TAYLOR RULE: ANALYSIS FOR BRAZIL

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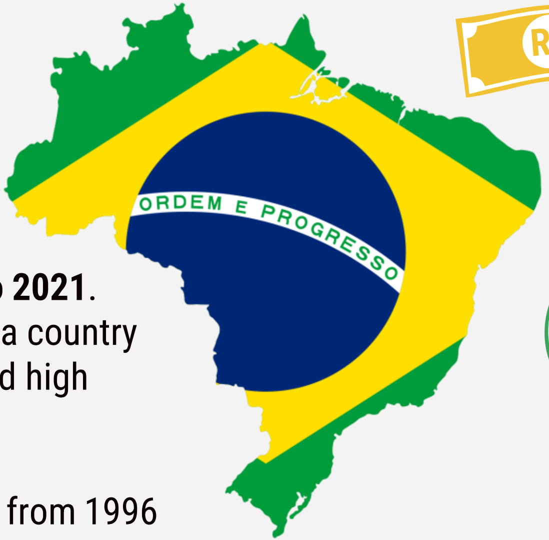
Introduction



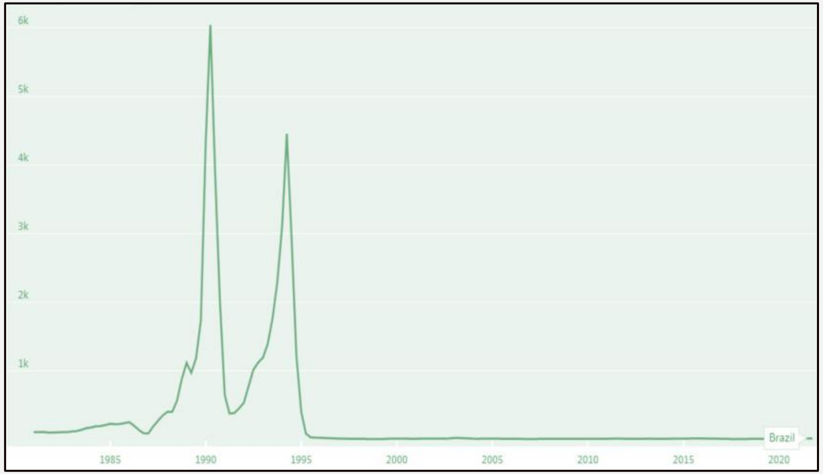
The object of our analysis is the **economic scenario of Brazil** from **1996 to 2021**.
Our objective was to verify whether the Taylor Rule was applicable even in a country with a rough historical background, characterized by political instability and high public debt and inflation.

The data we used for our analysis is mainly taken from the OECD archives, from 1996 to 2021.
Given the difficulty of retrieving monthly/quarterly data, we decided to use annual data, despite we know that our analysis will not be as accurate.

In the end, we decided to consider a new variable, the unemployment rate, and check whether it had significance in our final analysis.

Historical overview

Before starting, it is important to note how Brazilian's inflation had, from 1985 to 1995, an irregular behavior, and why.



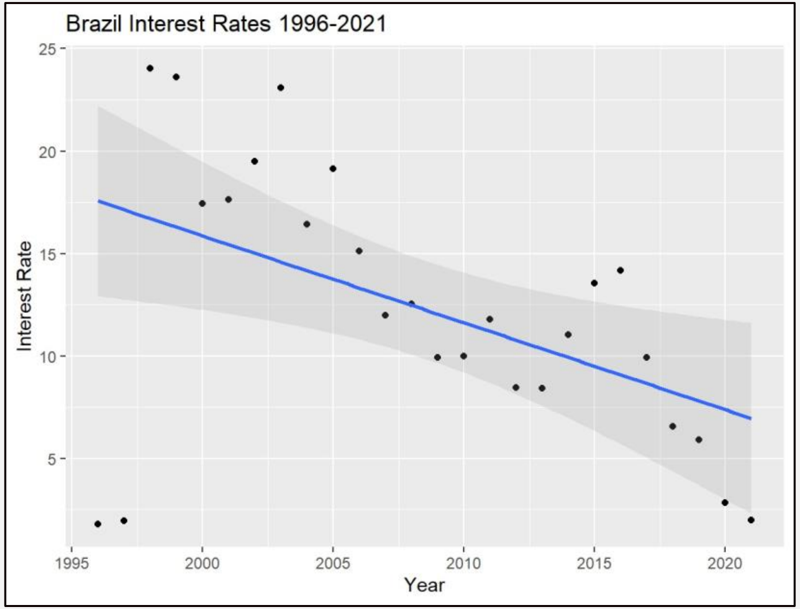
Inflation (CPI)Total, Annual growth rate (%), Q1 1981 – Q4 2021)

- From 1975 to 1990 Brazil was ruled by a military dictatorship. In the first years of this government, the country's GDP started growing slowly.
- However, in 1980 Brazil experienced a **debt crisis**, which led to a **steep decrease** of inflation, that reached 46.03%.
- Starting from 1994, a series of economic reforms known as "Plano Real" were introduced. These helped Brazil to gain stability and economic growth.

