIKON     -1.674772   0.169918   -9.856 < 2e-16 ***
## Brand_OLYMPUS   -1.402290   0.148843   -9.421 < 2e-16 ***
## Brand_PANASONIC -0.848726   0.154691   -5.487 4.22e-08 ***
## Brand_SAMSUNG   -3.366166   0.246819  -13.638 < 2e-16 ***
## Brand_SONY      -0.526336   0.136561   -3.854 0.000117 ***
## Country_BELGIUM -0.388364   0.224709   -1.728 0.083971 .
## Country_BULGARIA -1.072620   0.249300   -4.303 1.71e-05 ***
## `Country_CZECH REPUBLIC` -0.019296   0.231005   -0.084 0.933433
## Country_DENMARK -1.356244   0.239407   -5.665 1.52e-08 ***
## Country_FINLAND -0.776878   0.232519   -3.341 0.000838 ***
## Country_FRANCE  -0.887185   0.222992   -3.979 6.99e-05 ***
## Country_GERMANY -0.853222   0.228722   -3.730 0.000192 ***
## `Country_GREAT BRITAIN` -1.159520   0.325924   -3.558 0.000376 ***
## Country_GREECE  -0.019163   0.240369   -0.080 0.936461
## Country_HUNGARY -2.096707   0.236728   -8.857 < 2e-16 ***
## Country_IRELAND  0.456750   0.367443    1.243 0.213884
## Country_ITALY    -0.422759   0.219209   -1.929 0.053817 .
## Country_NETHERLANDS -0.705319   0.226324   -3.116 0.001837 **
## Country_POLAND   -1.379912   0.223782   -6.166 7.31e-10 ***
## Country_PORTUGAL -1.129268   0.227418   -4.966 6.98e-07 ***
## Country_ROMANIA  -2.987003   0.254214  -11.750 < 2e-16 ***
## Country_SLOVAKIA -0.600085   0.239175   -2.509 0.012127 *
## Country_SLOVENIA -0.703637   0.241744   -2.911 0.003616 **
## Country_SPAIN    -1.299759   0.219473   -5.922 3.30e-09 ***
## Country_SWEDEN   -0.176947   0.231299   -0.765 0.444283
## priceur         -0.043498   0.003266  -13.317 < 2e-16 ***
## type            2.856484   0.188615   15.144 < 2e-16 ***
## slr             9.579582   0.710572   13.482 < 2e-16 ***
## elect           0.581549   0.124479    4.672 3.03e-06 ***
## optical         2.371469   0.157644   15.043 < 2e-16 ***
## pixeltot        0.826709   0.051043   16.196 < 2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##

```

```
## Residual standard error: 3.292 on 8462 degrees of freedom
## Multiple R-Squared: -1.212, Adjusted R-squared: -1.221
## Wald test: 31.11 on 33 and 8462 DF, p-value: < 2.2e-16
```

## Nested logit

```
## [1] "ls" "lsj_g" "Brand_CANON"
## [4] "Brand_FUJIFILM" "Brand_KODAK" "Brand_NIKON"
## [7] "Brand_OLYMPUS" "Brand_PANASONIC" "Brand_SAMSUNG"
## [10] "Brand_SONY" "Country_AUSTRIA" "Country_BELGIUM"
## [13] "Country_BULGARIA" "Country_CZECH REPUBLIC" "Country_DENMARK"
## [16] "Country_FINLAND" "Country_FRANCE" "Country_GERMANY"
## [19] "Country_GREAT BRITAIN" "Country_GREECE" "Country_HUNGARY"
## [22] "Country_IRELAND" "Country_ITALY" "Country_NETHERLANDS"
## [25] "Country_POLAND" "Country_PORTUGAL" "Country_ROMANIA"
## [28] "Country_SLOVAKIA" "Country_SLOVENIA" "Country_SPAIN"
## [31] "Country_SWEDEN" "priceur" "type"
## [34] "slr" "elect" "optical"
## [37] "pixeltot"

