

# Banknotes in Circulation

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23/10/2020

## Banknotes in Circulation

### Overview

One of the main activities of Banco de Mexico is to issue new Banknotes and Coins and ensure an adequate level of Banknotes and Coins in Circulation to satisfy the Cash requirements of the people, businesses and companies, to allow the Economy of the country work properly.

The aim of this document is to analyze the Banknotes in Circulation using the SIE API with the `siebanxicor` R-package, and the custom function `sie_function` from the *SIE\_function.R* script.

### Quick overview

I use the developed custom function for an overview of the first draft to look into the Banknotes in Circulation by denomination.

```
# load libraries
library("siebanxicor")
library("tidyverse")

## -- Attaching packages ----- tidyverse 1.3.0 --

## v ggplot2 3.3.2      v purrr  0.3.4
## v tibble  3.0.3      v dplyr  1.0.2
## v tidyr   1.1.2      v stringr 1.4.0
## v readr   1.4.0      v forcats 0.5.0

## -- Conflicts ----- tidyverse_conflicts() --
## x dplyr::filter() masks stats::filter()
## x dplyr::lag()    masks stats::lag()

library(reshape2)

##
## Attaching package: 'reshape2'

## The following object is masked from 'package:tidyr':
##
## smiths
```

```

# call and set the token
token_file <- read.csv("../token/SIE_Token.csv", header=FALSE)

## Warning in read.table(file = file, header = header, sep = sep, quote = quote, :
## incomplete final line found by readTableHeader on '../token/SIE_Token.csv'

setToken(token_file$V2)

# call the customed function from an RScript
source("SIE_function.R")

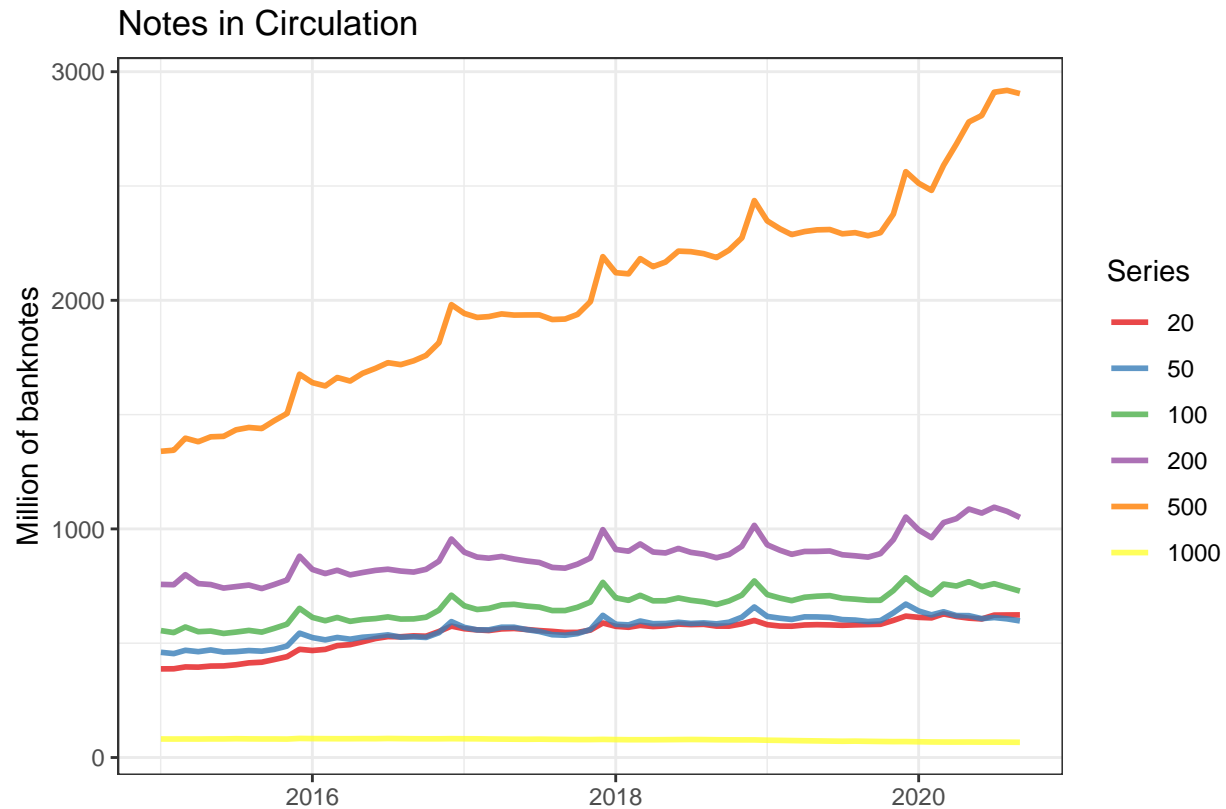
# setting the variables for current Notes in Circulation
my_series <- c('SM1472', 'SM1478', 'SM1479', 'SM1480', 'SM1481', 'SM1482')
my_names <- c('20', '50', '100', '200', '500', '1000')
my_title <- "Notes in Circulation"
my_start <- '2015-01-01'

my_route <- "../img/"

# run the function
series_NIC <- sie_function(my_series, my_names,
                           my_title, route = my_route,
                           y_lab = "Million of banknotes",
                           startDate = my_start)

## Saving 6.5 x 4.5 in image

