Housing in Luxembourg

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Introduction

We are going to collaborate on a very basic project in this chapter. We'll be working on this project through to the conclusion of the book. We tried rewrite that project using the strategies that was taught to us. We are going to have developed a repeatable analytical pipeline. We will start off simply by stating that only objective is to complete the analysis.

Also, We will carry out these studies using R Quarto. Some codes in the project is taken from Dr Bruno Rodrigues' book called "Creating Reproducible Analytical Pipelines with R".

Libraries

```
library(dplyr)
library(purrr)
library(readxl)
library(stringr)
library(janitor)
library(dplyr)
library(ggplot2)
library(purrr)
library(tidyr)
library(kableExtra)
```

##Saving and Cleaning Data

Next, the code below downloads the data, and puts it in a data frame:

```
# The url below points to an Excel file
# hosted on the book's github repository

#| message: false

url <- "https://is.gd/1vvBAc"

raw_data <- tempfile(fileext = ".xlsx")

download.file(url, raw_data,
              method = "auto",
              mode = "wb")
```

```
sheets <- excel_sheets(raw_data)

read_clean <- function(..., sheet){
  read_excel(..., sheet = sheet) |>
    mutate(year = sheet)
}

raw_data <- map(
  sheets,
  ~read_clean(raw_data,
              skip = 10,
              sheet = .)
                   ) |>
  bind_rows() |>
  clean_names()
```

```
New names:
• `*` -> `*...3`
• `*` -> `*...4`
```

```
raw_data <- raw_data |>
  rename(
    locality = commune,
    n_offers = nombre_doffres,
    average_price_nominal_euros = prix_moyen_annonce_en_courant
    average_price_m2_nominal_euros = prix_moyen_annonce_au_m2_e
    average_price_m2_nominal_euros = prix_moyen_annonce_au_m2_e
  ) |>
  mutate(locality = str_trim(locality)) |>
  select(year, locality, n_offers, starts_with("average"))
```

Running this code results in a neat data set:

```
raw_data
```

```
# A tibble: 1,343 × 5
   year  locality    n_offers average_price_nominal_euros
average_price_m2_nom…¹
   <chr> <chr>          <dbl> <chr>
<chr>
 1 2010  Bascharage       192 593698.31000000006
3603.57
 2 2010  Beaufort         266 461160.29
2902.76
 3 2010  Bech              65 621760.22
3280.51
 4 2010  Beckerich        176 444498.68
2867.88
 5 2010  Berdorf          111 504040.85
3055.99
```

```
 6 2010  Bertrange        264 795338.87
4266.46
 7 2010  Bettembourg      304 555628.29
3343.22
 8 2010  Bettendorf        94 495074.38
3235.26
 9 2010  Betzdorf         119 625914.47
3343.05
10 2010  Bissen            70 516465.57
3321.65
# ℹ 1,333 more rows
# ℹ abbreviated name: ¹average_price_m2_nominal_euros
```

The naming of the communes is not consistent. Let's look at and fix it.

```
raw_data |>
  filter(grepl("Luxembourg", locality)) |>
  count(locality)
```

```
# A tibble: 2 × 2
  locality             n
  <chr>            <int>
1 Luxembourg           9
2 Luxembourg-Ville     2
```

We can see that the city of Luxembourg is spelled in two different ways. It's the same with another commune, Pétange:

```
raw_data |>
  filter(grepl("P.tange", locality)) |>
  count(locality)
```

```
# A tibble: 2 × 2
  locality     n
  <chr>    <int>
1 Petange      9
2 Pétange      2
```

So sometimes it is spelled correctly, with an "é", sometimes not. Let's write some code to correct both these issues:

```
raw_data <- raw_data |>
  mutate(
    locality = ifelse(grepl("Luxembourg-Ville", locality),
                      "Luxembourg",
                      locality),
         locality = ifelse(grepl("P.tange", locality),
                           "Pétange",
                           locality)
```

```
        ) |>
  mutate(across(starts_with("average"),
        as.numeric))
```

Now this is interesting – converting the `average` columns to numeric resulted in some `NA` values. Let's see what happened:

```
raw_data |>
  filter(is.na(average_price_nominal_euros))
```

```
# A tibble: 290 × 5
   year  locality         n_offers average_price_nomina…¹
average_price_m2_nom…²
   <chr> <chr>               <dbl>                  <dbl>
<dbl>
 1 2010  Consthum                29                     NA
NA
 2 2010  Esch-sur-Sûre            7                     NA
NA
 3 2010  Heiderscheid            29                     NA
NA
 4 2010  Hoscheid                26                     NA
NA
 5 2010  Saeul                   14                     NA
NA
 6 2010  <NA>                    NA                     NA
NA
 7 2010  <NA>                    NA                     NA
NA
 8 2010  Total d'offres       19278                     NA
NA
 9 2010  <NA>                    NA                     NA
NA
10 2010  Source : Minist…        NA                     NA
NA
# ℹ 280 more rows
# ℹ abbreviated names: ¹average_price_nominal_euros,
#   ²average_price_m2_nominal_euros
```

