Final Report

Batch details	PGP-DSE (PGPDSE-FT Online Aug -21)
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Domain of Project	Macroeconomics
Project title	Turkey's Inflation Crisis
Group Number	7
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Date: 23rd April 2022

Signature of the Mentor

Signature of the Team Leader

Table of Contents

Abstract

The study researches the primary drivers of the ongoing currency and debt crisis of Turkey. The Turkish Lira – US Dollar exchange value is analyzed by way of factors like foreign direct investment, unemployment, interest rate, construction permits issued, current account and capital account. The quarterly dataset spans decades, beginning from 1990 and ending in 2021. After examining the data for normal distribution of errors, linearity, multicollinearity, homoscedasticity and correlation, we applied an ordinary least squares model. The results show that construction permits issued and the unemployment levels have significant effect on the exchange rate. Current account balance and Foreign direct investment in industry have moderate effect. Capital account balance, reserve assets, construction sector's contribution to GDP and foreign direct investment in agriculture seem to have nominal effect on the exchange rate.

Overview of the final process

Quarterly economic and financial data from 1990 to 2021 was collected from The Central Bank of Republic of Turkey, International Monetary fund and The Organisation for Economic Co-operation and Development.

Over 40 variables were considered – balance of payment items, gross domestic product by economic activity, external debt, interest rate, consumer price index for all items and energy in specific, consumption expenditure, total money in circulation, new job vacancies, unemployment, construction permits issued, sector wise foreign direct investment, cost of living items, industrial production and domestic producer prices index. The exchange rate of Turkish Lira against US Dollar is the dependent variable (hereafter, TRYUSD).

There were some datapoints missing in the set and they were filled with the help of the experimental multivariate imputer from scikit-learn. While outliers were recognized, they weren't removed owing to the fact that the data is collected from trusted sources and the problem studied contributed significantly to these outliers; not excluding them was imperative.

The data was standardized by way of z score computation in the scipy.stats module.

As a part of exploratory data analysis, scatterplots and pair plots were designed establishing the relationship between TRYUSD and a few crucial factors.

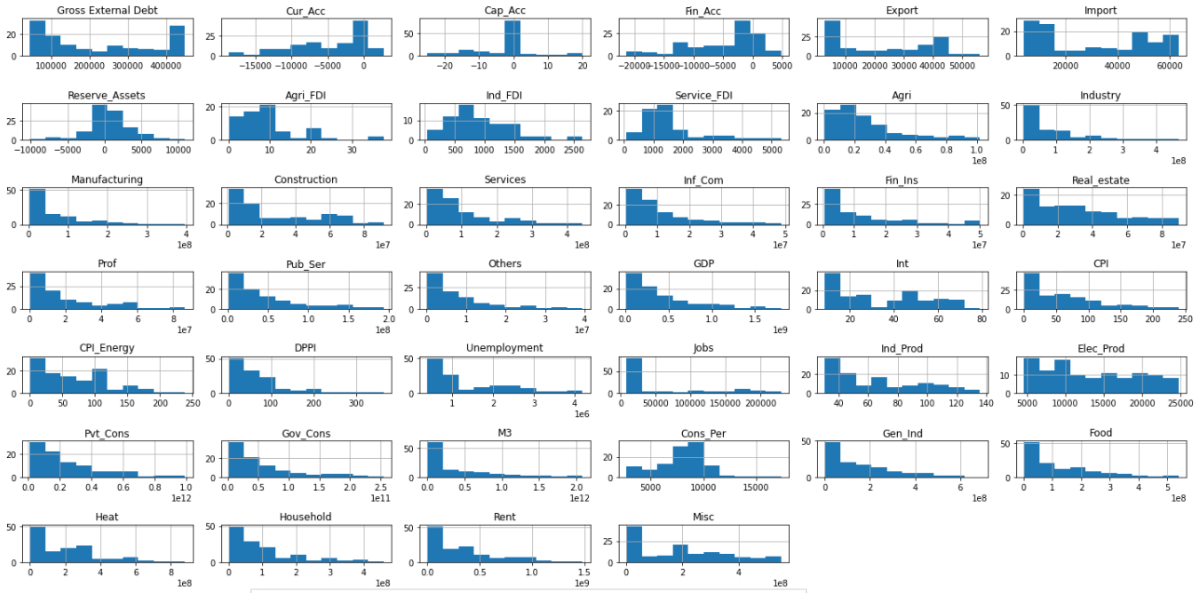
Most of the independent variables exhibited multicollinearity to varying degrees. This was reduced by way of calculating their variance inflation factor and successively eliminating the variables until the amount of multicollinearity was brought to an acceptable level.

Finally, multivariate linear regression was performed using ordinary least squares method from statsmodels. The efficacy of the model was arrived at with the aid of regression metrics in sci-kit learn.

