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How does the Taylor Rule affect the economy of Kazakhstan?

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Abstract

This paper examines the impact of the Taylor Rule on the economy of Kazakhstan, a developing country in Central Asia. The Taylor Rule is a popular rule used by many countries to guide their economies, including the National Bank of Kazakhstan. However, its impact on the Kazakhstani economy has not been fully studied. This study employs a quantitative research method using time series data from 1994 to 2022 on key macroeconomic variables such as GDP, inflation, and interest rates.

Additionally, the study found that the Taylor Rule had a significant impact on the revealing the interest rate of Kazakhstan. This paper also describes the importance of inflation targeting and its relationship with the Taylor Rule. This study summaries that while the Taylor rule is a useful guideline for monetary policy, it has limitations.

Key words: Taylor Rule, macroeconomic variables, GDP, inflation, interest rate.

Introduction

The Taylor Rule is a popular rule that helps central banking systems determine the appropriate level between economic growth and interest rates. This rule is named after its founder, John Taylor. Although this rule's roots may be found in earlier studies, Taylor originally put it out in a seminal paper titled "Discretion versus Policy Rules in Practice" which was released in 1993. Taylor was inspired to create the rule by what happened at the Federal Reserve in the 1970s and 1980s. The Fed's monetary policy during this time seemed to lack a defined, systematic approach, which caused fluctuations in inflation and economic instability. After such as problem, he aimed to provide a more open and normative framework for the determination of monetary

policy. Looking at the paper written by John Taylor, it is shown that the original Taylor Rule did not require much explanation. In particular, the central bank should raise interest rates when output exceeds potential or when inflation exceeds the target. However, the central bank should lower interest rates to stimulate economic activity when inflation falls below the target or when output does not keep up with potential. For many years, this rule has been used by many countries around the world to forecast or guide their monetary policies, including the National Bank of Kazakhstan. The reason for the use of Taylor Rules by many countries is their simplicity. Communicating with the public is made easy for policymakers – central banks in particular – by this simplicity. In addition, according to the Taylor Rule, central banks to maintain economic stability of the country should use inflation and GDP to come up with a target for the interest rate. However, there are some limitations that could be observed in that real interest rates and potential output are not observable. Also, inconsistencies arise as inflation calculations vary from many different counting methods.

Kazakhstan, a resource-rich country located in Central Asia, has also introduced the Taylor Rule. However, the impact of this rule on the economy of the Kazakhstan has not been fully studied. This paper aims to fill this gap by analyzing the impact of the Taylor Rule on the economic indicators of Kazakhstan.

The formula of Taylor Rule contains inflation targeting, which means that the country accepts targeting. The reason for the transition to inflation targeting is:

1) Stabilization of the economy. To achieve this goal, inflation must be kept low and stable. If this policy is not followed, it might affect the economy negatively. This means that savings depreciate and this reduces the possibility of investment, and more uncertainty undermines decision-making by economic agents.

2) Adaptive to shocks. This means that central banks can quickly respond to problems and adapt.
3) Floating exchange rate. It allows you to find a balance and maintain stability in the economy.
In addition, Taylor's rule in Kazakhstan implemented inflation targeting policy. The findings from the many sources demonstrated that Kazakhstan's interest rate policy does not follow the Taylor Rule. However, rather than the industrial output index, the exchange rate is what drives the changes in interest rates. The high rate of inflation and decision-makers' incapacity to select the appropriate policy tools at the appropriate moment may be contributing factors to the Taylor Rule's invalidity.

In 2015, the monetary policy of the National Bank switched to the inflation targeting policy. According to the National Bank, the necessity to establish steady and low inflation as a means of fostering economic sustainability conditioned the decision to adopt this particular policy. Unstable and high inflation leads to depreciation of savings, falling incentives to invest, makes long-term planning impossible and slows down economic growth. It means that inflation target policy is one of the key conditions for market reforms in the country. On September 2, 2015, the National Bank announced the interest rate's adoption as part of the shift to the inflation targeting policy. However, the final transition to the inflation targeting policy took place only in February 2016, when the National Bank launched full-fledged open market and permanent access operations, without which the application of the interest rate would not make sense.