It turns out that there are no prices for certain communes, but that we also have some rows with garbage in there. Let's go back to the raw data to see what this is about:

What we are going to do is create two datasets: one with data on communes, and the other on national prices. Let's first remove the rows stating the sources:

```
raw_data <- raw_data |>
  filter(!grepl("Source", locality))
```

Let's now only keep the communes in our data:

```
commune_level_data <- raw_data |>
    filter(!grepl("nationale|offres", locality),
           !is.na(locality))
```

And let's create a dataset with the national data as well:

```
country_level <- raw_data |>
  filter(grepl("nationale", locality)) |>
  select(-n_offers)

offers_country <- raw_data |>
  filter(grepl("Total d.offres", locality)) |>
  select(year, n_offers)

country_level_data <- full_join(country_level, offers_country)
  select(year, locality, n_offers, everything()) |>
  mutate(locality = "Grand-Duchy of Luxembourg")
```

So let's scrape and save this list:

```
current_communes <- "https://is.gd/lux_communes" |>
  rvest::read_html() |>
  rvest::html_table() |>
  purrr::pluck(2) |>
  janitor::clean_names() |>
  dplyr::filter(name_2 != "Name") |>
  dplyr::rename(commune = name_2) |>
  dplyr::mutate(commune = stringr::str_remove(commune, " .$"))
```

Let's see if we have all the communes in our data:

```
setdiff(unique(commune_level_data$locality),
        current_communes$commune)
```

```
 [1] "Bascharage"          "Boevange-sur-Attert" "Burmerange"
 [4] "Clémency"            "Consthum"            "Ermsdorf"
 [7] "Erpeldange"          "Eschweiler"
"Heiderscheid"
[10] "Heinerscheid"        "Hobscheid"           "Hoscheid"
[13] "Hosingen"            "Luxembourg"          "Medernach"
[16] "Mompach"             "Munshausen"          "Neunhausen"
[19] "Rosport"             "Septfontaines"       "Tuntange"
[22] "Wellenstein"         "Kaerjeng"
```

We see many communes that are in our `commune_level_data`, but not in `current_communes`.

It's decided to re-host it on Github pages to avoid problems in the future:

```
former_communes <- "https://is.gd/lux_former_communes" |>
  rvest::read_html() |>
  rvest::html_table() |>
  purrr::pluck(3) |>
  janitor::clean_names() |>
  dplyr::filter(year_dissolved > 2009)

former_communes
```

```
# A tibble: 20 × 3
   name                year_dissolved reason
   <chr>                        <int> <chr>
 1 Bascharage                    2011 merged to form Käerjeng
 2 Boevange-sur-Attert           2018 merged to form
Helperknapp
 3 Burmerange                    2011 merged into Schengen
 4 Clemency                      2011 merged to form Käerjeng
 5 Consthum                      2011 merged to form Parc
Hosingen
 6 Ermsdorf                      2011 merged to form Vallée de
l'Ernz
 7 Eschweiler                    2015 merged into Wiltz
 8 Heiderscheid                  2011 merged into Esch-sur-
Sûre
 9 Heinerscheid                  2011 merged into Clervaux
10 Hobscheid                     2018 merged to form Habscht
11 Hoscheid                      2011 merged to form Parc
Hosingen
12 Hosingen                      2011 merged to form Parc
Hosingen
13 Mompach                       2018 merged to form Rosport-
Mompach
14 Medernach                     2011 merged to form Vallée de
l'Ernz
15 Munshausen                    2011 merged into Clervaux
16 Neunhausen                    2011 merged into Esch-sur-
Sûre
17 Rosport                       2018 merged to form Rosport-
Mompach
18 Septfontaines                 2018 merged to form Habscht
19 Tuntange                      2018 merged to form
Helperknapp
20 Wellenstein                   2011 merged into Schengen
```

As you can see, since 2010 many communes have merged to form new ones. We can now combine the list of current and former communes, as well as harmonise their names:

```
communes <- unique(c(former_communes$name,
                     current_communes$commune))
# we need to rename some communes

# Different spelling of these communes between wikipedia and th

communes[which(communes == "Clemency")] <- "Clémency"
communes[which(communes == "Redange")] <- "Redange-sur-Attert"
communes[which(communes == "Erpeldange-sur-Sûre")] <- "Erpeldar
communes[which(communes == "Luxembourg City")] <- "Luxembourg"
communes[which(communes == "Käerjeng")] <- "Kaerjeng"
communes[which(communes == "Petange")] <- "Pétange"
```

Let's run our test again:

```
setdiff(unique(commune_level_data$locality),
        communes)
```

```
character(0)
```

Save the Data

```
write.csv(commune_level_data, "commune_level_data.csv", row.nam
write.csv(country_level_data, "country_level_data.csv", row.nam
```