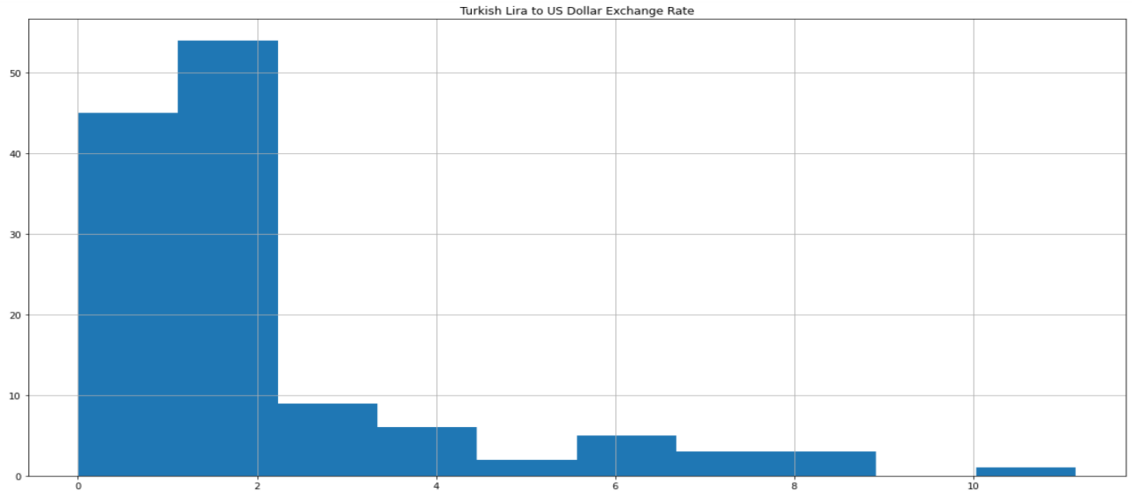
Step by Step Summary & Visualization

I. Data Pre-Processing

- Our data set was prepared using the Quarterly Economic Data of Turkey from 1990-2021 comprising of 40 variables.



- TRY USD was chosen as the target variable and other independent variables were plotted to check the distribution. TRYUSD is the exchange rate of Turkish Lira with US Dollars. TRYUSD was plotted to check the distribution of dependent variable



II. Missing Values and Outlier Treatment

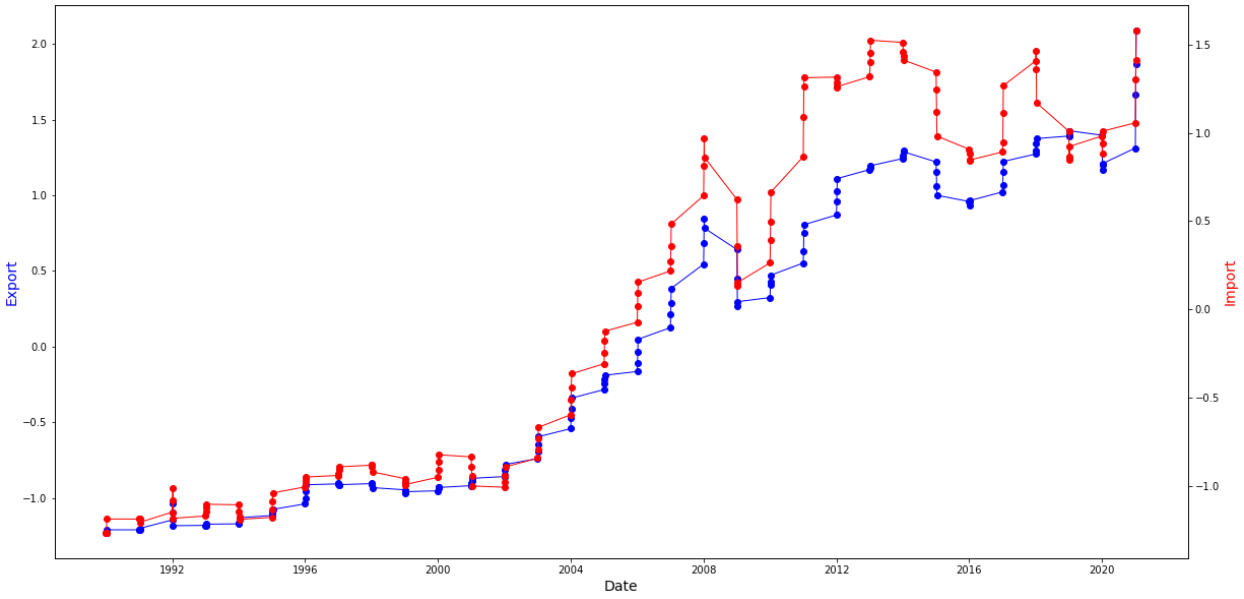
- Missing values were counted and treated using iterative imputer.
- Outliers were detected but the treatment was not done as this case study is about an unprecedented event, it is crucial for the outliers to be considered.

III. Scaling

- Scaling was done using z-score technique.