Basically, the relevance of this topic is twofold. First, the Taylor Rule is used in monetary policy and credit policy for sustainable development of Kazakhstan's economy. Second, Kazakhstan is a developing country that has undergone many political and economic changes in recent years, including the adoption of a floating exchange rate regime in 2015. The application of Taylor's

Rule is important for investors and politicians as well as for academic researchers to understand the economy of Kazakhstan. The formula of Taylor Rule is expressed as follows:

$$i = \Pi_e + 0.5(Y_e - Y_t) + 0.5(\Pi_e - \Pi_t)$$

where i is the degree of interest rate, Π_e is the inflation target, $(Y_e - Y_t)$ is output gap which is the difference between actual GDP and potential GDP and $(\Pi_e - \Pi_t)$ is the difference between the targeted inflation rate and actual inflation rate. John Taylor originally proposed, based on empirical evidence, how responsive he thought monetary policy should be to change. Eventually we have a constant 0.5, which is selected on the basis of empirical data.

The inflation gap is measured by the GDP deflator. The reason of using GDP deflator is that it estimates all products and services produced by the country, while the CPI uses only accounts for consumer goods.

Therefore, through this work, the impact of Taylor's Rule on the economy of the Kazakhstan will be determined comprehensively. It is done by looking at the relevant macroeconomic indicators of the country and monetary policy implications for the future by reviewing special literature.

Literature Review

Taylor's Rule has been studied mostly on macroeconomic indicators of developed countries. However, there are relatively few studies of Taylor's Rule on emerging market economies, including Kazakhstan. In this section, we will study the effect of Taylor's Rule on the economy of Kazakhstan by reviewing relevant literature.

According to many studies, Taylor's Rule has shown positive results for developed countries economies, and it has been found to be an effective tool to stabilize inflation and output. Nonetheless, its effectiveness for emerging market economies has not been fully studied. Study by Galindo (2009) found out that Taylor Rule was not always an effective tool to stabilize inflation and output in Latin American countries. Another study by Hsiao and Tahmisciouglu (2013) investigated the use of Taylor Rule in Turkey and found that it helps to stabilize the inflation rate, but it was not shown the positive results on stabilizing the output. According to Toker (2020), he estimated that in terms of Taylor Rule, the short-term interest rate responds positively to variations in the output gap. The short-term interest rate is predicted to respond positively to the exchange rate fluctuations in the extended rule in a manner akin to that of the extended Taylor Rule.

In the case of Kazakhstan, the effect of Taylor's Rule on the country's economy has not been fully studied. The study by Karatayev and Suleimenova (2018) analyzed the effect of Taylor Rule in Kazakhstan from 2000 to 2016 and identified that it was an effective tool in stabilizing inflation, but for the stabilization of output, negative results were shown. Another study by Kusainov and Yelubayev (2019) explored the impact of Taylor Rule on the exchange rate of Kazakhstan and concluded that it had an outstanding impact on the exchange rate. According to Chernyavskiy (2017), after the implementation of inflation targeting, the nominal anchor of monetary policy was the target inflation rate. The National Bank started using the Taylor rule as part of the new regime's implementation in order to proactively respond to deviation in inflation from the target level and deviation in the output from its potential value. Bagzhanov, Tuleuov, and Zhuzbayev (2021) explored that the fiscal authorities' pro-cyclical activities not only encourage budget imbalances but also hinder the fiscal policy measures from mitigating business

cycle swings. Conversely, the monetary policy follows the Taylor rule to concentrate on maintaining price stability, even within the parameters of the inflation targeting regime. Overall, Taylor Rule could be an effective tool in stabilizing inflation and output in certain cases, but its effectiveness may change depending on some economic conditions. In the case of Kazakhstan, additional research is needed to find the impact of Taylor's Rule on the economy and macroeconomic stabilization.

Methodology and Data

Research goal: To determine whether the National Bank of Kazakhstan is guided by the Taylor Rule.

Research hypothesis: Taylor rule plays a role in stabilizing key macroeconomic variables in Kazakhstan.