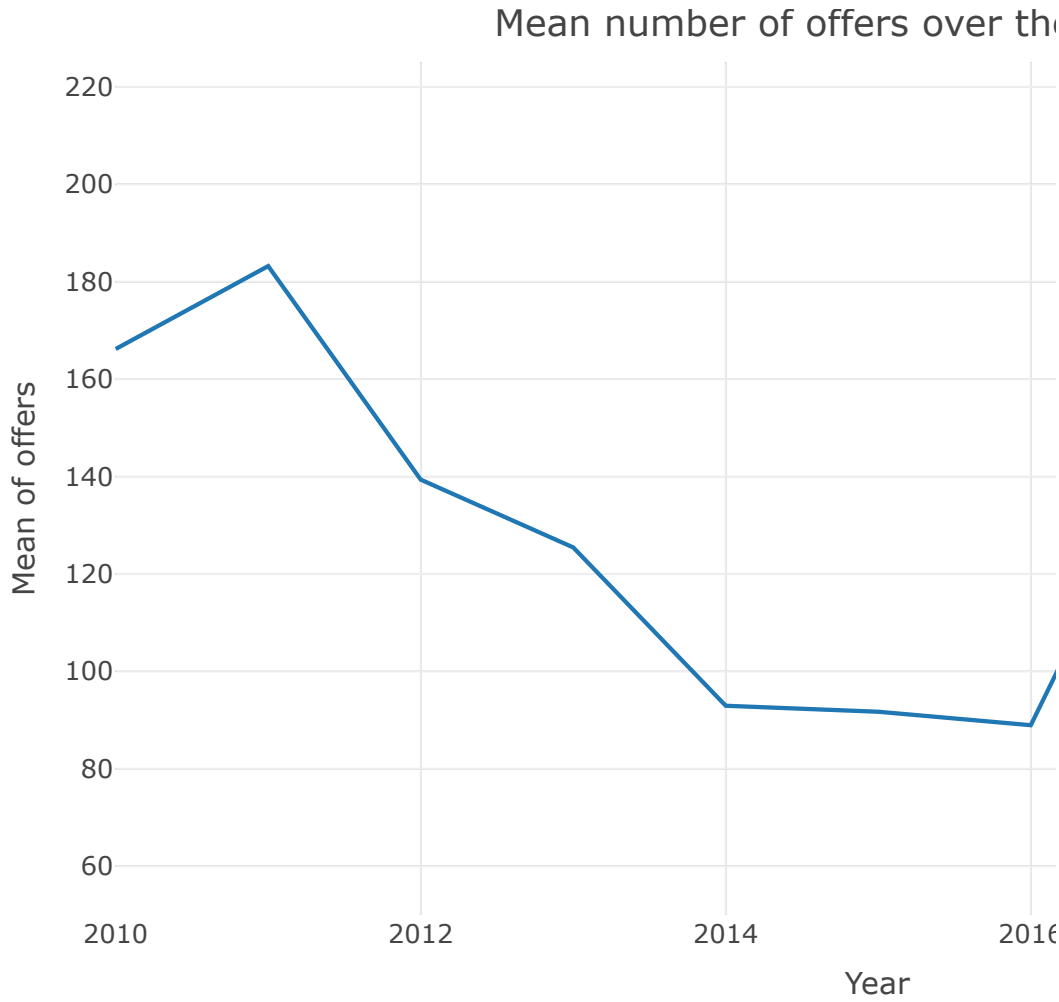
Analysis and Plots

Change of the offers over the years

```
#Let's load the datasets:
library(plotly)
```

```
Attaching package: 'plotly'

The following object is masked from 'package:ggplot2':

    last_plot

The following object is masked from 'package:stats':

    filter

The following object is masked from 'package:graphics':

    layout
```

```
commune_level_data <- read.csv("commune_level_data.csv")
country_level_data <- read.csv("country_level_data.csv")

q1 <- commune_level_data |>
  select(locality,year, n_offers) |>
  group_by(year) |>
  summarize_at(c("n_offers"), mean)

# Create a line graph using Plotly
plot <- plot_ly(data = q1, x = ~year, y = ~n_offers, type = 'sc
  layout(title = 'Mean number of offers over the Years',
         xaxis = list(title = 'Year'),
         yaxis = list(title = 'Mean of offers',range = c(50,225
plot
```



Offers started from above in 2010, reached their peak in 2011 and decreased until 2016. Although they increased again after 2016, they remained lower than the first years.