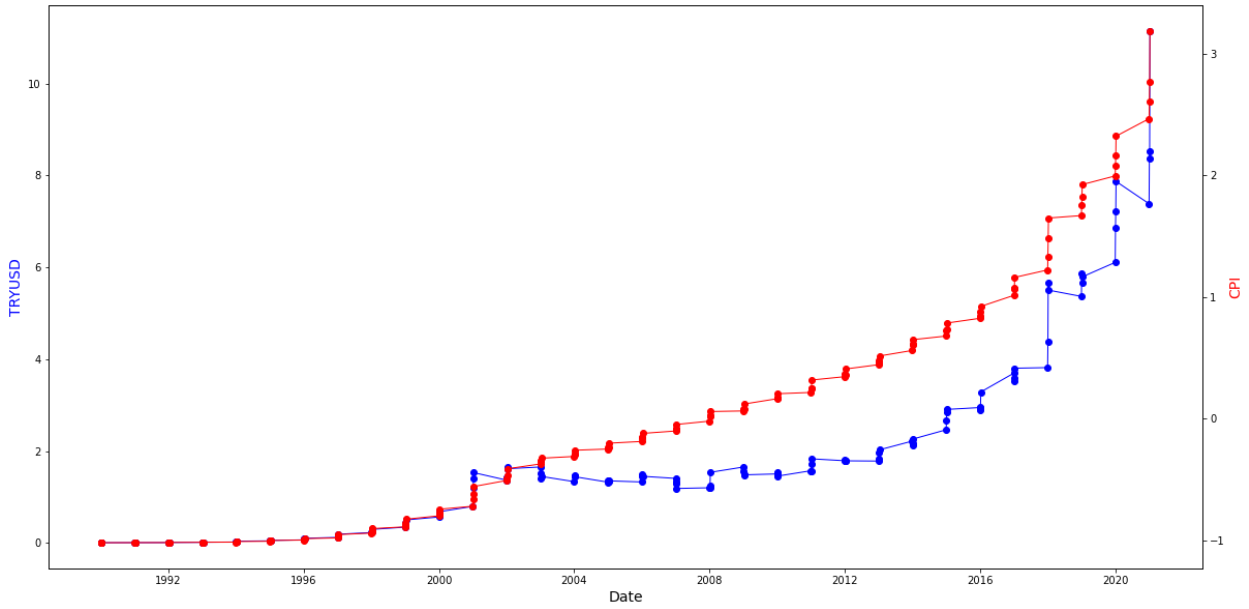
IV. Exploratory Data Analysis

- Different Plots were plotted of target variable-TRYUSD against some crucial economic factors such as CPI, DPPI, Construction permits etc. with respect to time.
- **Exports and Imports over time**



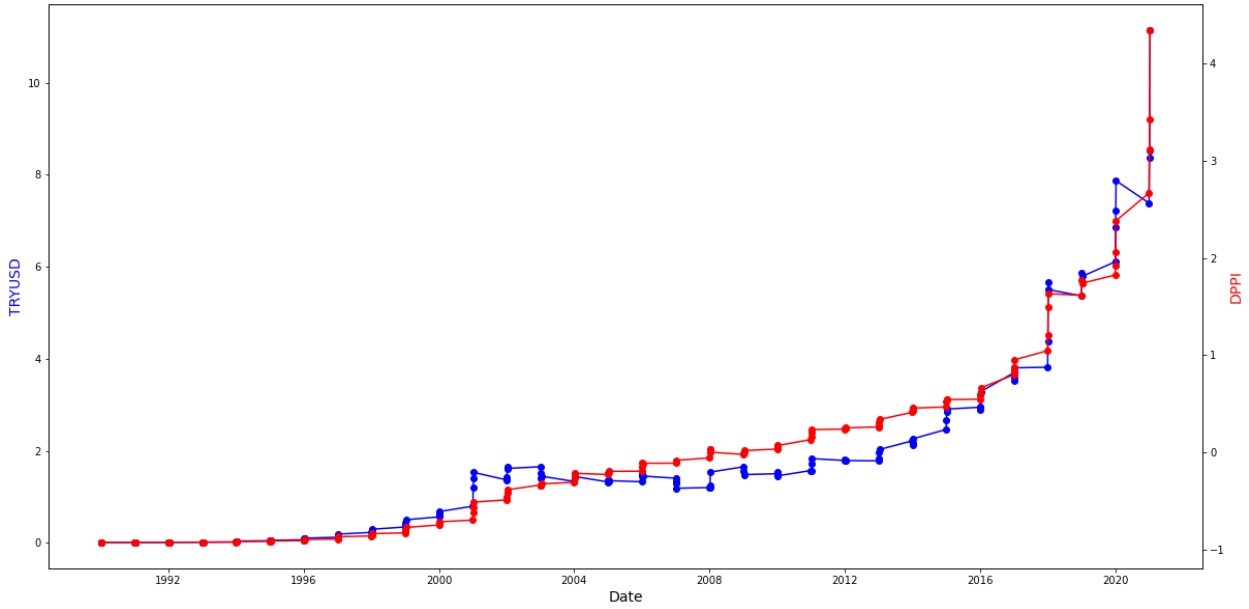
This plot shows the value of exports and imports over time. It is typical of developing nations to import more than they export, and Turkey is no different in that regard. Between 2011 and 2016 there seems to be an abnormally high quantity of imports, but the trend has changed in the crisis period. This change owes to the fact that the Turkish Lira has depreciated enough to make imports exorbitant.

