Econometric Model

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Descriptive analysis: Short-term interest rate

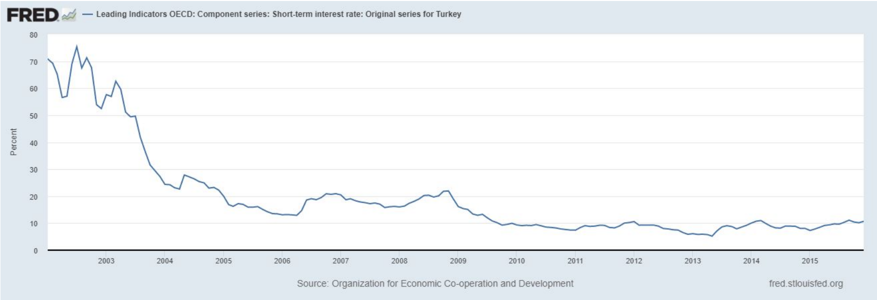
In Turkey, the interest rates are calculated by TÜİK, the Turkish Statistical Institute.

The TCMB (Central Bank of the Republic of Türkiye) uses the interest rates as a means to influence the level of economic inflation and economic activity, with the interest in and of itself influencing the price of borrowing money in Turkey.

The graph shows Turkey's short-term interest rates in the years 2002-2015. Below are some notes on the factors influencing the changes:

2002-2013 - introduction and implementation of monetary policies created by the IMF (International Monetary Fund) in the aftermath of the 2001 economic crisis

2014-2016 - devaluation of currency juxtaposed with just enough economic growth to compensate and create a growing PPP



Descriptive analysis: Model explanation

In our model we use Taylor's regression to estimate the short-term interest rate for Turkey.

The input data we used in our formula was inflation (measured by the CPI (Consumer Price Index) and the inverse exchange rate, in the years 2002-2015. We chose this period of time because it coincided with the introduction of a new monetary policy after a big economic crisis in Turkey, therefore clearly showing the impact of the changes introduced into the economy.

Descriptive analysis: Initial model explanation

Below is Taylor's formula which we use in order to calculate the short-term interest rate.

$$i_t = \alpha + \beta_\pi \pi_t + \beta_y y_t + \varepsilon_t$$

This formula was selected by us due to the fact that its alpha variable represents the sum of the inflation and the short-term interest rate. This intercept is an exogenous variable, and as such is not affected by the multipliers used in the other parts of the formula.

$$i_t = \alpha + \beta_\pi(\pi_t - \pi^*) + \beta_y y_t$$

Descriptive analysis: Testing of initial model

From the output given to us by the Taylor formula we can see that our model gave very high levels of significance and a high R^2.

We then performed more tests on our model in order to check its linearity, homoscedasticity, and serial correlation. We used the RESET test, the Studentized Breusch-Pagan test, and the Breusch-Godfrey test, for each of the characteristics respectively.

```
> reg1 = lm(annualinrate ~ annualcpi + opgap)
> summary(reg1)

Call:
lm(formula = annualinrate ~ annualcpi + opgap)

Residuals:
   Min     1Q Median     3Q    Max 
-6.069 -4.583 -1.050  1.835 12.631 

Coefficients:
            Estimate Std. Error t value Pr(>|t|)    
(Intercept)   0.5784     2.9368   0.197    0.847    
annualcpi     1.5563     0.1890   8.235 4.95e-06 ***
opgap         0.2280     0.4365   0.522    0.612    
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 6.284 on 11 degrees of freedom
Multiple R-squared:  0.8778,	Adjusted R-squared:  0.8556 
F-statistic: 39.53 on 2 and 11 DF,  p-value: 9.506e-06
```

Alternative model specifications: Using GDP and the output gap

The change introduced in our alternative model was substituting both of the initial indicators with GDP and the output gap.