```



```
## idSerie title startDate endDate
## 1 SM1472 Total of banknotes in circulation 20 pesos 1993-01-01 2020-09-01
## 2 SM1480 Total of banknotes in circulation 200 pesos 1993-01-01 2020-09-01
## 3 SM1482 Total of banknotes in circulation 1,000 pesos 1993-01-01 2020-09-01
## 4 SM1478 Total of banknotes in circulation 50 pesos 1993-01-01 2020-09-01
## 5 SM1479 Total of banknotes in circulation 100 pesos 1993-01-01 2020-09-01
## 6 SM1481 Total of banknotes in circulation 500 pesos 1993-01-01 2020-09-01
## frequency dataType unit
## 1 Monthly Stocks Millions of pieces
## 2 Monthly Stocks Millions of pieces
## 3 Monthly Stocks Millions of pieces
## 4 Monthly Stocks Millions of pieces
## 5 Monthly Stocks Millions of pieces
## 6 Monthly Stocks Millions of pieces
```

And this is an example of how does the Notes in Circulation (NIC) tidy data frame looks like:

```
## date value serie serie_name
## 409 2020-04-01 67.5 SM1482 1000
## 410 2020-05-01 67.6 SM1482 1000
## 411 2020-06-01 67.3 SM1482 1000
## 412 2020-07-01 67.2 SM1482 1000
## 413 2020-08-01 66.9 SM1482 1000
## 414 2020-09-01 66.5 SM1482 1000
```

## Getting a squared data frame

Tidy data is not always the easiest way to look at through the human-eye. The next code chunk wrangles the previously obtained tidy data frame into a messy and square data frame with one column per denomination.

```
# get square data frame
squared_NIC <- dcast(series_NIC, date~serie)

# rename the series
names(squared_NIC) <- c("date", my_names)

# order by date
squared_NIC <- squared_NIC[order(as.Date(squared_NIC$date, format = "%Y-%m-%d")),]

# print an example of the data frame
squared_NIC %>% head()
```

```
##           date      20      50     100     200      500 1000
## 1 2015-01-01 387.7 460.2 555.1 757.2 1339.6 81.0
## 2 2015-02-01 388.0 454.6 546.5 755.8 1344.2 80.8
## 3 2015-03-01 396.2 469.0 571.0 799.7 1396.9 81.0
## 4 2015-04-01 395.3 462.9 550.3 760.6 1381.3 80.8
## 5 2015-05-01 399.9 470.5 553.1 756.6 1402.8 81.3
## 6 2015-06-01 400.5 461.3 542.7 741.1 1404.9 81.2
```