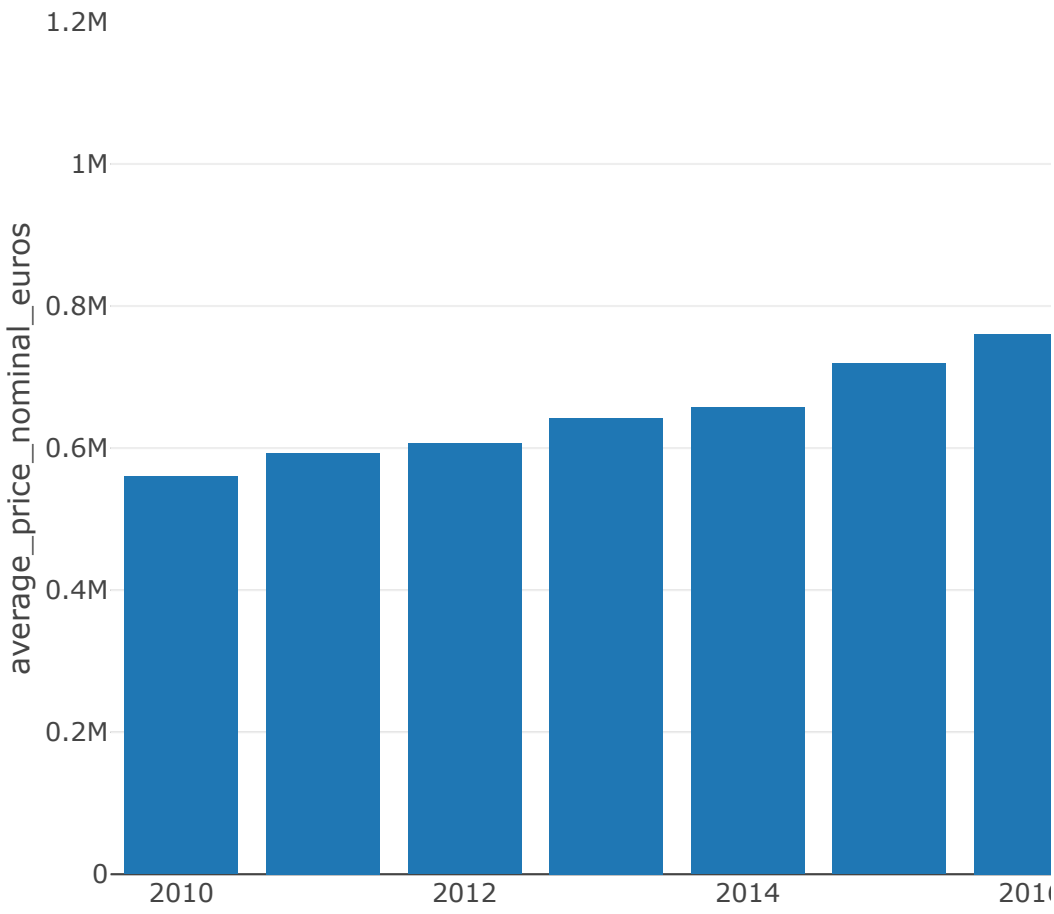
Change of the nominal average prices over the years

```
years_of_interest <- c(2010, 2011, 2012,2013,2014, 2015, 2016,

q2 <- commune_level_data |>
  select(year, average_price_nominal_euros) |>
```

```
  filter(year %in% years_of_interest) |>
  group_by(year) |>
  summarize_at(c("average_price_nominal_euros"), mean, na.rm =
q2
```

```
# A tibble: 11 × 2
    year average_price_nominal_euros
   <int>                       <dbl>
 1  2010                     559721.
 2  2011                     593391.
 3  2012                     606444.
 4  2013                     642044.
 5  2014                     657443.
 6  2015                     719049.
 7  2016                     760318.
 8  2017                     811466.
 9  2018                     863948.
10  2019                     967101.
11  2020                    1105294.
```

```
bar_plot <- plot_ly(data = q2, x = ~year, y = ~average_price_nc

bar_plot <- bar_plot %>%
  layout(yaxis = list(range = c(0, 1.2e6)))

bar_plot
```