The research is conducted using yearly time series data from 1994 to 2022 on key macroeconomic variables such as GDP, inflation and interest rate. Data will be taken from the official website of the National Bank of Kazakhstan and other similar sources such as the Bureau of National Statistics, World Bank. The analysis is performed in Excel and Python. In Excel, we computed the potential GDP, output gap and inflation gap. The difference between actual GDP and potential GDP is equal to output gap. The data were taken from the official website of National Bank of Kazakhstan. In addition, to compute the inflation gap, we take the difference between the targeted inflation rate and actual inflation rate. The main estimations are conducted in Python.

One of the important variables of identifying Taylor Rule is Potential GDP, because statistics of other variables is provided by official sources such as the National Bank of Kazakhstan, the

Bureau of National Statistics (BNS) and others. However, to identify the Potential GDP, we should use a certain methodology. As mentioned before, Potential GDP is the maximum level of GDP in which an economy could produce sustainably when all available resources – including labor, capital, and technology without causing inflationary pressures. In simpler terms, it is a benchmark for determining if an economy is producing more, less, or as its potential level. Basically, Potential GDP is crucial for policymakers when implementing the rule on identifying the interest rate. The main reasons are:

Output Gap Analysis: The difference between actual GDP and potential GDP is equal to the output gap which shows policymakers raising or lowering interest rates. When actual GDP exceeds potential GDP, a positive output gap indicates an overheated economy and possible inflationary pressures. To cool down the economy in this situation, the Taylor rule suggests stricter monetary policy, such as an increase in interest rates. On the other hand, a negative output gap – that is, an actual GDP that is less than potential GDP – may be a sign of economic slack and call for accommodating monetary policy, such as a reduction in interest rates to boost growth.

Forward Guidance: Potential GDP has a part in giving the public and financial markets ahead direction regarding the path of future monetary policy. Central banks can demonstrate their commitment to attaining sustainable economic growth while preserving price stability by factoring projected GDP growth into their policy decisions. Overall, knowing potential GDP aids policymakers in evaluating the health of the economy, spotting inflationary or recessionary threats, and creating the right monetary policy responses to meet their goals.

The basic formula to identify the potential GDP is:

Potential GDP = long term growth rate of labor force + long term growth rate in labor productivity, in which:

1) Long term growth rate of labor force: This aspect shows the total population that is available for employment in the economy.

2) Long term growth rate in labor productivity: This component is defined as quantity of output generated per unit of labor input (Jayachandran, 2024).

Through the addition of labor force and labor productivity growth rates over an extended period, the formula proposes that future GDP growth can be broken down into these two primary drivers. Essentially, increases in labor productivity and labor force growth are both necessary for potential GDP growth.

To find the data of long-term growth rate of labor force and long-term growth rate in labor productivity, the data are taken from the BNS and the National Bank of Kazakhstan.

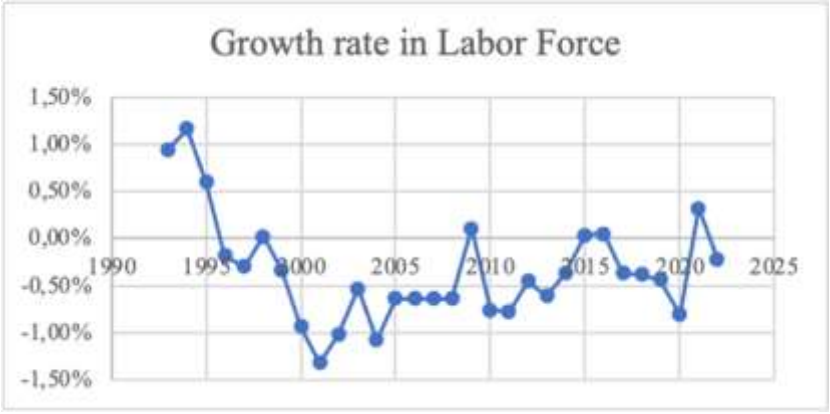


Figure 1. Growth rate in Labor Force in Kazakhstan (calculation made by Authors)