- **TRYUSD vs CPI**



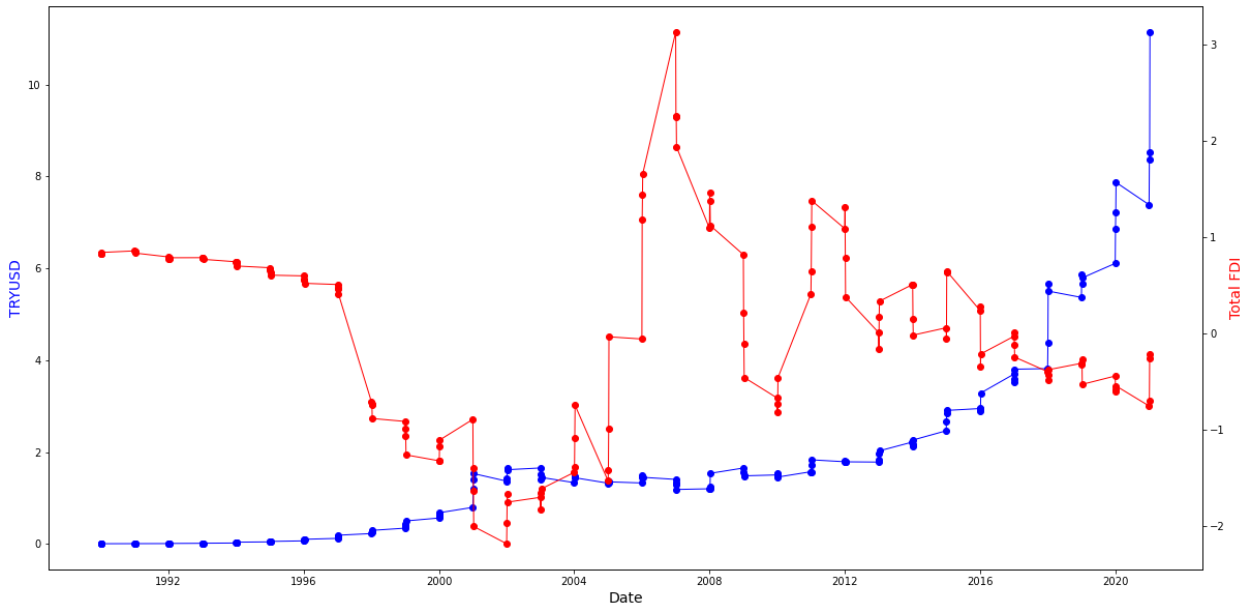
This plot shows a direct relationship between TRYUSD AND CPI- Consumer Price Index, CPI denotes the cost of daily need products (like food, medicines that the consumer must pay. This indicates that on an average, a Turkish resident must pay more than last year for those products. This is a sign of inflation.

- **TRYUSD vs DPPI**



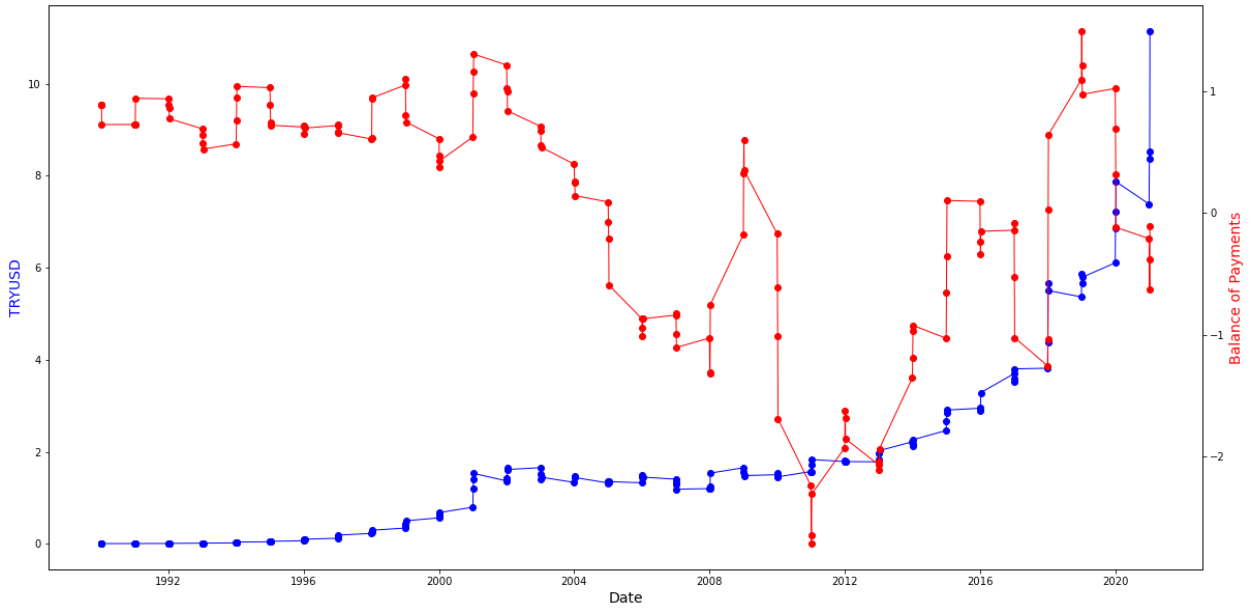
This plot shows a direct relation between TRYUSD AND DPPI-Domestic producer price index. DPPI is like CPI but from a producer point of view. Price volatility coupled with the COVID pandemic affected the price of intermediate goods and imports, leading to rising cost of production. Hence, we can conclude that the price of products is increasing post 2018.