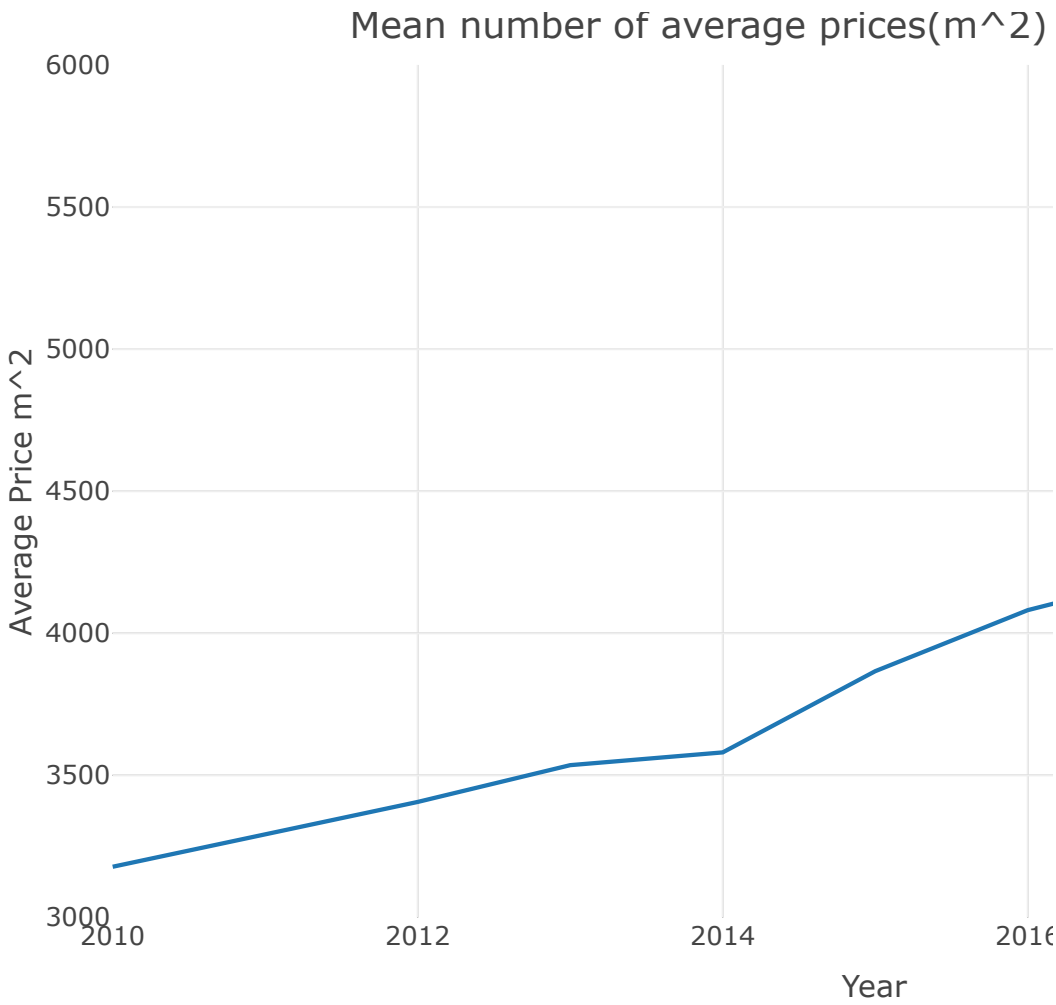


year

Average nominal prices, starting with approximately 560 thousand, increase every year and reach 1.1 million in 2020. It is clear that there is an inflationary effect.

Change of the nominal average prices(m^2) over the years

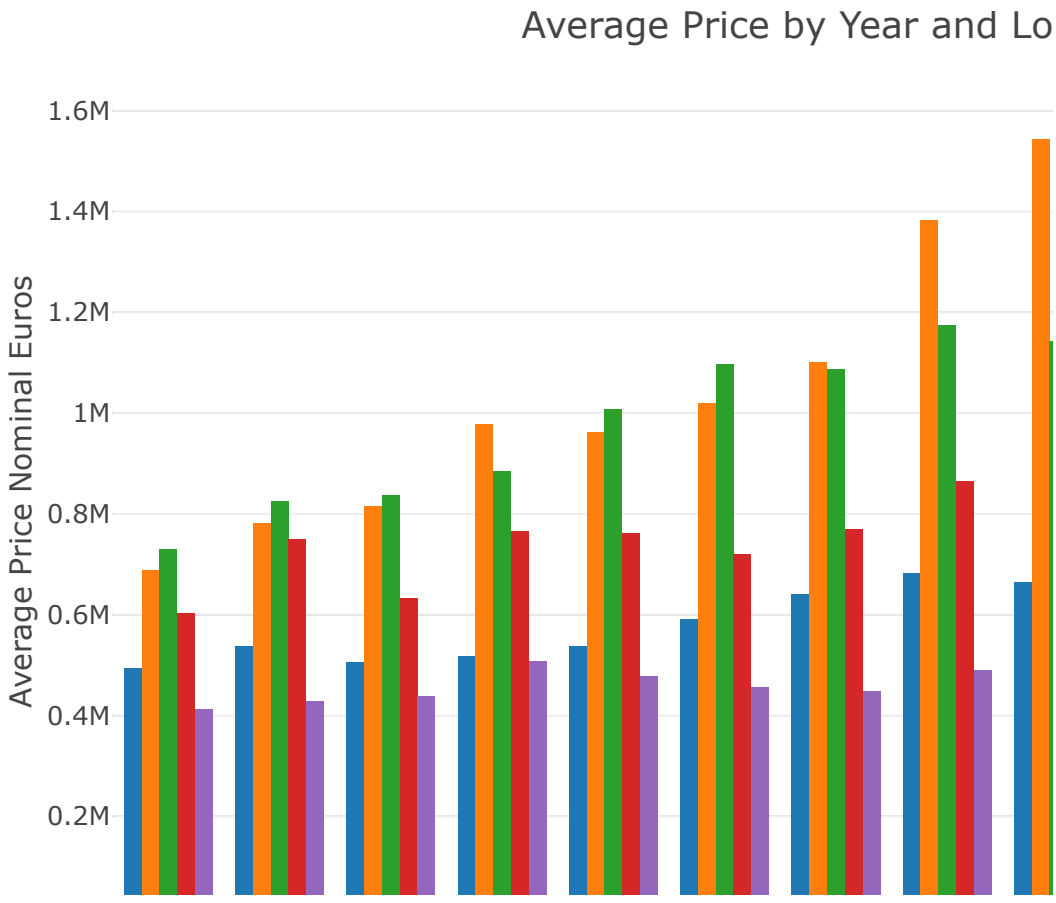
```
years_of_interest_2 <- c(2010, 2011, 2012,2013,2014, 2015, 2016

 q2_ne <- commune_level_data |>
   select(year, average_price_m2_nominal_euros) |>
    filter(year %in% years_of_interest_2) |>
    group_by(year) |>
    summarize_at(c("average_price_m2_nominal_euros"), mean, na.


line_plot_new <- plot_ly(data = q2_ne, x = ~year, y = ~average_
   layout(title = 'Mean number of average prices(m^2) over the
         xaxis = list(title = 'Year'),
         yaxis = list(title = 'Average Price m^2',range = c(300

line_plot_new
```