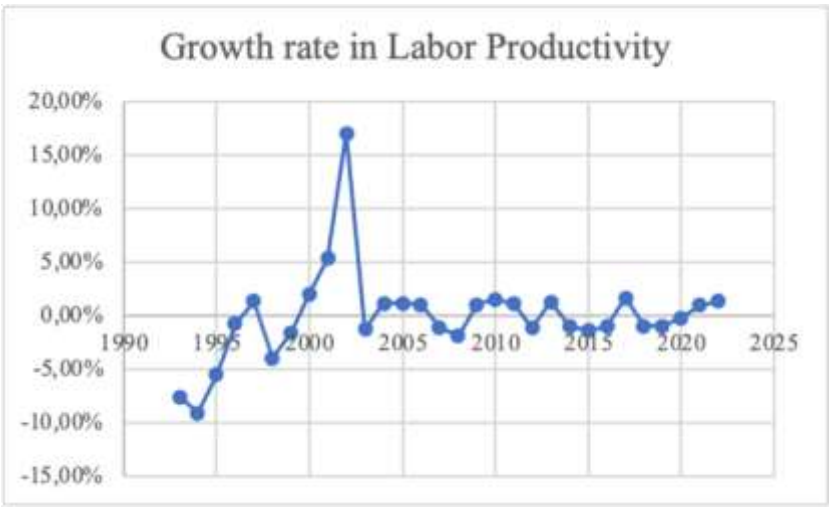


Figure 2. Growth rate in Labor Productivity in Kazakhstan (calculation made by Authors)

As a result, the potential GDP was found with the addition of growth rate in labor force to growth rate in labor productivity as it shown above on the graphs. With the help of finding potential GDP, it would guide our further research on finding Taylor Rule.

A quantitative analysis helps to determine the impact of Taylor Rule on the economy of Kazakhstan and understand whether the National Bank of Kazakhstan is correctly setting inflation target and interest rate by applying this rule.

We used OLS regression to estimate the effect of interest rate on basic Taylor Rule formula. It is an equilibrium interest rate, inflation, inflation gap and output gap.

№	Name	Definition	Formula
1	Output gap	It is a way to assess how well an economy is doing.	Actual GDP – Potential GDP
2	Inflation gap	Is an economic term to guide monetary and fiscal policy decisions.	Target inflation rate – Actual inflation rate

3	Potential GDP	It is the maximum level of GDP in which an economy could produce sustainably.	Long term growth rate of labor force + Long term growth rate of labor productivity
4	GDP growth	Is the percentage change in the GDP over a specific period.	GDP 2 – GDP 1/GDP 1

To check whether a given time series is stationary or not, we use the Augmented Dickey Fuller Test (ADF Test). We set two hypotheses: the null hypothesis is that the data has a unit root, which is non-stationarity, and the alternative hypothesis is stationary data.