##
## Call:
## lm(formula = ls ~ . - Brand_CANON - Country_AUSTRIA, data = model4_data)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -0.36242 -0.03372 -0.00482  0.02914  0.37382
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)   -1.032e+00  1.083e-02  -95.298 < 2e-16 ***
## lsj_g          9.993e-01  5.458e-04 1830.690 < 2e-16 ***
## Brand_FUJIFILM -1.966e-03  4.640e-03  -0.424  0.67172
## Brand_KODAK    -4.272e-03  4.646e-03  -0.920  0.35784
## Brand_NIKON    -1.766e-03  4.095e-03  -0.431  0.66624
## Brand_OLYMPUS  -2.377e-03  3.871e-03  -0.614  0.53924
## Brand_PANASONIC -2.087e-03  4.374e-03  -0.477  0.63325
## Brand_SAMSUNG  -4.101e-03  4.239e-03  -0.967  0.33332
## Brand_SONY     -1.194e-03  3.861e-03  -0.309  0.75723
## Country_BELGIUM -2.385e-01  6.492e-03 -36.731 < 2e-16 ***
## Country_BULGARIA -1.067e+00  7.196e-03 -148.232 < 2e-16 ***
## `Country_CZECH REPUBLIC` -6.021e-01  6.534e-03 -92.152 < 2e-16 ***
## Country_DENMARK -1.537e+00  6.827e-03 -225.091 < 2e-16 ***
## Country_FINLAND -1.957e-02  6.715e-03  -2.914  0.00358 **
## Country_FRANCE  -3.420e-01  6.381e-03 -53.598 < 2e-16 ***
## Country_GERMANY -2.369e-01  6.525e-03 -36.301 < 2e-16 ***
## `Country_GREAT BRITAIN` -7.084e-01  8.768e-03 -80.793 < 2e-16 ***
## Country_GREECE  -8.719e-01  6.587e-03 -132.380 < 2e-16 ***
## Country_HUNGARY -9.548e-01  6.611e-03 -144.438 < 2e-16 ***
## Country_IRELAND -7.836e-01  1.064e-02 -73.655 < 2e-16 ***
## Country_ITALY   -5.379e-01  6.301e-03 -85.372 < 2e-16 ***
## Country_NETHERLANDS 6.734e-02  6.472e-03  10.404 < 2e-16 ***
## Country_POLAND  -7.625e-01  6.444e-03 -118.326 < 2e-16 ***
## Country_PORTUGAL -7.519e-01  6.577e-03 -114.321 < 2e-16 ***
## Country_ROMANIA  -1.953e+00  7.046e-03 -277.257 < 2e-16 ***
```

```
## Country_SLOVAKIA      -1.227e+00  6.806e-03 -180.258 < 2e-16 ***
## Country_SLOVENIA      -8.660e-01  6.969e-03 -124.254 < 2e-16 ***
## Country_SPAIN          -4.892e-01  6.252e-03 -78.241 < 2e-16 ***
## Country_SWEDEN        -8.619e-02  6.677e-03 -12.907 < 2e-16 ***
## priceur               -2.603e-05  1.469e-05  -1.772  0.07640 .
## type                  -1.442e-03  5.453e-03  -0.264  0.79150
## slr                   3.407e-03  6.302e-03   0.541  0.58882
## elect                 -1.057e+00  3.408e-03 -310.084 < 2e-16 ***
## optical               2.742e-03  3.091e-03   0.887  0.37495
## pixeltot              8.301e-04  6.094e-04   1.362  0.17323
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.09519 on 8461 degrees of freedom
## Multiple R-squared:  0.9982, Adjusted R-squared:  0.9981
## F-statistic: 1.343e+05 on 34 and 8461 DF,  p-value: < 2.2e-16
```

```
model5_data <- cameras %>%
  select(c("ls", "lsj_g",
           starts_with("Brand_"),
           starts_with("Country_"),
           "priceur",
           "type", "slr", "elect", "optical", "pixeltot",
           starts_with("i")))
colnames(model5_data)
```