Square meter prices**(m^2)** increase significantly over the years.

Average Price change of the selected communes in each year

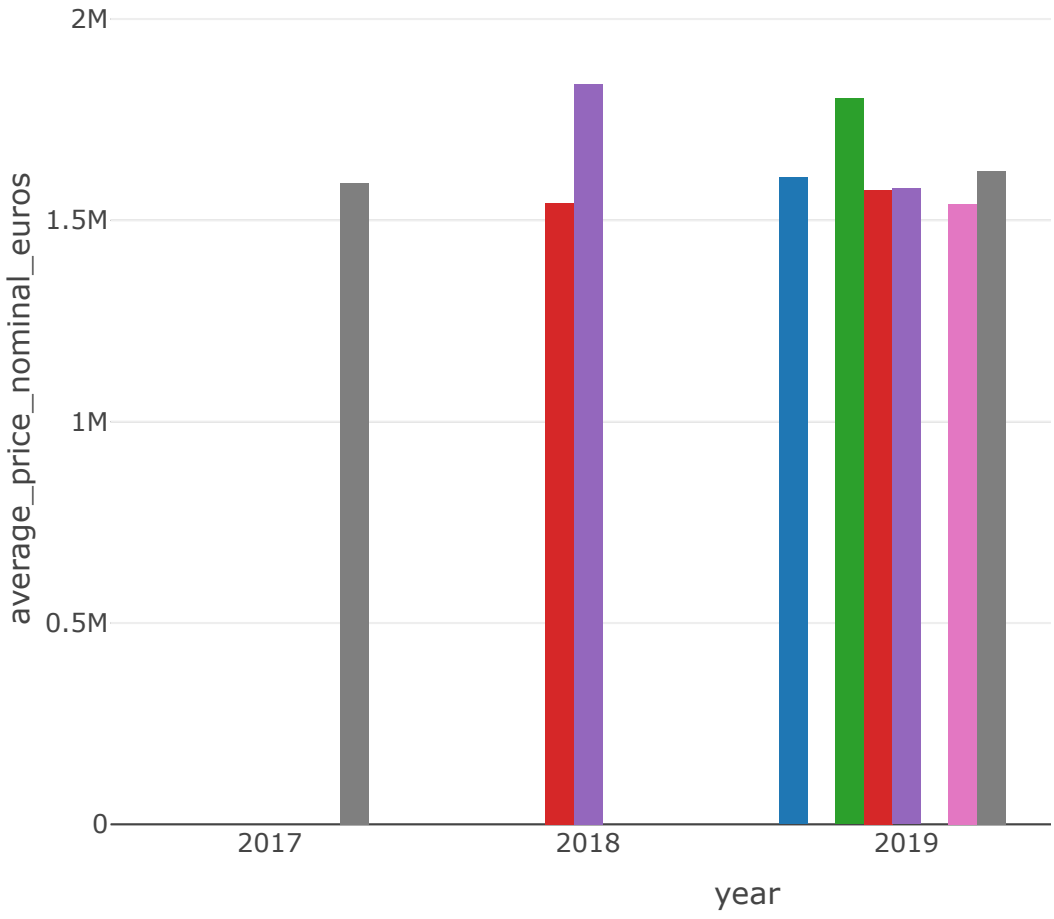
```r
years_of_interest_2 <- c(2010, 2011, 2012,2013,2014, 2015, 2016
communes <- c("Luxembourg",
              "Esch-sur-Alzette",
              "Mamer",
              "Schengen",
              "Wincrange")

 q3 <- commune_level_data |>
   select(year, locality, average_price_nominal_euros) |>
    filter(year %in% years_of_interest_2) |>
    filter(locality %in% communes) |>
    group_by(year,locality) |>
    summarize_at(c("average_price_nominal_euros"), mean, na.rm

q3$year <- as.character(q3$year)

 # ggplot(q3, aes(fill=locality, x=year, y=average_price_nomina
 #    geom_bar(position="dodge", stat="identity")

bar_plot_ly <- plot_ly(data = q3, x = ~year, y = ~average_price

bar_plot_ly <- bar_plot_ly %>%
  layout(title = 'Average Price by Year and Locality',
         xaxis = list(title = 'Year'),
         yaxis = list(title = 'Average Price Nominal Euros'),
         barmode = 'Communes')

bar_plot_ly
```



