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()

| Country | Sales | Average price |
| --- | --- | --- |
| AUSTRIA | 1,101,194 | 209.6870 |
| BELGIUM | 1,223,913 | 202.6413 |
| 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 | 2,271,100 | 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()

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

| 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 |
| CANON | NETHERLANDS | 523,041 | 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 | 114,682 | 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 |
| 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 |
| 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 | 236,031 | 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 |
| 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 |
| SAMSUNG | IRELAND | 14,589 | 172.2848 |
| SAMSUNG | ITALY | 814,707 | 149.7212 |
| SAMSUNG | NETHERLANDS | 311,986 | 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 | 527,451 | 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

## Create logs of prices and quantities

Basic plot of tea price against time:

## Hedonic price regression

model1\_data <- cameras %>%  
 select(lsalesunits, lpriceur, 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)

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 = model1\_data)  
summary(hedonic1)

##   
## Call:  
## lm(formula = lpriceur ~ . - lsalesunits - type - slr - elect -   
## optical - pixeltot, data = model1\_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 = model1\_data)  
summary(hedonic2)

##   
## Call:  
## lm(formula = lsalesunits ~ . - type - slr - elect - optical -   
## pixeltot, data = model1\_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 = model1\_data)  
summary(hedonic3)

##   
## Call:  
## lm(formula = lpriceur ~ . - lsalesunits, data = model1\_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 = model1\_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 created above  
 !!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 + 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   
 #instruments start here   
 + 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 + 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 + i7\_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\_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) | # need to include again all the regressors in the ivreg function  
 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   
 #instruments start here   
 + 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) # 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.

| 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 | -9.621807 | -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.

| Country | CANON | FUJIFILM | KODAK | NIKON | OLYMPUS | PANASONIC | SAMSUNG | SONY |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| AUSTRIA | 0.013273408 | 0.0014119512 | 0.0030297413 | 0.0105577246 | 0.0059959989 | 0.008638825 | 0.0013327145 | 0.010742268 |
| BELGIUM | 0.007792430 | 0.0016973739 | 0.0023853287 | 0.0054798279 | 0.0014597587 | 0.009394431 | 0.0022066710 | 0.008386045 |
| BULGARIA | 0.005164817 | 0.0015439002 | 0.0010696782 | 0.0025891581 | 0.0033746294 | 0.002717644 | 0.0020274882 | 0.004685868 |
| CZECH REPUBLIC | 0.004258081 | 0.0013003647 | 0.0009855344 | 0.0032795831 | 0.0055613131 | 0.008312178 | 0.0011673146 | 0.003438017 |
| DENMARK | 0.005020161 | 0.0004956031 | 0.0002321558 | 0.0024647682 | 0.0016700175 | 0.001139913 | 0.0010628542 | 0.003512698 |
| FINLAND | 0.019308163 | 0.0006449350 | 0.0005420429 | 0.0073893269 | 0.0070202536 | 0.004387184 | 0.0026533671 | 0.004397160 |
| FRANCE | 0.004463418 | 0.0030506514 | 0.0021151115 | 0.0050403927 | 0.0019512715 | 0.011851443 | 0.0019431380 | 0.005502644 |
| GERMANY | 0.013335719 | 0.0022470046 | 0.0023973866 | 0.0044453510 | 0.0017740051 | 0.010287353 | 0.0022451321 | 0.005959272 |
| GREAT BRITAIN | 0.017362913 | 0.0072170641 | 0.0047322014 | 0.0099097354 | 0.0040728674 | 0.008822178 | 0.0039940570 | 0.011235806 |
| GREECE | 0.003396885 | 0.0003972133 | 0.0018403799 | 0.0027348919 | 0.0032273745 | 0.001574880 | 0.0009904938 | 0.005836750 |
| HUNGARY | 0.002516727 | 0.0042054801 | 0.0006970857 | 0.0021829168 | 0.0016587253 | 0.004620128 | 0.0015935090 | 0.002268863 |
| IRELAND | 0.017139212 | 0.0281319348 | 0.0133657502 | 0.0175462309 | 0.0063051184 | 0.009272311 | 0.0040451650 | 0.015350646 |
| ITALY | 0.004305700 | 0.0015495881 | 0.0016336443 | 0.0059166419 | 0.0013328028 | 0.003586564 | 0.0025088947 | 0.003900037 |
| NETHERLANDS | 0.009905980 | 0.0030138997 | 0.0013306107 | 0.0056055477 | 0.0037366114 | 0.009077622 | 0.0030426692 | 0.010961276 |
| POLAND | 0.004677806 | 0.0014464049 | 0.0009472683 | 0.0037197820 | 0.0021440445 | 0.004251390 | 0.0010608874 | 0.005288217 |
| PORTUGAL | 0.003877408 | 0.0023035083 | 0.0006393151 | 0.0031369415 | 0.0026564278 | 0.001935569 | 0.0020595187 | 0.005923850 |
| ROMANIA | 0.001226081 | 0.0014926795 | 0.0002686798 | 0.0009199098 | 0.0005551688 | 0.001607327 | 0.0005368215 | 0.001807331 |
| SLOVAKIA | 0.002161256 | 0.0012434789 | 0.0003385039 | 0.0016182845 | 0.0042587547 | 0.004277091 | 0.0010183014 | 0.002956304 |
| SLOVENIA | 0.007052366 | 0.0009813688 | 0.0008657170 | 0.0054813031 | 0.0040338607 | 0.001167088 | 0.0011801212 | 0.005850414 |
| SPAIN | 0.005015945 | 0.0021354171 | 0.0015417513 | 0.0044172341 | 0.0039685670 | 0.003092705 | 0.0007265355 | 0.004242023 |
| SWEDEN | 0.012292948 | 0.0037273768 | 0.0009660325 | 0.0132136824 | 0.0064874399 | 0.006288464 | 0.0033470052 | 0.006921579 |

## Merger simulation