So, we decided to analyze the period starting from 1996, since the data abut the previous years were not clear, and difficult to find.

Short-Term Interest Rates

The first data we need is the annual short-term interest rate from 1996 to 2021:

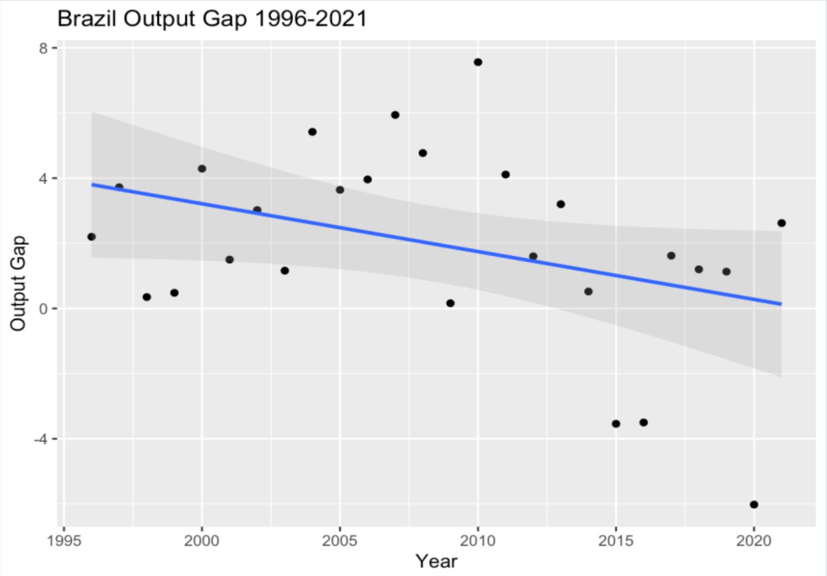


It is noticeable that, except for some outliers, the overall behavior of the short-term interest rate tends to constantly decrease over time.

Despite this decrease, the interest rates are quite high compared to other countries of the world in the same period. This was often considered as one of the reasons for which Brazil had great difficulties in developing its economy.

GDP Gap

Then, we will use the GDP gap of Brazil from 1996 to 2021:

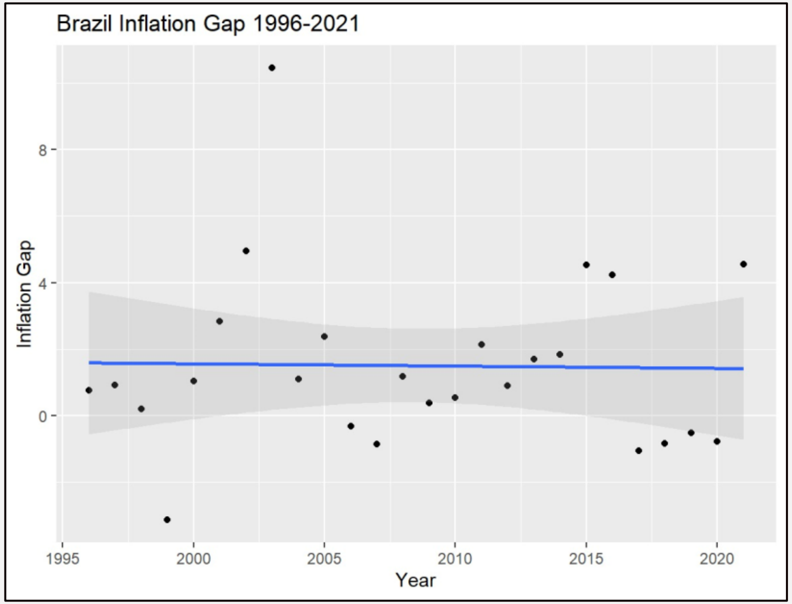


The overall trend shows an irregular behavior of the GDP gap over time.
However, looking at the actual GDP, we notice a constant increase over time.
The main reasons of this increase are mostly considered to be different reforms implemented in the 1990s, that reduced state intervention and increased competition through privatization, deregulation, and trade liberalization.