```
## [1] "ls"                "lsj_g"              "Brand_CANON"
## [4] "Brand_FUJIFILM"    "Brand_KODAK"        "Brand_NIKON"
## [7] "Brand_OLYMPUS"     "Brand_PANASONIC"    "Brand_SAMSUNG"
## [10] "Brand_SONY"        "Country_AUSTRIA"     "Country_BELGIUM"
## [13] "Country_BULGARIA"  "Country_CZECH REPUBLIC" "Country_DENMARK"
## [16] "Country_FINLAND"   "Country_FRANCE"      "Country_GERMANY"
## [19] "Country_GREAT BRITAIN" "Country_GREECE"      "Country_HUNGARY"
## [22] "Country_IRELAND"   "Country_ITALY"       "Country_NETHERLANDS"
## [25] "Country_POLAND"    "Country_PORTUGAL"    "Country_ROMANIA"
## [28] "Country_SLOVAKIA"  "Country_SLOVENIA"    "Country_SPAIN"
## [31] "Country_SWEDEN"    "priceur"             "type"
## [34] "slr"              "elect"               "optical"
## [37] "pixeltot"         "i1_type"             "i2_type"
## [40] "i3_type"          "i4_type"             "i7_type"
## [43] "i1_con"           "i2_con"              "i3_con"
## [46] "i4_con"           "i7_con"              "i1_slr"
## [49] "i2_slr"           "i3_slr"              "i4_slr"
## [52] "i7_slr"           "i1_elect"            "i2_elect"
## [55] "i3_elect"         "i4_elect"            "i7_elect"
## [58] "i1_optical"       "i2_optical"          "i3_optical"
## [61] "i4_optical"       "i7_optical"          "i1_pixeltot"
## [64] "i2_pixeltot"      "i3_pixeltot"         "i4_pixeltot"
## [67] "i7_pixeltot"
```

```
ivlogit2 <- ivreg(ls ~ Brand_FUJIFILM + Brand_KODAK + Brand_NIKON + Brand_OLYMPUS + Brand_PANASONIC + Brand_SAMSUNG + Brand_SONY +
  +Country_BELGIUM + Country_BULGARIA + `Country_CZECH REPUBLIC` + Country_DENMARK + Country_GERMANY + `Country_GREAT BRITAIN` + Country_GREECE + Country_HUNGARY + Country_IRELAND + Country_NETHERLANDS +
  + Country_ROMANIA + Country_SLOVAKIA + Country_SLOVENIA + Country_SPAIN + Country_SWEDEN |
  lsj_g) | # need to include again all the regressors in the ivreg function
```

```

Brand_FUJIFILM + Brand_KODAK + Brand_NIKON + Brand_OLYMPUS + Brand_PANASONIC + Brand_SAM
+ Country_BELGIUM + Country_BULGARIA + `Country_CZECH REPUBLIC` + Country_DENMARK + Coun
+ `Country_GREAT BRITAIN` + Country_GREECE + Country_HUNGARY + Country_IRELAND + Country
+ Country_ROMANIA + Country_SLOVAKIA + Country_SLOVENIA + Country_SPAIN + Country_SWEDE
  #instruments start here
+ i1_con + i2_con + i3_con + i4_con + i7_con + i1_type + i2_type + i3_type + i4_type
  i1_elect + i2_elect + i3_elect + i4_elect + i7_elect + i1_optical + i2_optical
  i2_pixeltot + i3_pixeltot + i4_pixeltot + i7_pixeltot
, data = model5_data) # excluded Brand_CANON + Country_AUSTRIA
summary(ivlogit2)

```