We then performed the same tests and compared the results, noticing the similar level of linearity, a significantly lower p-value of homoscedasticity, and a very high p-value for serial correlation.

```
> reg2 = lm(annualinrate ~ gdp + annualcpi)
> summary(reg2)

Call:
lm(formula = annualinrate ~ gdp + annualcpi)

Residuals:
    Min      1Q  Median      3Q     Max 
-4.0912 -2.2169  0.3732  1.1934  6.1371 

Coefficients:
              Estimate Std. Error t value Pr(>|t|)    
(Intercept)  2.605e+01  4.674e+00   5.575 0.000166 ***
gdp         -2.909e-11  5.242e-12  -5.548 0.000173 ***
annualcpi    1.068e+00  1.196e-01   8.930 2.26e-06 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 3.264 on 11 degrees of freedom
Multiple R-squared:  0.967,	Adjusted R-squared:  0.961 
F-statistic: 161.4 on 2 and 11 DF,  p-value: 7.059e-09
```

```
> resettest(reg2) #RESET Test

	RESET test

data:  reg2
RESET = 4.1484, df1 = 2, df2 = 9, p-value = 0.05287

> bptest(reg2) #Breusch-Pagan Test

	studentized Breusch-Pagan test

data:  reg2
BP = 3.245, df = 2, p-value = 0.1974

> bgtest(reg2) #Breusch-Godfrey (LM) Test

	Breusch-Godfrey test for serial correlation of order up to 1

data:  reg2
LM test = 2.0069e-05, df = 1, p-value = 0.9964
```

Alternative model specifications: Using GDP and the inverse exchange rate

The change introduced in the second alternative model was substituting GDP for the inflation rate.

We once again performed the same tests and noticed the very low p-value for linearity and homoscedasticity, and a relatively high p-value for serial correlation.

We rejected this alternative model due to its lack of linearity (RESET test).

```
> reg3 = lm(annualinrate ~ gdp + annualexrate)
> summary(reg3)

Call:
lm(formula = annualinrate ~ gdp + annualexrate)

Residuals:
     Min       1Q   Median       3Q      Max 
-11.0396  -7.0373   0.8661   3.4822  16.4745 

Coefficients:
               Estimate Std. Error t value Pr(>|t|)    
(Intercept)   8.591e+01  2.155e+01   3.986 0.002136 ** 
gdp          -6.955e-11  1.253e-11  -5.549 0.000173 ***
annualexrate -3.177e+01  2.468e+01  -1.287 0.224364    
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 8.74 on 11 degrees of freedom
Multiple R-squared:  0.7637,	Adjusted R-squared:  0.7208 
F-statistic: 17.78 on 2 and 11 DF,  p-value: 0.0003579


> resettest(reg3) #RESET Test

	RESET test

data:  reg3
RESET = 47.402, df1 = 2, df2 = 9, p-value = 1.664e-05

> bptest(reg3) #Breusch-Pagan Test

	studentized Breusch-Pagan test

data:  reg3
BP = 5.9803, df = 2, p-value = 0.05028

> bgtest(reg3) #Breusch-Godfrey (LM) Test

	Breusch-Godfrey test for serial correlation of order up to 1

data:  reg3
LM test = 0.72239, df = 1, p-value = 0.3954
```

Alternative model specifications: Using inflation, GDP, inverse exchange rate and the output gap

In this alternative model we used all of the inputs used in the other model in different variations.