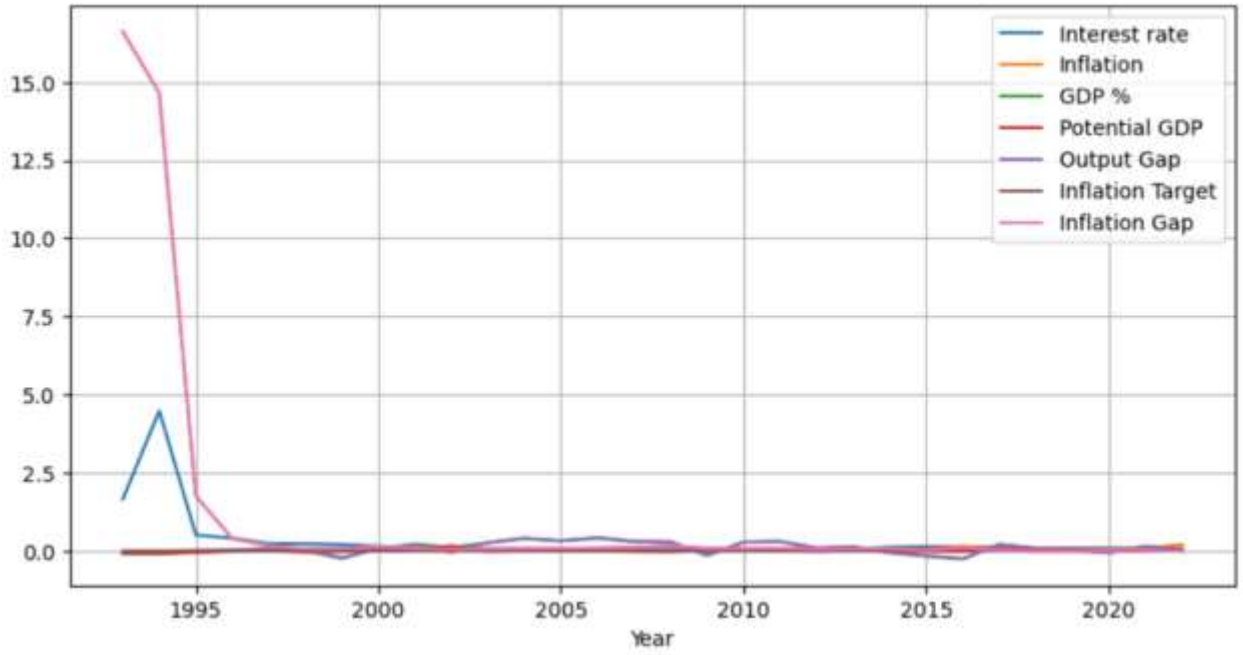


Figure 3. ADF test data for stationarity (calculation made by Authors)

ADF Test:

- ADF Statistic: -3.717
- p-value: 0.004
- Critical Values at 1%, 5%, 10%
- Significance levels: -3.679, -2.968, -2.623.

Based on the results of the ADF test, we can conclude that time series is stationary, because of p-value (0.004), which is less than the significance level of 0.05, so we reject the null hypothesis that the data has a unit root.

It means that our statistical properties such as mean, variance, and autocorrelation are stable. Stationary data is useful for modeling and predicting time series.

Results

Our study aimed to investigate the relationship between the implementation of the Taylor Rule and the observed changes in the macroeconomic indicators from 1994 to 2022 years. We used OLS regression to estimate the effect of interest rates on basic Taylor rule formula. It is inflation target, inflation gap and output gap.

We use the interest rate as a dependent variable and other variables such as inflation target, inflation gap and output gap as independent.

The overall model fit is good, with an R-squared value of 0.737, indicating that 73.7% of the variation in interest rate was explained by the independent variables. And it showed a strong relationship. In addition, based on the result of OLS regression model, the regression model is

statistically significant, with the F-statistic of 15.90. Theoretically, basic meaning of identifying F-statistic is the ratio of explained variance to the unexplained variance and to determine whether regression model is statistically significance or not it is compared to a critical value at a selected significance level (e.g., 0.05). In addition, when the F-statistic is higher than the critical value, then it shows that regression model is statistically significance, and the null hypothesis is rejected.

```
            feature       VIF
0  Inflation Target  1.000013
1     Inflation Gap  1.000376
2        Output Gap  1.000364
                            OLS Regression Results
==============================================================================
Dep. Variable:          Interest rate   R-squared:                       0.737
Model:                            OLS   Adj. R-squared:                  0.691
Method:                 Least Squares   F-statistic:                     15.90
Date:                Tue, 28 May 2024   Prob (F-statistic):           3.49e-05
Time:                        19:21:35   Log-Likelihood:                -15.087
No. Observations:                  21   AIC:                             38.17
Df Residuals:                      17   BIC:                             42.35
Df Model:                           3
Covariance Type:            nonrobust
==========================================================================================
                         coef    std err          t      P>|t|      [0.025      0.975]
------------------------------------------------------------------------------------------
const                  0.1572      0.191      0.823      0.422      -0.246       0.560
Inflation Target      -0.7478      7.367     -0.102      0.920     -16.291      14.795
Inflation Gap          0.1796      0.028      6.312      0.000       0.120       0.240
Output Gap            -0.2312      0.819     -0.282      0.781      -1.960       1.497
==============================================================================
Omnibus:                       15.871   Durbin-Watson:                   3.022
Prob(Omnibus):                  0.000   Jarque-Bera (JB):               48.209
Skew:                           0.577   Prob(JB):                     3.40e-11
Kurtosis:                      10.332   Cond. No.                         298.
==============================================================================

Notes:
[1] Standard Errors assume that the covariance matrix of the errors is correctly specified.
```