```

##
## Call:
## ivreg(formula = ls ~ Brand_FUJIFILM + Brand_KODAK + Brand_NIKON +
##   Brand_OLYMPUS + Brand_PANASONIC + Brand_SAMSUNG + Brand_SONY +
##   Country_BELGIUM + Country_BULGARIA + `Country_CZECH REPUBLIC` +
##   Country_DENMARK + Country_FINLAND + Country_FRANCE + Country_GERMANY +
##   `Country_GREAT BRITAIN` + Country_GREECE + Country_HUNGARY +
##   Country_IRELAND + Country_ITALY + Country_NETHERLANDS + Country_POLAND +
##   Country_PORTUGAL + Country_ROMANIA + Country_SLOVAKIA + Country_SLOVENIA +
##   Country_SPAIN + Country_SWEDEN + priceur + type + slr + elect +
##   optical + pixeltot + (priceur + lsj_g) | Brand_FUJIFILM +
##   Brand_KODAK + Brand_NIKON + Brand_OLYMPUS + Brand_PANASONIC +
##   Brand_SAMSUNG + Brand_SONY + Country_BELGIUM + Country_BULGARIA +
##   `Country_CZECH REPUBLIC` + Country_DENMARK + Country_FINLAND +
##   Country_FRANCE + Country_GERMANY + `Country_GREAT BRITAIN` +
##   Country_GREECE + Country_HUNGARY + Country_IRELAND + Country_ITALY +
##   Country_NETHERLANDS + Country_POLAND + Country_PORTUGAL +
##   Country_ROMANIA + Country_SLOVAKIA + Country_SLOVENIA + Country_SPAIN +
##   Country_SWEDEN + type + slr + elect + optical + pixeltot +
##   i1_con + i2_con + i3_con + i4_con + i7_con + i1_type + i2_type +
##   i3_type + i4_type + i7_type + i1_slr + i2_slr + i3_slr +
##   i4_slr + i7_slr + i1_elect + i2_elect + i3_elect + i4_elect +
##   i7_elect + i1_optical + i2_optical + i3_optical + i4_optical +
##   i7_optical + i1_pixeltot + i2_pixeltot + i3_pixeltot + i4_pixeltot +
##   i7_pixeltot, data = model5_data)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -0.506513 -0.061680 -0.004567  0.057909  0.551856
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)    -1.1305634   0.0365311  -30.948 < 2e-16 ***
## Brand_FUJIFILM   -0.0344936   0.0088832   -3.883 0.000104 ***
## Brand_KODAK      -0.0729972   0.0155393   -4.698 2.67e-06 ***
## Brand_NIKON      -0.0326358   0.0081476   -4.006 6.24e-05 ***
## Brand_OLYMPUS    -0.0272234   0.0070851   -3.842 0.000123 ***
## Brand_PANASONIC  -0.0166151   0.0061333   -2.709 0.006763 **
## Brand_SAMSUNG    -0.0668693   0.0141139   -4.738 2.20e-06 ***
## Brand_SONY       -0.0108131   0.0050393   -2.146 0.031923 *
## Country_BELGIUM  -0.2398434   0.0077801  -30.828 < 2e-16 ***
## Country_BULGARIA -1.0679130   0.0085994 -124.184 < 2e-16 ***
## `Country_CZECH REPUBLIC` -0.5902177  0.0081658  -72.280 < 2e-16 ***

```

```
## Country_DENMARK      -1.5311074  0.0082474 -185.648 < 2e-16 ***
## Country_FINLAND      -0.0314616  0.0085109  -3.697 0.000220 ***
## Country_FRANCE       -0.3521836  0.0079087 -44.531 < 2e-16 ***
## Country_GERMANY      -0.2484373  0.0081551 -30.464 < 2e-16 ***
## `Country_GREAT BRITAIN` -0.7239620  0.0111209 -65.099 < 2e-16 ***
## Country_GREECE       -0.8540116  0.0086610 -98.604 < 2e-16 ***
## Country_HUNGARY      -0.9756873  0.0090481 -107.834 < 2e-16 ***
## Country_IRELAND      -0.7675600  0.0136276 -56.324 < 2e-16 ***
## Country_ITALY        -0.5344869  0.0075595 -70.704 < 2e-16 ***
## Country_NETHERLANDS   0.0538074  0.0082693   6.507 8.11e-11 ***
## Country_POLAND       -0.7728882  0.0080386 -96.148 < 2e-16 ***
## Country_PORTUGAL     -0.7575211  0.0079789 -94.941 < 2e-16 ***
## Country_ROMANIA      -1.9735718  0.0093785 -210.436 < 2e-16 ***
## Country_SLOVAKIA     -1.2147878  0.0084995 -142.925 < 2e-16 ***
## Country_SLOVENIA     -0.8622551  0.0083512 -103.250 < 2e-16 ***
## Country_SPAIN        -0.5035591  0.0080835 -62.294 < 2e-16 ***
## Country_SWEDEN       -0.0864273  0.0079912 -10.815 < 2e-16 ***
## priceur              -0.0008870  0.0001776  -4.996 5.99e-07 ***
## type                 0.0423776  0.0126438   3.352 0.000807 ***
## slr                  0.1904640  0.0392750   4.850 1.26e-06 ***
## elect               -1.0380358  0.0080410 -129.092 < 2e-16 ***
## optical              0.0452023  0.0098385   4.594 4.40e-06 ***
## pixeltot            0.0160796  0.0033004   4.872 1.12e-06 ***
## lsj_g               0.9851199  0.0039139  251.696 < 2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.1136 on 8461 degrees of freedom
## Multiple R-Squared: 0.9974, Adjusted R-squared: 0.9974
## Wald test: 2.695e+04 on 34 and 8461 DF, p-value: < 2.2e-16
```

## Price elasticities based on logit