For the selected communes, although the Mamer region was dominant in the first few years, we see that the Luxembourg region was the leader in the following years. They are followed by Schengen, Esch-sur-Alzette and Wincrange, respectively.

The most expensive average price nominal euros in the last 4 years (over than 1.5million)

```
years_of_interest_3 <- c(2017,2018,2019,2020)

q4 <- commune_level_data |>
   select(year, locality, average_price_nominal_euros) |>
    filter(year %in% years_of_interest_3 & 1506490 < average_pr
    group_by(year,locality) |>
    #summarize_at(c("average_price_nominal_euros"), mean, na.rm
   arrange(desc(average_price_nominal_euros))


bar_plot_q4 <- plot_ly(data = q4, x = ~year, y = ~average_price
bar_plot_q4
```




```
#Assign 1 to 18 for the order.
```

```
q4 <- cbind(order = c(1:18), q4)

#table
  kbl(q4, booktabs = T) |>
    kable_styling(full_width = T) |>
    column_spec(1, width = "8cm")
```

order	year	locality	average_price_nominal_euros
1	2020	Schuttrange	2010937
2	2020	Kopstal	1978531
3	2020	Bertrange	1891532
4	2018	Niederanven	1837880
5	2020	Strassen	1814700
6	2019	Leudelange	1802527
7	2020	Niederanven	1749576
8	2020	Steinsel	1675188
9	2019	Strassen	1621751
10	2020	Luxembourg	1606490
11	2019	Bertrange	1606353
12	2017	Strassen	1593570
13	2019	Niederanven	1579153
14	2019	Luxembourg	1576214
15	2018	Luxembourg	1542371
16	2019	Steinsel	1540155
17	2020	Leudelange	1534376
18	2020	Walferdange	1520943

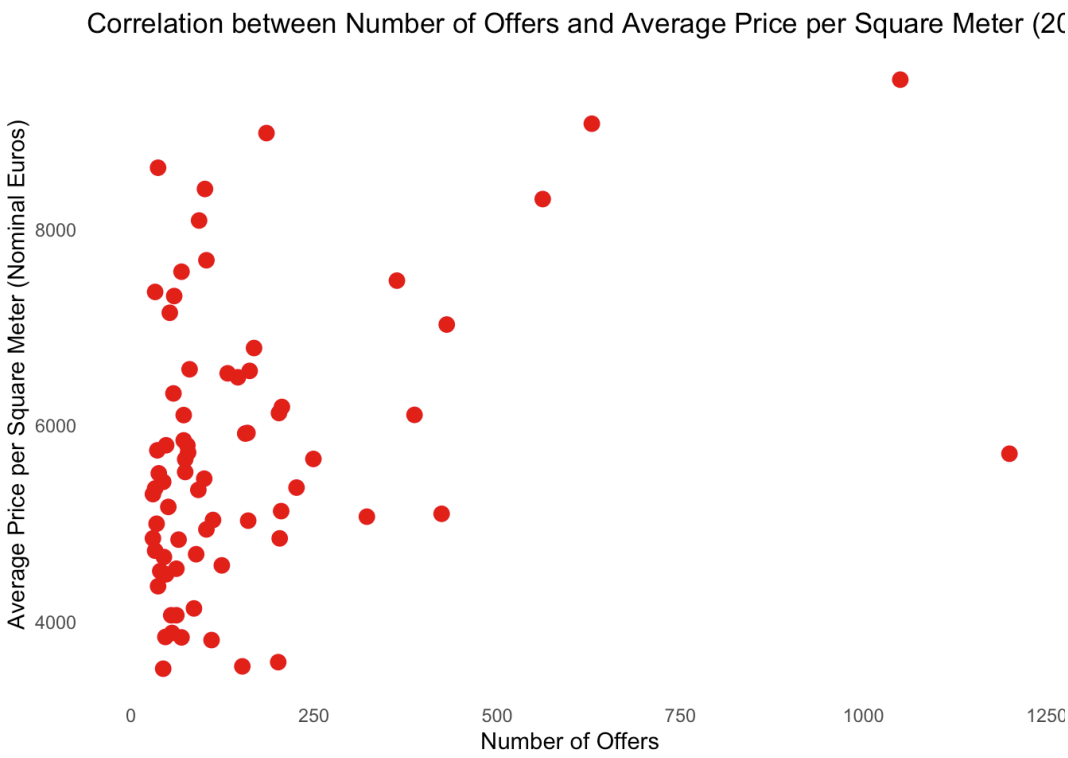
Considering inflation equality, house prices have increased significantly every year. Buying a house can be seen as a good investment tool. When we look at the first bar plot, we see that there are more than 1.5 million houses in 2020 and 2019. The other table gives us the list in order. Prices for 2020 stand out again.