- **TRYUSD and Total FDI**



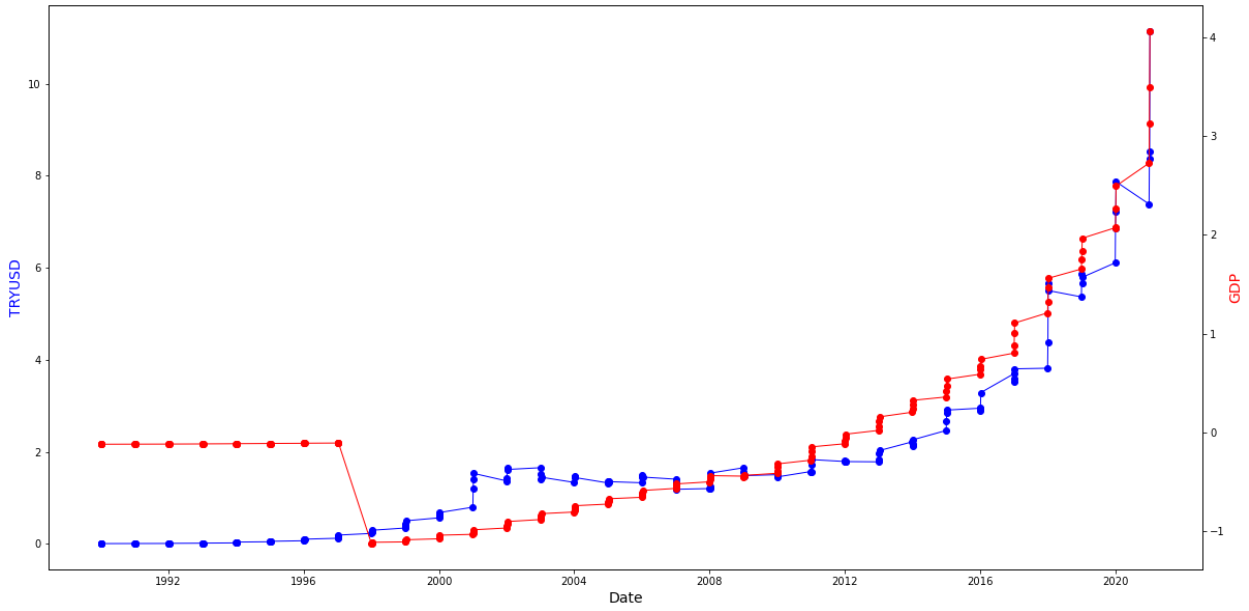
The graph above exhibits the relationship between TRYUSD and total Foreign Direct Investment over time. Turkey actively sought FDI after 1980 with liberal economic policies and foreign currency borrowings, culminating in a political and economic crisis in 2001. But the country recovered rather quickly, appreciation of Turkish Lira seems to have helped pull in more FDI; the period between 2000 and 2008 attests to that. The Great Recession of 2008 seems to have had a heavily negative impact on the economy. Since then, marginal growth was registered until the exchange rate volatility and inflation crisis of 2017.

- TRYUSD and Balance of Payments



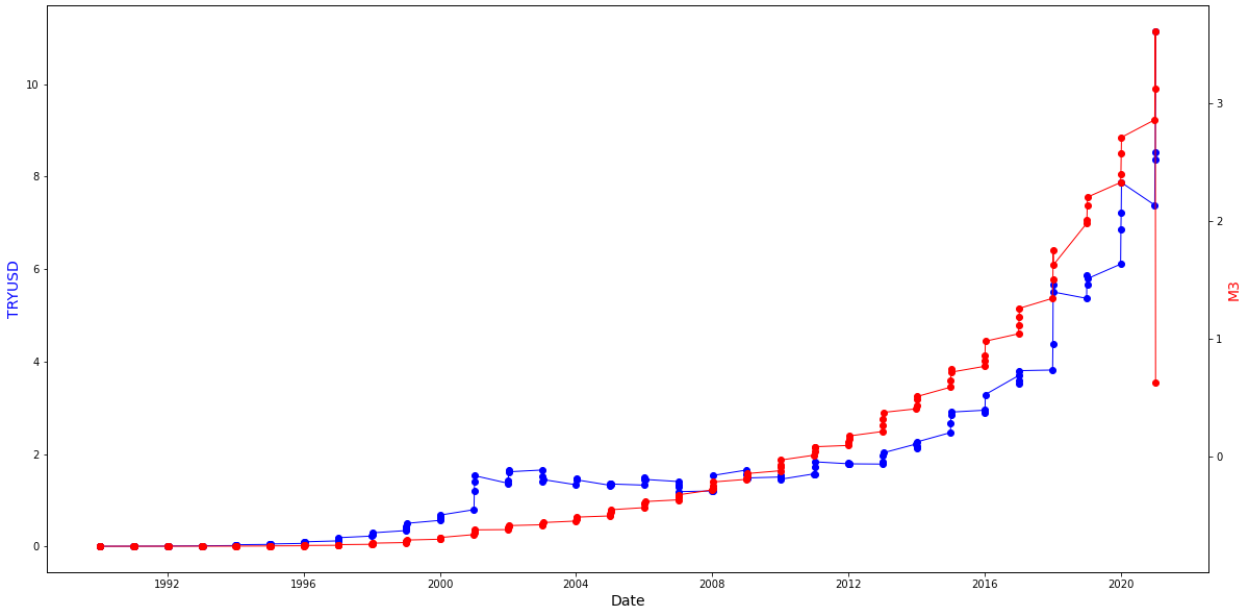
This graph shows a relation between Exchange rate and Balance of Payments. Balance of Payments is the sum of current account, capital account and financial account. Balance of Payments is the difference between flow of funds into a country and out to the rest of the world. What is clear from the above graph is that Turkey has never had a grasp of its account deficits, and that the current crisis isn't an odd event but the culmination of a series of bad fiscal management