```
library("broom")

sum <- tidy(ivlogit1)
sum()

## [1] 0

alpha = coef(summary(ivlogit1))["priceur", "Estimate"]
cameras$own = alpha*cameras$priceur*(1-cameras$share)
cameras$cross = -alpha*cameras$priceur*cameras$share

cameras %>%
  group_by(Country, Brand) %>%
  summarise(mean_own = mean(own)) %>%
  tidyr::pivot_wider(id_cols= Country, names_from = Brand, values_from = mean_own) %>%
  ungroup() %>%
  flextable()

## `summarise()` has grouped output by 'Country'. You can override using the
## `.groups` argument.

## Warning: Warning: fonts used in `flextable` are ignored because the `pdflatex`
## engine is used and not `xelatex` or `lualatex`. You can avoid this warning
```



```
## by using the `set_flextable_defaults(fonts_ignore=TRUE)` command or use a
## compatible engine by defining `latex_engine: xelatex` in the YAML header of the
## R Markdown document.
```

Country	CANON	FUJIFILM	KODAK	NIKON	OLYMPUS	PANASONIC	SAMSUNG	SONY
AUSTRIA	-10.043134	-8.004239	-5.895316	-8.798418	-9.511111	-11.465711	-6.475249	-10.996250
BELGIUM	-9.981913	-7.111123	-6.612456	-9.210438	-9.400830	-10.340781	-6.596844	-9.785010
BULGARIA	-11.584846	-5.890657	-5.905306	-8.279332	-9.034643	-9.210003	-5.953176	-9.910127
CZECH REPUBLIC	-11.101118	-8.313071	-7.485421	-9.742169	-9.348349	-9.997621	-7.017228	-10.526799
DENMARK	-10.467392	-8.366749	-6.602096	-9.676757	-10.162512	-10.955409	-7.125157	-10.602318
FINLAND	-10.061001	-8.172839	-5.644891	-8.756637	-8.716184	-9.922282	-6.441192	-9.083801
FRANCE	-9.680793	-7.151886	-5.411919	-8.738479	-8.498807	-10.453211	-6.274587	-9.331001
GERMANY	-10.365551	-7.253125	-5.871145	-9.214203	-8.761645	-10.305812	-6.431022	-9.754503
GREAT BRITAIN	-10.134382	-6.722361	-4.621209	-9.665955	-8.998981	-10.136082	-7.006454	-9.370006
GREECE	-11.363561	-8.774223	-6.647080	-10.410967	-10.424612	-10.287735	-6.797066	-10.222774
HUNGARY	-10.443136	-7.210941	-5.663420	-9.403100	-7.978403	-9.167850	-6.087040	-8.761576
IRELAND	-10.232995	-7.371308	-7.480910	-11.933457	-10.028752	-10.424260	-7.490030	-10.530687
ITALY	-10.303388	-7.721522	-6.330233	-9.509318	-8.821127	-10.584350	-6.510092	-10.000385
NETHERLANDS	-10.5621807	-7.261377	-5.913256	-8.994504	-8.839693	-10.611205	-6.018530	-9.276026
POLAND	-10.241709	-7.238770	-6.509480	-8.592369	-8.645091	-9.312800	-6.763542	-9.145214
PORTUGAL	-9.814775	-7.219772	-5.663198	-8.827022	-9.206987	-9.866157	-6.913223	-10.143556
ROMANIA	-9.604458	-6.456436	-5.270007	-9.347027	-7.726481	-7.729690	-5.418021	-8.875695
SLOVAKIA	-11.345743	-9.117288	-6.031619	-9.763140	-9.276429	-10.701386	-6.960809	-9.902776
SLOVENIA	-10.475859	-9.344020	-5.451291	-8.931565	-10.332834	-11.298850	-7.020987	-9.783928
SPAIN	-9.519972	-6.257147	-5.971992	-7.939785	-8.371236	-9.430357	-6.377587	-9.098355
SWEDEN	-11.051813	-8.035591	-5.979045	-9.346295	-9.616936	-11.201963	-6.994794	-9.728154