In addition, the macroeconomic policy framework, which consisted in inflation targeting and flexible exchange rate regime, helped to increase the degree of openness in the economy, and so, growth.

Inflation Gap

Lastly, we will need the inflation gap from 1996 to 2021:



As we can see from the graph, inflation gap are quite irregular: periods of positive and negative gaps are not uniformly distributed.
Periods of positive inflation gap implies the presence of a period of inflation; at the contrary, periods of negative gap implies deflation.

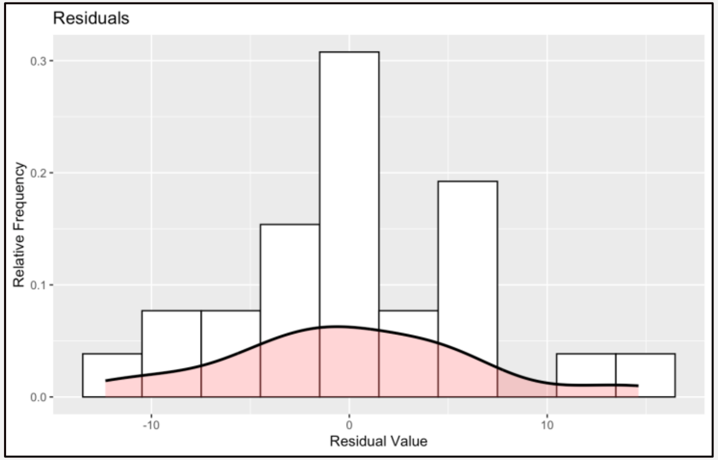
An important cause of Brazilian’s stabilization was due to different reforms starting from 1994, which successfully decreased the rate of inflation to a one-digit figure.
In the subsequent years, inflation fluctuated slightly, as we can see from gaps that are not too large.

Linear Regression Analysis

At this point, we can run a linear regression on R, and check whether the output gap and the inflation gap are relevant variables in the estimation of the short-term interest rate.

```
Call:
lm(formula = interest_rate ~ Outgap + Inflationgap, data = data)

Residuals:
     Min       1Q   Median       3Q      Max
-12.3276  -3.8802  -0.3718   4.3902  14.6147
```



Firstly, we can notice that the residuals are quite symmetrically distributed around 0.

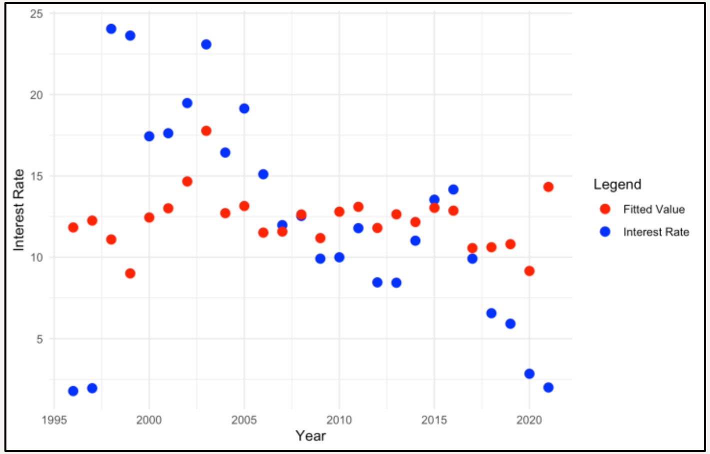
In fact, the shape of the distribution looks like a Normal one, as we can see from the graph.
Later on, we will run a normality test.

Linear Regression Analysis

Looking at the coefficients, we can notice that:

```
Coefficients:
              Estimate Std. Error t value Pr(>|t|)    
(Intercept)    10.9024     1.7851   6.107 3.14e-06 ***
Outgap          0.2062     0.4459   0.463    0.648    
Inflationgap    0.6338     0.5020   1.263    0.219    
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

- The standard error is quite small, which implies that our model may be a good fit for our data.
- The t-value is greater for the inflation gap, which is then more relevant than the output gap.
- Lastly, the p-value for the inflation gap is smaller than that of the output gap, implying that this variable is most likely significant in the model.
- At the contrary, the output gap is probably less relevant.



Also, these coefficients imply that a 1 unit increase in the output gap leads to a 0.2 increase in the short-term interest rate, and a 1 unit increase in inflation gap imply a 0.63 increase in short-term interest rate.

Linear Regression Analysis

Lastly:

```
Residual standard error: 6.675 on 23 degrees of freedom
Multiple R-squared:  0.06911,	Adjusted R-squared:  -0.01184 
F-statistic: 0.8538 on 2 and 23 DF,  p-value: 0.4389
```

- The Multiple R-squared and the Adjusted R-squared, both have low values: this is partly due to the fact that the analysis conducted only had 25 observations and 2 independent variables (so, 23 degrees of freedom).
- Similarly, the F-statistic has a value close to 1;
- Then, the p-value is quite high. This implies that, given the small number of data points in the model, the model fit is not precise in explaining the dependent variable.

Adding a New Variable

We then tried to consider a new independent variable: the unemployment rate, to see whether it could be relevant in the model or not.