- TRYUSD and GDP



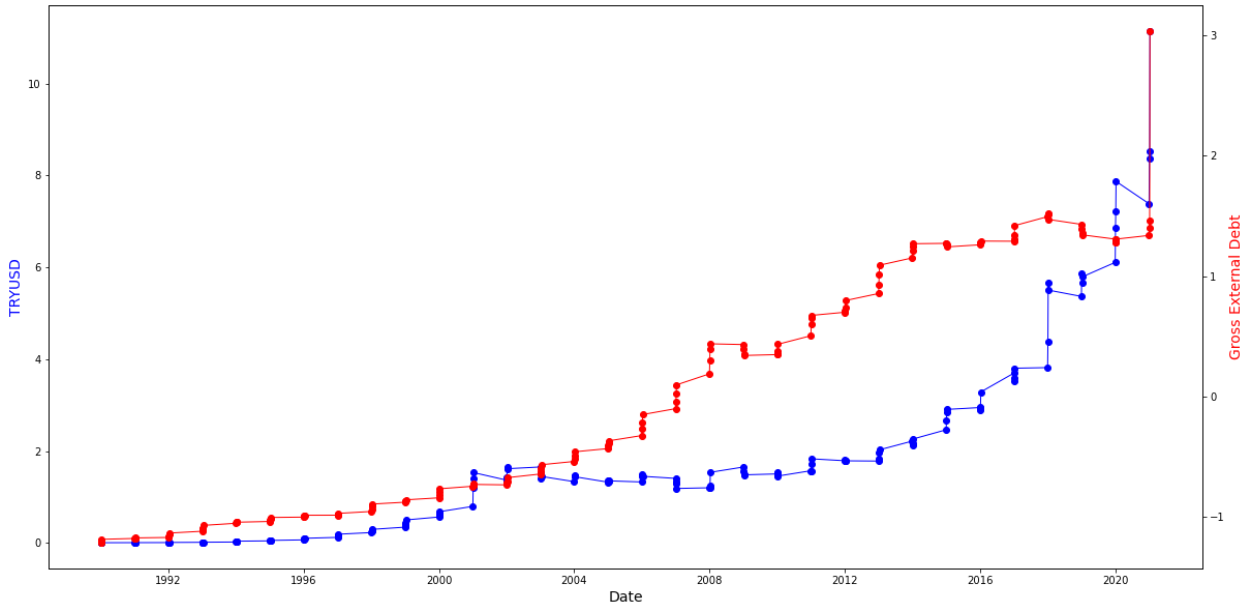
This graph shows a relation between Exchange rate and Gross Domestic Product against Time. GDP is the value of the goods and services produced in a country. The positive relationship between these two variables owes to the fact that there is a demand for goods produced domestically, outside of Turkey. While the early 90s seem to reflect the better outcomes of a liberal economic policy (higher GDP, relatively lower TRYUSD), the gap has been bridged since the late 90s.

- TRYUSD and M3



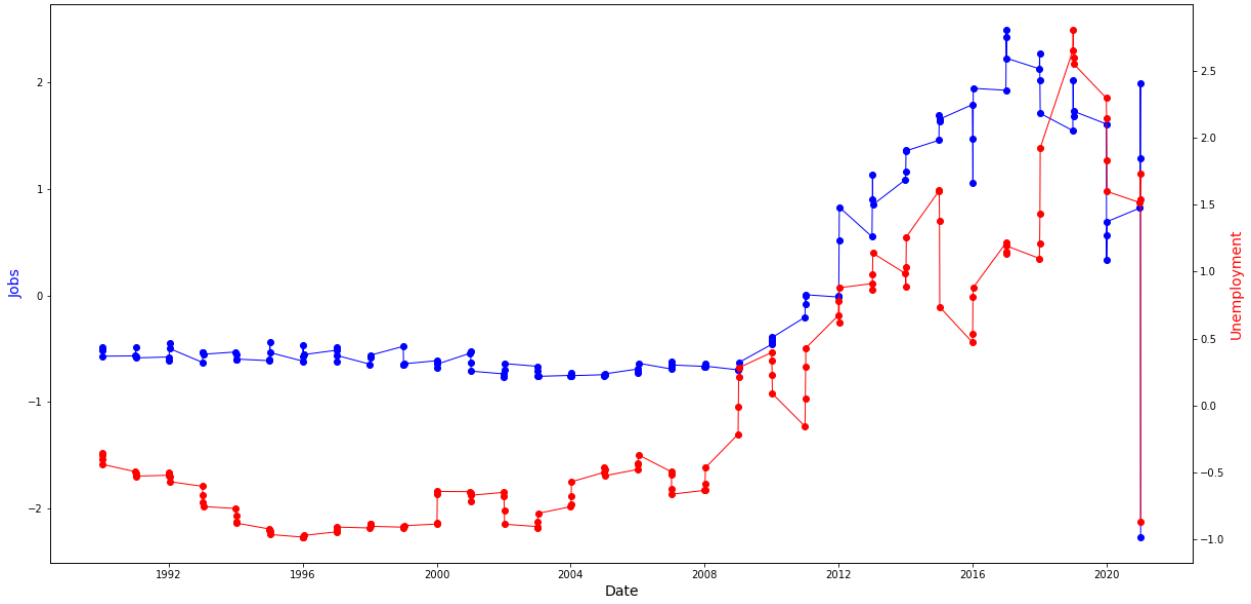
M3 signifies the total money supply of a country. It includes currency in circulation, demand deposits, currency out of circulation but available; savings deposits and certificate deposits; large time deposits, institutional money market funds. Falling interest rates lead to depreciation of money in the long term, which is exactly what's been exhibited in the graph above. Since 2008, this phenomenon seems to have worsened.

- **TRYUSD and Gross External Debt**



Turkey has a history of heavy reliance of external debt. The problems associated with this scenario is that the country is bound to exchange rate volatility and eventual depreciation of domestic currency because the debt is valued in foreign currency.