## Looking into the annual growth

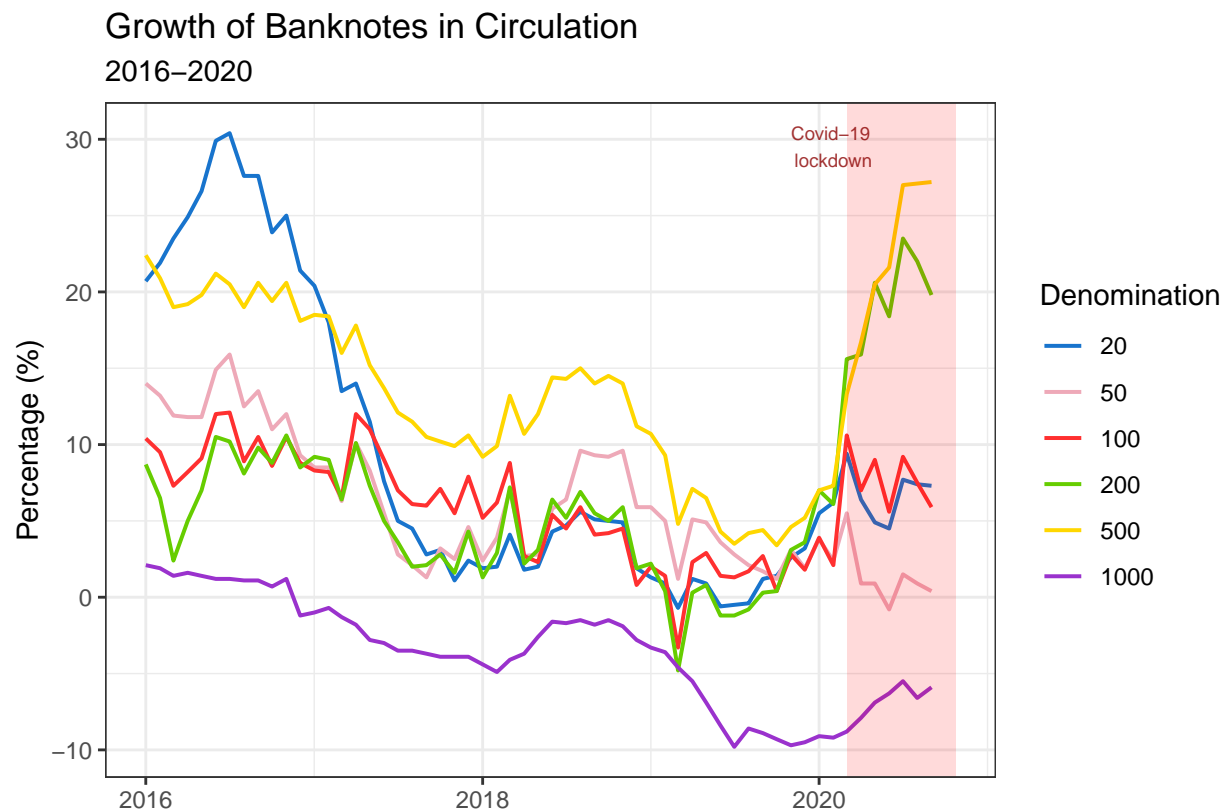
It would be also useful to look into the annual growth (comparing the number of NIC of a specific month vs. the data of the same month from the previous year).

```
# get the growth rate
growth_NIC <- series_NIC %>%
  group_by(serie) %>%
  mutate(annual_growth = round((value - lag(value, 12)) * 100 / lag(value, 12), 1)) %>%
  subset(select = -c(value)) %>%
  drop_na()

# print an example of the data frame
growth_NIC %>% tail()
```

```
## # A tibble: 6 x 4
## # Groups:   serie [1]
##   date      serie serie_name annual_growth
##   <date>    <chr>  <fct>         <dbl>
## 1 2020-04-01 SM1482 1000          -7.9
## 2 2020-05-01 SM1482 1000          -6.9
## 3 2020-06-01 SM1482 1000          -6.3
## 4 2020-07-01 SM1482 1000          -5.5
## 5 2020-08-01 SM1482 1000          -6.6
## 6 2020-09-01 SM1482 1000          -5.9
```

```
# plot
growth_NIC %>% ggplot() +
  geom_line(aes(x = date, y = annual_growth, color = serie_name), size = 0.7) +
  labs(title = "Growth of Banknotes in Circulation", subtitle = "2016-2020", x = "", y = "Percentage (%)") +
  scale_color_manual(values = c("dodgerblue3", "pink2", "firebrick1", "chartreuse3", "gold", "darkorchid3", "darkred1")) +
  annotate(geom = "rect", xmin = as.Date("2020-03-01", "%Y-%m-%d"), xmax = as.Date(Sys.Date(), "%Y-%m-%d"), ymin = -10, ymax = 30) +
  annotate("text", x = as.Date("2020-02-01", "%Y-%m-%d"), y = 29.5, label = "Covid-19 \nlockdown", size = 16, color = "darkred1") +
  theme_bw()
```



```
# save plot
ggsave(paste0(my_route, "Growth of Banknotes in Circulation.png"))
```

## Saving 6.5 x 4.5 in image

## Cumulative growth over the year

While the previous graph shows the annual growth of Banknotes in Circulation, a level graph of the cumulative growth of Banknotes in Circulation show us the need of cash during the year.