```
Call:
lm(formula = interest_rate ~ Outgap + Inflationgap + unemployment,
    data = data)

Residuals:
     Min       1Q   Median       3Q      Max 
-11.1621  -3.8630  -0.3999   4.7560  13.8918 

Coefficients:
              Estimate Std. Error t value Pr(>|t|)
(Intercept)  13.944869   8.713724   1.600    0.124
Outgap        0.007742   0.734516   0.011    0.992
Inflationgap  0.657290   0.519147   1.266    0.219
unemployment -0.281083   0.957359  -0.294    0.772

Residual standard error: 6.818 on 22 degrees of freedom
Multiple R-squared:  0.07091,	Adjusted R-squared:  -0.05579 
F-statistic: 0.5597 on 3 and 22 DF,  p-value: 0.6472
```

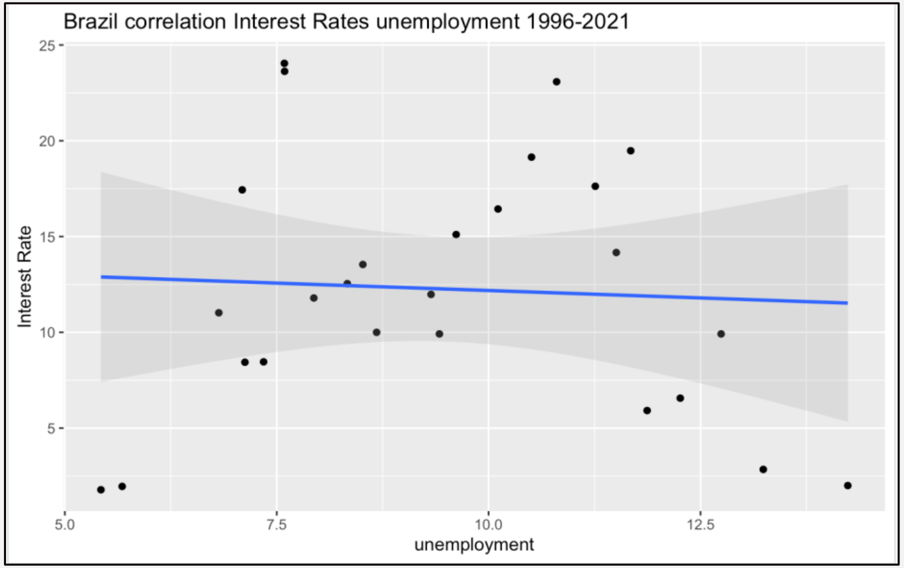
- The residuals are symmetrically distributed around the mean.
- The standard error is quite high, which seems to imply that the unemployment rate is not very relevant in the model.
- This is confirmed with the p-value, which is quite large.

So, we can conclude that the unemployment rate is not relevant in the model.

Adding a New Variable

The conclusion reached in the previous slide can be further checked by computing the correlation between the short-term interest rate and the unemployment rate.
In fact, the correlation is close to 0, as we can see from the computation and from the graph.

```
> cor(unemployment, interest_rate)
[1] -0.055633
```



Final Tests

Firstly, we will perform a RESET test, in order to study the linearity of the model.
After having computed the test on R, considering the powers of 2 and 3, we can notice that the p-value is equal to 0.28. This implies that most likely the null hypothesis of normality is rejected, and that the best fit for this model is not a linear one.
This can be further explained by the fact that adding the second and third power of our explanatory variables in the model had an addictional explanatory power.

```
> resettest(taylor_reg, power = 2:3, type = "fitted")

	RESET test

data:  taylor_reg
RESET = 1.3504, df1 = 2, df2 = 21, p-value = 0.2807
```

Final Tests

Lastly, we will perform a Jarque and Bera test for normality.
The result gives a p-value of 0.9, which also implies that the null hypothesis of normality of the residuals is rejected.

```
> jarque.bera.test(residuals(taylor_reg))

	Jarque Bera Test

data:  residuals(taylor_reg)
X-squared = 0.25597, df = 2, p-value = 0.8799
```

THANK YOU

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