- **New jobs created and unemployment**



Climbing unemployment levels and falling job vacancies are tied to each other. High unemployment levels guarantee a decrease in purchasing power and overall production potential of the country. This in turn affects creation of new jobs because there will be no need to leverage human resources; the demand doesn't match supply.

V. Statistical Significance of Variables

Since the final model wouldn't account for all the variables in the dataset, some crucial independent variables and their statistical significance are explored. Simple linear regression was performed and their P values was compared against a significance level of 0.05.

- #H0: There is no relationship between Interest rate and TRYUSD
  #H1: There exists a relationship between Interest rate and TRYUSD
  P-value=0; P - value<0.05. This implies that change in TRYUSD can be predicted by Interest. H0 is rejected.

- #H0: There is no relationship between BOP and TRYUSD
  #H1: There exists a relationship between BOP and TRYUSD
  P-value=0.0647; P - value>0.05(significance level). This implies that the change in TRYUSD cannot be predicted by BOP. H0 is not rejected

- #H0: There is no relationship between Total FDI and TRYUSD
  #H1: There exists a relationship between Total FDI and TRYUSD
  P-value=0.022565; P - value<0.05(significance level). This implies that change in TRYUSD can be predicted by Total FDI. H0 is rejected.

- #H0: There is no relationship between Financial Account balance and TRYUSD
  #H1: There exists a relationship between Financial Account balance and TRYUSD
  P-value=0.4966; P – value>0.05(significance level). This implies that change in TRYUSD cannot be predicted by Financial Account balance. H0 is not rejected.

- #H0: There is no relationship between Money Supply (M3) and TRYUSD
  #H1: There exists a relationship between Money Supply (M3) and TRYUSD
  P-value=0; P - value<0.05(significance level). This implies that change in TRYUSD can be predicted by Money Supply FDI. H0 is rejected.

VI. Model Evaluation

- After sorting the independent variables on the basis of their variance inflation factor values, 8 independent variables were chosen for the final model. The purpose of this exercise was to treat multicollinearity in the dataset. The highest VIF score recorded was 3.1134, implying that there's only moderate correlation between the predictors.
- The 8 variables are as follows:
  Unemployment, FDI in Industry, Current Account, GDP from Construction, FDI in Agriculture, Construction Permits issued, Capital Account and Reserve Assets
- The data is divided into training set and test set for performance of machine learning algorithm (Training size = 70%, Test size = 30%)
- The model has been built based on the train set and test set.

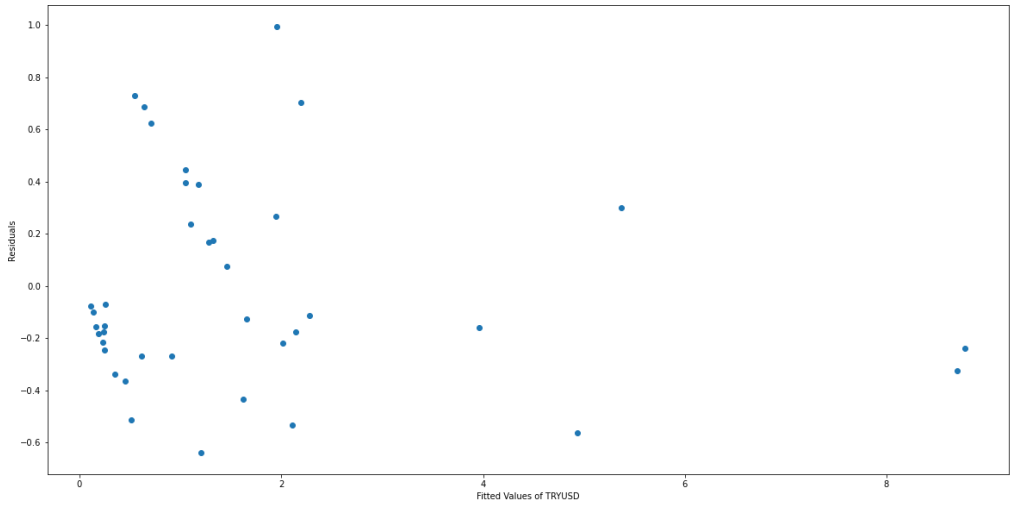
Regression Model Evaluation

- The purpose of the model is to analyse inflation by having TRYUSD (exchange rate between Turkish Lira and US Dollar) as the dependent variable. Through the regression model, those predictors that can be improved upon to affect TRYUSD are identified.

- Overall, the model satisfies the assumptions of linear regression model. Dependent variable is continuous; Linear Relationship between Independent and Target variable; No multi-collinearity is observed; No Auto correlation is observed; No heteroscedasticity is observed.

- R squared value is 0.957 and the Adjusted R squared value is 0.952. Results shows that 95.2% of the variance in TRYUSD value can be accounted for by the 8 predictors collectively.

- The TRYUSD value score is equal to:
    - -0.5955(Current Account) + 0.1730(Capital Account) + -0.2244 (Reserve Assets) + 0.1691(FDI in Agriculture) + -0.4277(FDI in Industry) + 0.3061(Construction as a GDP contributor) + 0.7152(Unemployment) + -1.2504(Construction permits issued), per one unit increase in each factor.
- All the variables in the model pass the test of significance (P-value<0.05)
- The Durbin-Watson test statistic is 2.038; there's little to no autocorrelation detected
- The Jarque-Bera statistic of 3.573 implies that the data follows a normal distribution
- Mean Squared Error (0.1551), Root Mean Square Error (0.3938), Mean Absolute Error (0.3292) and Mean Absolute Percentage Error (9.7718). Root mean square error value is close zero, implying that the regression line generated is a better fit.