The first step would be get the Banknotes in Circulation per year.

```
# get the growth rate
df_total_NIC <- series_NIC %>%
  group_by(date) %>%
```

```
summarise(NIC = sum(value)) %>%
mutate(year = format(as.Date(date, format = "%Y-%m-%d"), "%Y")) %>%
mutate(month = format(as.Date(date, format = "%Y-%m-%d"), "%b"))
```

```
## `summarise()` ungrouping output (override with `.groups` argument)
```

```
# set order of months
df_total_NIC$month = factor(df_total_NIC$month, levels = c("Jan", "Feb", "Mar", "Apr", "May", "Jun", "Jul", "Aug", "Sep", "Oct", "Nov", "Dec"))

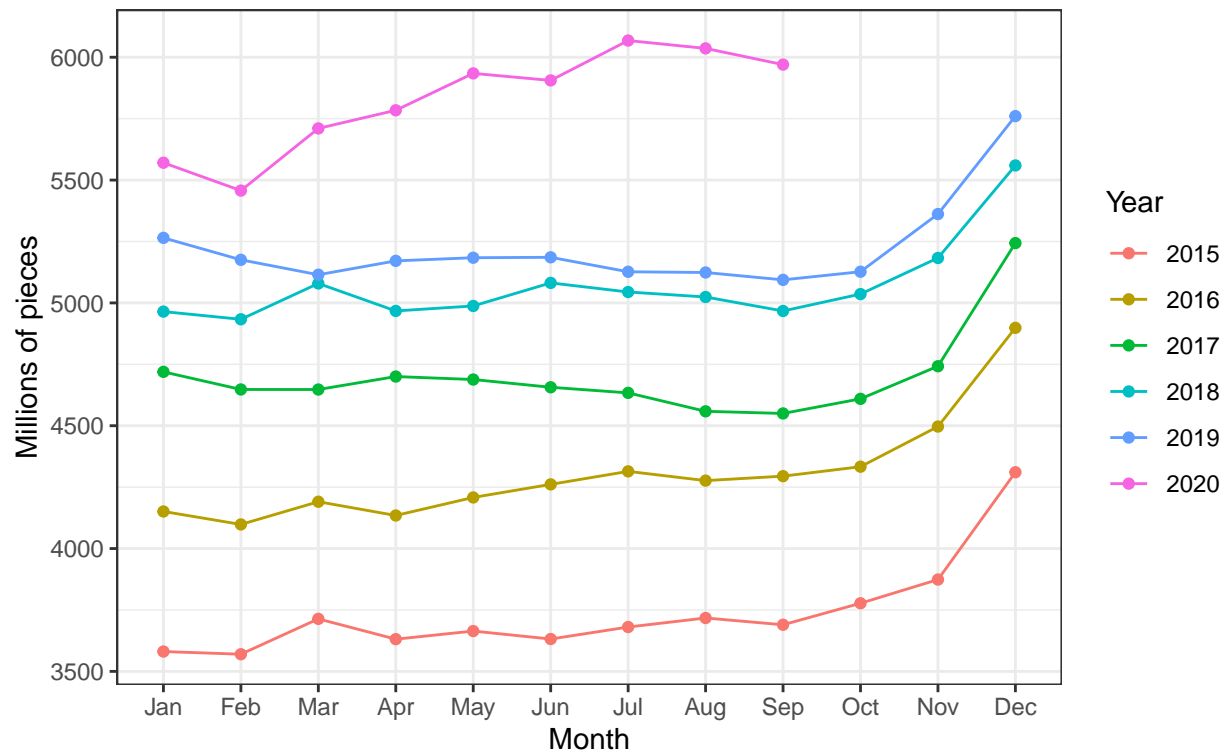
# show data.frame
df_total_NIC %>% head()
```

```
## # A tibble: 6 x 4
##   date      NIC year month
##   <date>    <dbl> <chr> <fct>
## 1 2015-01-01 3581. 2015 Jan
## 2 2015-02-01 3570. 2015 Feb
## 3 2015-03-01 3714. 2015 Mar
## 4 2015-04-01 3631. 2015 Apr
## 5 2015-05-01 3664. 2015 May
## 6 2015-06-01 3632. 2015 Jun
```

```
# plot
df_total_NIC %>% ggplot(aes(x = month, y = NIC, color = year, group = year))+
  geom_line() +
  geom_point() +
  labs(title = "Banknotes in Circulation", subtitle = "2015-2020, per year", x = "Month", y = "Millions")
  theme_bw()
```

## Banknotes in Circulation

2015–2020, per year



```
# save plot
ggsave(paste0(my_route, "Total Banknotes in Circulation per year.png"))
```