```
cameras %>%
  group_by(Country, Brand) %>%
  summarise(mean_cross = mean(cross)) %>%
  tidyr::pivot_wider(id_cols= Country, names_from = Brand, values_from = mean_cross) %>%
  ungroup() %>%
  flextable()
```

```
## `summarise()` has grouped output by 'Country'. You can override using the
## `.groups` argument.
```

```
## Warning: Warning: fonts used in `flextable` are ignored because the `pdflatex`
## engine is used and not `xelatex` or `lualatex`. You can avoid this warning
## by using the `set_flextable_defaults(fonts_ignore=TRUE)` command or use a
```

```
## compatible engine by defining `latex_engine: xelatex` in the YAML header of the
## R Markdown document.
```

Country	CANON	FUJIFILM	KODAK	NIKON	OLYMPUS	PANASONIC	SAMSUNG	SONY
AUSTRIA	0.013273408	0.001411951	0.003029741	0.010557724	0.005995998	0.008638825	0.001332714	0.010742268
BELGIUM	0.007792430	0.001697373	0.002385328	0.005479827	0.001459758	0.009394431	0.002206671	0.008386045
BULGARIA	0.005164817	0.001543900	0.001069678	0.002589158	0.003374629	0.002717644	0.002027488	0.004685868
CZECH REPUB- LIC	0.004258081	0.001300364	0.000985534	0.003279583	0.005561313	0.008312178	0.001167314	0.003438017
DENMARK	0.005020161	0.000495603	0.000232155	0.002464768	0.001670017	0.001139913	0.001062854	0.003512698
FINLAND	0.019308163	0.000644935	0.000542042	0.007389326	0.007020253	0.004387184	0.002653367	0.004397160
FRANCE	0.004463418	0.003050651	0.002115111	0.005040392	0.001951271	0.011851443	0.001943138	0.005502644
GERMANY	0.013335719	0.002247004	0.002397386	0.004445351	0.001774005	0.010287353	0.002245132	0.005959272
GREAT BRITAIN	0.017362913	0.007217064	0.004732201	0.009909735	0.004072867	0.008822178	0.003994057	0.011235806
GREECE	0.003396885	0.000397213	0.001840379	0.002734891	0.003227374	0.001574880	0.000990493	0.005836750
HUNGARY	0.002516727	0.004205480	0.000697085	0.002182916	0.001658725	0.004620128	0.001593509	0.002268863
IRELAND	0.017139212	0.028131934	0.013365750	0.017546230	0.006305118	0.009272311	0.004045165	0.015350646
ITALY	0.004305700	0.001549588	0.001633644	0.005916641	0.001332802	0.003586564	0.002508894	0.003900037
NETHERLANDS	0.005905980	0.003013899	0.001330610	0.005605547	0.003736611	0.009077622	0.003042669	0.010961276
POLAND	0.004677806	0.001446404	0.000947268	0.003719782	0.002144044	0.004251390	0.001060887	0.005288217
PORTUGAL	0.003877408	0.002303508	0.000639315	0.003136941	0.002656427	0.001935569	0.002059518	0.005923850
ROMANIA	0.001226081	0.001492679	0.000268679	0.000919909	0.000555168	0.001607327	0.000536821	0.001807331
SLOVAKIA	0.002161256	0.001243478	0.000338503	0.001618284	0.004258754	0.004277091	0.001018301	0.002956304
SLOVENIA	0.007052366	0.000981368	0.000865717	0.005481303	0.004033860	0.001167088	0.001180121	0.005850414
SPAIN	0.005015945	0.002135417	0.001541751	0.004417234	0.003968567	0.003092705	0.000726535	0.004242023
SWEDEN	0.012292948	0.003727376	0.000966032	0.013213682	0.006487439	0.006288464	0.003347005	0.006921579

## Merger simulation