Figure 4. OLS Regression Results (calculation made by Authors)

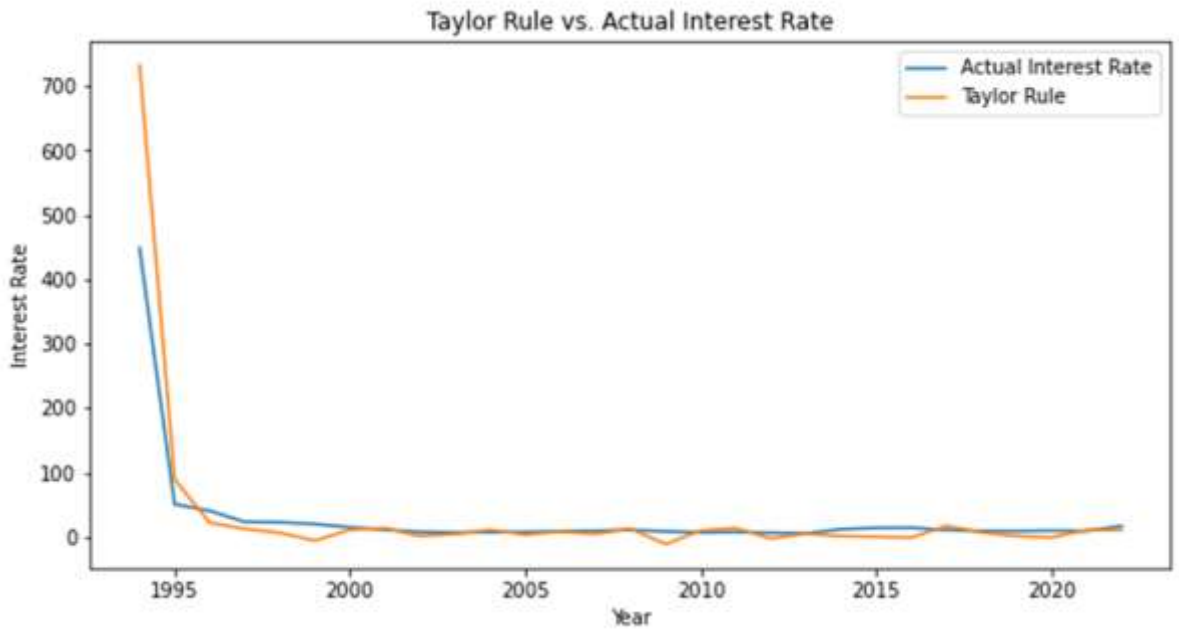
The Variance Inflation Factor (VIF) is used to check multicollinearity between variables. To measure the degree of multicollinearity, we look at results, where all variables are equal to 1. It means there is no multicollinearity.

Based on the result of OLS regression model, overall inflation target may not be statistically significant because of the small magnitude of the t-statistic of -0.102. In addition, a coefficient of -0.7478 determines that the dependent variable is predicted to decline by 0.7478 points for every point increase in the inflation target.

Only the inflation gap turned out to be statistically significant. The findings statistically support the positive effect of the inflation gap on the interest rate. It needs to add that inflation gap coefficient stipulates 0.1796 and standard error equals to 0.028.

In addition, the output gap shows that it is not statistically significant because of the low number of t-statistic. So, OLS regression model suggests that there may be a lack of validity in the link between the interest rate (dependent variable) and the output gap (independent variable) in the regression model.

Finally, we show the graph with the predicted value of the interest rate determined by the Taylor Rule according to our model and data and the actual interest rate of the National Bank of Kazakhstan for the period under analysis.



Graph 1. Taylor Rule and actual interest rate (calculation made by Authors)

From the graph, we see that the National Bank of Kazakhstan is indeed guided by the Taylor rule when determining their interest rates. Only in the early 1990s, there was a deviation between the Taylor Rule interest rate and actual interest rate. However, starting from 1995 till today the interest rate based on Taylor rule and the actual interest rate nearly converges.