## Saving 6.5 x 4.5 in image

The next step is obtain the growth rate using January as starting point.

```
# fix the initial value for each year
df_initial <- df_total_NIC %>%
  #mutate(NIC_diff = NIC - lag(NIC) ) %>%
  melt(id = c("month", "year"), measure="NIC") %>%
  dcast(month ~ year) %>%
  subset(select = c("month", "2016", "2017", "2018", "2019", "2020")) %>% slice(1)
df_initial <- as.numeric(df_initial[1,2:6])

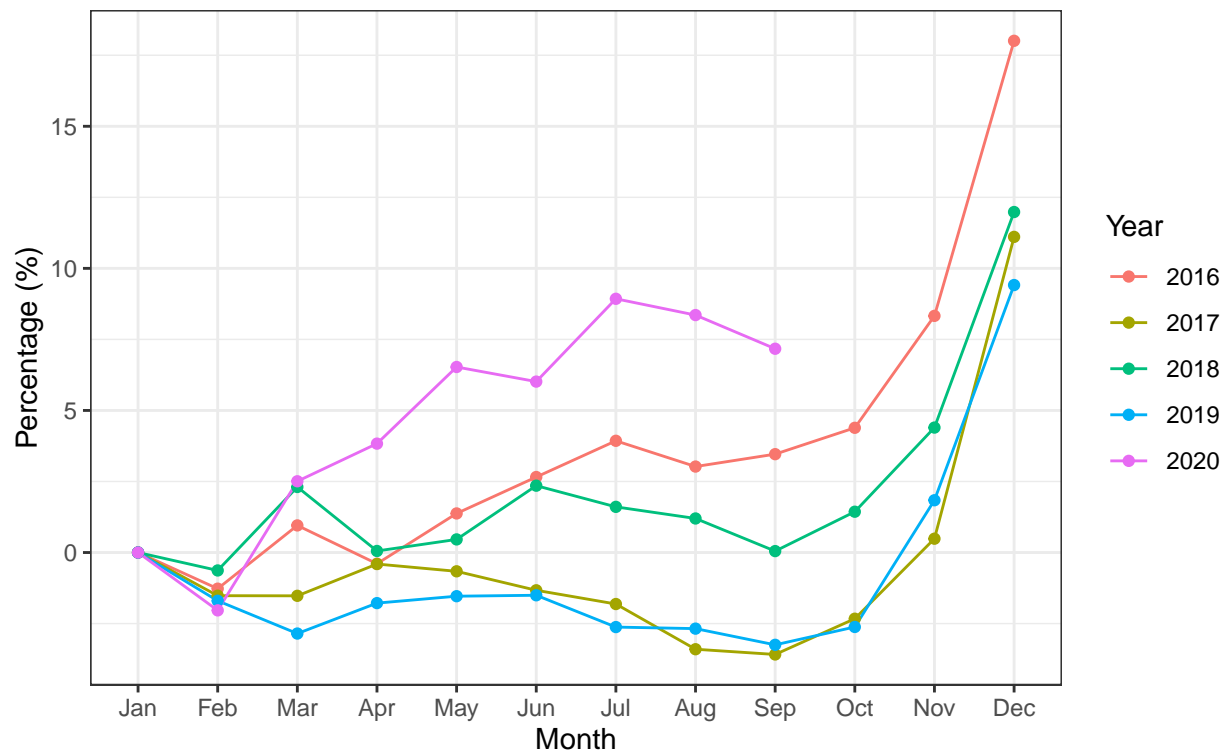
# get the difference for the value reported in each month
# compared with the January value of the same year
df_diff_NIC <- df_total_NIC %>%
  mutate(NIC_diff = NIC - lag(NIC) ) %>%
  melt(id = c("month", "year"), measure="NIC_diff") %>%
  dcast(month ~ year) %>%
  subset(select = c("month", "2016", "2017", "2018", "2019", "2020"))
the_months <- df_diff_NIC[[1]]
the_columns <- colnames(df_diff_NIC)
df_diff_NIC[1,2:6] <- 0
```

```
df_diff_NIC <- df_diff_NIC[,2:6] %>%
  apply(2, cumsum) %>% matrix(ncol=5)

# get the growth dataframe
my_matrix <- sweep(df_diff_NIC, 2, df_initial, "/") * 100
df_growth_NIC <- data.frame(the_months, my_matrix) %>%
  rename_all(~the_columns) %>%
  melt(id=c("month"))

# plot
df_growth_NIC %>% ggplot(aes(x = month, y = value, color = variable, group = variable)) +
  geom_line() +
  geom_point() +
  labs(title = "Cumulative Growth of Banknotes in Circulation",
       subtitle = "2016-2020",
       x="Month", y="Percentage (%)",
       color = "Year") +
  theme_bw()
```

Cumulative Growth of Banknotes in Circulation  
2016–2020



```
# save plot
ggsave(paste0(my_route, "Cumulative Growth of Banknotes in Circulation.png"))
```

```
## Saving 6.5 x 4.5 in image
```