The performed tests showed noticing the similar level of linearity, a slightly lower p-value of homoscedasticity, and once again a very high p-value for serial correlation.

```
> reg4 = lm(annualinrate ~ gdp + annualcpi + annualexrate + opgap)
> summary(reg4)

Call:
lm(formula = annualinrate ~ gdp + annualcpi + annualexrate +
    opgap)

Residuals:
    Min      1Q  Median      3Q     Max
-4.1706 -2.2132  0.3413  1.1761  6.1800

Coefficients:
               Estimate Std. Error t value Pr(>|t|)
(Intercept)   2.628e+01  1.203e+01   2.185  0.05668 .
gdp          -2.916e-11  7.496e-12  -3.890  0.00368 **
annualcpi     1.072e+00  1.517e-01   7.068 5.87e-05 ***
annualexrate -3.850e-01  1.139e+01  -0.034  0.97377
opgap         2.422e-02  2.622e-01   0.092  0.92844
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 3.607 on 9 degrees of freedom
Multiple R-squared:  0.9671,    Adjusted R-squared:  0.9524
F-statistic: 66.08 on 4 and 9 DF,  p-value: 1.141e-06
```

```
> resettest(reg4) #RESET Test

        RESET test

data:  reg4
RESET = 3.5643, df1 = 2, df2 = 7, p-value = 0.0856

> bptest(reg4) #Breusch-Pagan Test

        studentized Breusch-Pagan test

data:  reg4
BP = 4.0774, df = 4, p-value = 0.3956

> bgtest(reg4) #Breusch-Godfrey (LM) Test

        Breusch-Godfrey test for serial correlation of order up to 1

data:  reg4
LM test = 1.3683e-05, df = 1, p-value = 0.997
```

Alternative model specifications: Using inflation, GDP and the output gap

The change introduced in our alternative model was substituting GDP for the inflation rate, keeping the inflation and adding the output gap as another variable.

After conducting the tests we once again noticed a similar level of p-value for the linearity test, a relatively lower p-value of homoscedasticity, and for another time a very high p-value for serial correlation.

```
> reg5 = lm(annualinrate ~ annualcpi + gdp + opgap)
> summary(reg5)

Call:
lm(formula = annualinrate ~ annualcpi + gdp + opgap)

Residuals:
    Min      1Q  Median      3Q     Max 
-4.1723 -2.2165  0.3771  1.1934  6.2006 

Coefficients:
              Estimate Std. Error t value Pr(>|t|)    
(Intercept)  2.592e+01  5.124e+00   5.058 0.000493 ***
annualcpi    1.073e+00  1.386e-01   7.747 1.56e-05 ***
gdp         -2.900e-11  5.572e-12  -5.205 0.000398 ***
opgap        2.201e-02  2.410e-01   0.091 0.929011    
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 3.422 on 10 degrees of freedom
Multiple R-squared:  0.9671,	Adjusted R-squared:  0.9572 
F-statistic: 97.89 on 3 and 10 DF,  p-value: 1.034e-07
```

```
> resettest(reg5) #RESET Test

	RESET test

data:  reg5
RESET = 3.7317, df1 = 2, df2 = 8, p-value = 0.07164

> bptest(reg5) #Breusch-Pagan Test

	studentized Breusch-Pagan test

data:  reg5
BP = 3.4514, df = 3, p-value = 0.3271

> bgtest(reg5) #Breusch-Godfrey (LM) Test

	Breusch-Godfrey test for serial correlation of order up to 1

data:  reg5
LM test = 2.1065e-06, df = 1, p-value = 0.9988
```

Diagnostic checks on the preferred model

In the end we chose our preferred model to be the one with the inflation rate and output gap as variables. We then performed a few tests in order to check the OLS assumptions for this model.

RESET test for linearity

Studentized Breusch-Pagan test for homoscedasticity

Breusch-Godfrey test for serial correlation

All of the tests passed at a high significance level.

```
> resettest(reg1) #RESET Test

        RESET test

data:  reg1
RESET = 4.2594, df1 = 2, df2 = 9, p-value = 0.04993
```

```
> bptest(reg1) #Breusch-Pagan Test

        studentized Breusch-Pagan test

data:  reg1
BP = 1.3628, df = 2, p-value = 0.5059
```

```
> bgtest(reg1) #Breusch-Godfrey (LM) Test

        Breusch-Godfrey test for serial correlation of order up to 1

data:  reg1
LM test = 2.4428, df = 1, p-value = 0.1181
```

Summary

We chose our model based on its relatively good performance, while maintaining the OLS assumptions, as seen in the previous slides with the passed tests.

In our other models we noticed a lot of the time the majority of the tests passed, proving that all of our chosen variables fit our economic model and matched our regression and initial assumptions in regards to the reliability and fit of our chosen inputs.

Bibliography

https://data.oecd.org/

https://fred.stlouisfed.org/