Conclusion

This study sought to evaluate if the Taylor rule plays a role in shaping the macroeconomic policy of the Kazakhstan's central bank. We indeed found out that the Tailor Rule was a guide for the monetary policy of Kazakhstan.

At the same time, we found out that there are no statistically significance relationship exists between interest rate and inflation target, between interest rate and output gap on the reason of small magnitude of the t-statistic based on the OLS regression model. However, it is seen that

there is statistically significant relationship between interest rate and inflation gap based on the large t-statistic.

To summarize, Taylor rule is the important framework to determine appropriate level of interest rate to guide National Bank of Kazakhstan. While it may serve as a useful guideline, its limitations in certain contexts highlight the importance of adopting a nuanced approach to monetary policy decision-making.

Limitations

During the research we encountered a few limitations, such like:

- Difficulties on finding the data we needed because there are not reliable data on the beginning of 1990 till 2000 years;
- Taylor Rule was not fully studied and analyzed extensively, especially in Kazakhstan which cause a problem when finding an applicable sources and citations.

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APPENDIX

Year	Interest rate	GDP	Inflation	GDP %	Potential GDP	Output Gap	Inflation Target	Inflation Gap
1993	1.652	23.41	16.62	-0.092268261	-0.075316096	-0.01695217	0	1.76
1994	4.483	21.25	14.65	- 0.09	- 0.08	- 0.02	0	0.39
1995	0.508	20.37	1.76	- 0.04	- 0.05	0.01	0	1.76
1996	0.406	20.75	0.39	0.02	- 0.01	0.03	0	0.39
1997	0.233	22.17	0.17	0.07	0.01	0.06	0	0.17
1998	0.227	22.14	0.07	- 0.00	- 0.04	0.04	0	0.07
1999	0.2	16.87	0.08	- 0.24	- 0.02	- 0.22	0	0.08
2000	0.15	18.29	0.13	0.08	0.01	0.07	0	0.13
2001	0.111	22.15	0.08	0.21	0.04	0.17	0	0.08
2002	0.0775	24.64	0.06	0.11	0.16	- 0.05	0	0.06
2003	0.07	30.83	0.06	0.25	-0.0186	0.27	0	0.06
2004	0.07	43.15	0.07	0.40	0.0006	0.40	0	0.07
2005	0.08	57.12	0.08	0.32	0.0051	0.32	0	0.08
2006	0.09	81	0.09	0.42	0.0037	0.41	0	0.09
2007	0.10	104.8	0.11	0.29	-0.0178	0.31	0	0.11
2008	0.11	133.4	0.17	0.27	-0.026	0.30	0	0.17
2009	0.09	115.3	0.07	- 0.14	0.0112	- 0.15	0	0.07
2010	0.07	148	0.07	0.28	0.0073	0.28	0	0.07
2011	0.07	192.6	0.08	0.30	0.0028	0.30	0	0.08
2012	0.07	208	0.05	0.08	-0.0166	0.10	0	0.05
2013	0.06	236.6	0.06	0.14	0.0063	0.13	0	0.06
2014	0.12	221.4	0.07	- 0.06	-0.0139	- 0.05	0	0.07
2015	0.14	184.4	0.07	- 0.17	-0.0143	- 0.15	0.05	0.02
2016	0.14	137.3	0.15	- 0.26	-0.0104	- 0.25	0.05	0.10
2017	0.11	166.8	0.07	0.21	0.0124	0.20	0.05	0.02
2018	0.09	179.3	0.06	0.07	-0.0139	0.09	0.05	0.01
2019	0.09	181.7	0.05	0.01	-0.0143	0.03	0.04	0.01
2020	0.10	171.1	0.07	- 0.06	-0.0104	- 0.05	0.04	0.03
2021	0.09	197.1	0.08	0.15	0.0124	0.14	0.04	0.04
2022	0.17	203.21	0.20	0.03	0.0108	0.02	0.04	- 0.02

Figure 5. Analyzing basic parameters