Is there a correlation between the number of offers and the average house price per square meter in Luxembourg for the year 2020?

```
# Filter the data for the year 2020
data_2020 <- commune_level_data |>
  filter(year == 2020)

my_colors <- scales::brewer_pal(palette = "Set1")(1)
```

```
ggplot(data_2020, aes(x = n_offers, y = average_price_m2_nomina
  geom_point(color = my_colors[1], size = 3) +
  labs(title = "Correlation between Number of Offers and Averag
       x = "Number of Offers",
       y = "Average Price per Square Meter (Nominal Euros)") +
  theme_minimal() +
  theme(panel.grid.major = element_blank(), panel.grid.minor =
  scale_color_manual(values = my_colors)
```

```
Warning: Removed 31 rows containing missing values
(`geom_point()`).
```

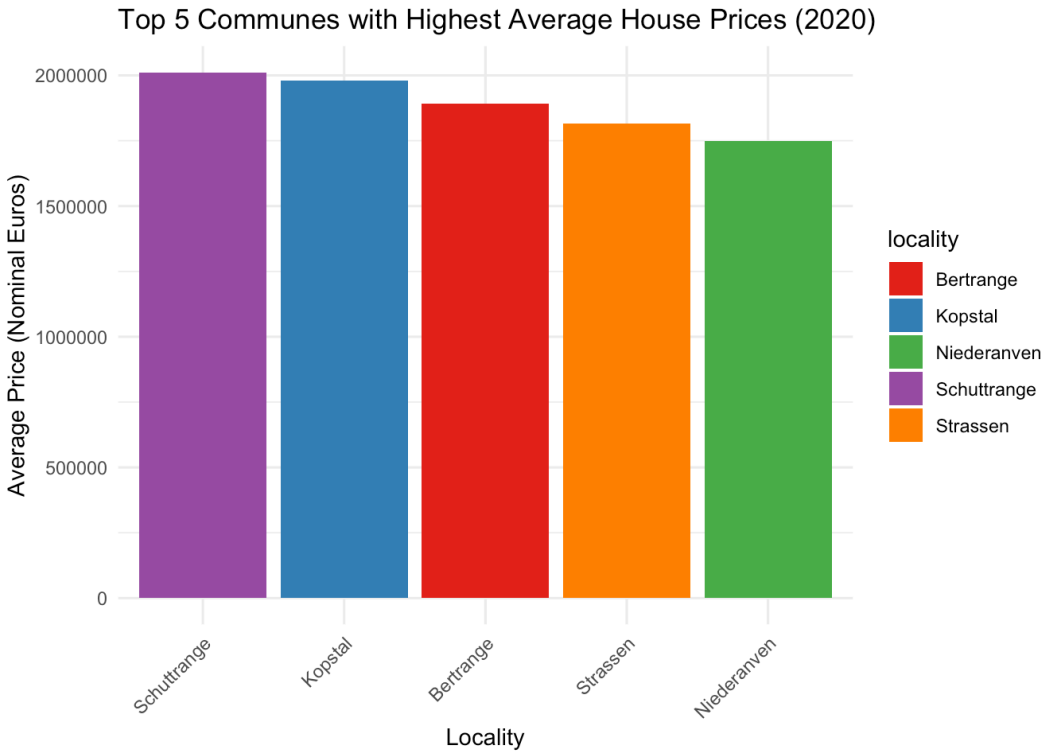


It seems there is no correlation between number of offers and average price(m^2)

What are the top 5 communes with the highest average house prices in the most recent year (2020)?

```
# Filter the data for the year 2020
data_2020 <- commune_level_data |>
  filter(year == 2020)

# Sort the data by average_price_nominal_euros in descending or
top_5_communes_2020 <- data_2020 |>
  arrange(desc(average_price_nominal_euros)) |>
  head(5)

# Create a bar plot
my_colors <- scales::brewer_pal(palette = "Set1")(5)
```

```r
ggplot(top_5_communes_2020, aes(x = reorder(locality, -average_
  geom_bar(stat = "identity") +
  labs(title = "Top 5 Communes with Highest Average House Price
       x = "Locality",
       y = "Average Price (Nominal Euros)") +
  theme_minimal() +
  theme(axis.text.x = element_text(angle = 45, hjust = 1)) +
  scale_fill_manual(values = my_colors)
```



As we examined a little in our previous questions, we only took the values in 2020 for the question. Accordingly, Schuttrange leads the top 5 communes in terms of expensive prices.

References

https://raps-with-r.dev/project_start.html

https://quarto.org/docs/computations/r.html