- The residuals are scattered in a random fashion, there is no distinctive pattern to their placement. There exists a linear relationship.
- Hyper investment in construction sector (The issuance of construction permits indicates this) and burgeoning unemployment levels have been detrimental to the currency value. While the negative coefficient of Construction Permits may indicate a different outcome, the proof of this factor can be seen in the positive coefficient of the GDP component of Construction. One unit increase in unemployment results in a 0.7152 increase in TRYUSD value.

- The primary market of agriculture sector are the people of Turkey. FDI in this sector makes the cost of final agriculture goods expensive, meaning inflation. Therefore, the regression coefficient is positive. So, one unit increase in Agriculture FDI results in 0.1691 increase in TRYUSD value.
- On the other hand, FDI in industry can be beneficial in the long run since it results in better employment opportunities for skilled workers, the goods can be exported to other countries, resulting in an inflow of forex. Which is why the regression coefficient is negative. So, one unit increase in FDI in Industry results in 0.4277 decrease in TRYUSD value.
- Turkey shows marginal surplus in current account which is a measurement of a country's trade where the value of the goods and services export exceeds the value of the products it imports. It is likely to be unsustainable and lead to harmful consequences when it is persistently large (Current account deficit) reserved assets are headed for rock bottom and external debt is mounting due to poor governance. One unit increase in current account and reserved assets results in 0.5955 and 0.2244 decrease in TRYUSD. The immediate need is to address the existing current account deficit and depleting reserve assets.
- The capital account's balance will inform economists whether the country is a net importer or net exporter of capital. Here the capital account is negative. A negative capital account balance indicates a predominant money flow outbound from a country to other countries. So, one unit increase in capital account results in 0.1730 increase in TRYUSD value.

Comparison to Benchmark

There are no real-world scenarios to compare the current economic status-quo of Turkey as this is an upshot of an unconventional policy. Perfunctory data about economies can be that went through comparable levels of inflationary crisis can be provided, but the steps to improve them are quite different in Turkey's case. Ideally in Turkey's situation, applying the

Contractionary Monetary Policy is the only solution that can put the country on a way out of this crisis, but the conflicting views of the President and the Central Bank is causing the deceleration in the progress.

Implications

Out of forty different variables that were considered, only eight remained in the model since that's the nature of economic factors. Based on the negative regression coefficients of current account, reserve assets, industrial FDI and construction permits issued, it can be observed that the current monetary policy and the hyper investment in construction sector isn't doing any favours to Turkey's economy. Monetary and fiscal policy go hand in hand and their politicisation needs to be curtailed, which means that the central bank must be the primary arbiter of policy making. This is crucial because, their impact can be seen on the high negative coefficient of reserve assets. It's high time that Turkey considers their economic reality and deal with it in a pragmatic manner rather than idealistic; the point is, protectionism at this point is pushing the country into further turmoil, when their entire economy post-2001 was built upon heavy external borrowings. Monetary regime is at the crux of economic well-being, and Turkey has pushed itself into this hole because of an utterly untenable regime. They should go back to the basics i.e., increase the interest rates, actively seek FDI and reduce dependence on import for agriculture.

Limitations

This study doesn't include the impact of the Covid-19 global pandemic, since data regarding that wasn't available at the time of analysis. So, the results of this project are limited in the sense that the interaction effect of a global crisis and a domestic one is not captured. It can be assumed that the inflation crisis was exacerbated by the costs, trials and tribulations of Covid-19. In March 2020, exports decreased by 17.81% while imports increased by 3.13%. The current account deficit as of January 2020 was two times that of January 2019. The effect can also be seen in consumer price index, and high unemployment rates. Turkey's Economic Confidence Index fell

from 97.5 to 91.8 in March 2020, a sharp decline when compared to the previous month. To mitigate this, a stimulus package of $15.4 billion was announced, but this is a temporary fix.

The important constraint that was faced while working on the problem statement is that in this case study, the deliberation is on a crisis affecting an entire economy - hence on a whopping scale. The chosen dataset consists of a mere forty variables that are taken into consideration whereas an economy has innumerable variables playing a role; especially sociocultural factors. After treating the dataset for multicollinearity, nine variables were gathered that seemed to be the vital players in the dataset. For the model to work in the real world, it is necessary to collect a lot more data and have experts like economists, statisticians, etc. on board who will be well-acquainted with the policy structures and economical theorems.

Closing Reflections

The intricacies of the case study were daunting since it is a currently unfolding event. Apart from a cursory idea about the crisis, there was quite a bit of reliance on intuition since it was difficult to distil the various threads that a case study such as this can lead to, and arrive at the nucleus of the analysis detailed in this report. The scope of this study guaranteed the need for a lot of data. This led to the mammoth task of ascertaining trustworthy data from reliable sources, with granularity being the focal point of this exercise. There were some difficulties faced while structuring the process of framing the study, very evident in the interim report submitted earlier. Rearrangements and combinations of steps taken at each level refined the procedure eventually snowballing into the final model and the relevant conclusions. A standard blueprint of data analysis is convenient but it's moot if it isn't tailored to the needs of the problem being evaluated.