Economic Forecasting: Term Paper

Impact of Inflation Rate on U.S. Dollar to Euro Exchange Rate

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**Thesis/Hypothesis:**

U.S. Dollar to Euro Exchange Rate has been fluctuating quite often over the past 10 years. I am interested in looking at the changes in the foreign exchange rate between U.S. Dollar and Euro as a recession is expected soon and that would increase the inflation. I believe there would be a relationship between inflation and its impact on the respective exchange rates in the next 2 years.

**Introduction:**

An exchange rate is a comparison between a national currency and a foreign currency (Flynn). U.S. Dollar to Euro Exchange rate is the currency conversion that shows dollar value equal to one euro. Exchange rates are implemented to stabilize national economies. I am interested in knowing about the exchange rates between U.S. Dollar and Euro because since the economy is changing a bit right now, I would like to know the impact of expected inflation on exchange rates in near future because that would eventually make changes in purchasing power of individuals in both the economies. I have taken data from January 1st, 2012 to January 1st, 2022 which is not seasonally adjusted, and the frequency is monthly. For this paper, I would be focusing on economy of the United States and Europe to determine the exchange rate. Also, I am taking into account forecasted Inflation rate as the independent variable that could potentially affect the US Dollar to Euro Exchange rate that I am aiming to forecast in this paper. I will be using three approaches to forecast the exchanges rate for the next ten years – Holt Winters, ARIMA, and ARDL. Inflation has negative impact on a country’s currency value and exchange rates (Team). Along with inflation, a lot of other factors do affect the exchange rates of a nation such as interest rates, purchasing power of money etc. A low rate of inflation does not guarantee a favorable exchange rate for a country, but an extremely high inflation rate is likely to impact the country’s exchange rates with other nations negatively (Team). It would be interesting to run the ARDL model with forecasted inflation rate as the independent variable and determine the forecast for the U.S. Dollar to Euro Exchange Rate for the next 5 years.

**Plot:**

Chart, histogram

Description automatically generated

Figure 1

Chart, box and whisker chart

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Figure 2

Figure 1 shows the U.S. Dollar to Euro Exchange Rate over the time period of 10 years from January 2012 to January 2022. After running the summary for the time series, I could see the lowest exchange rate was 1.054 and the highest was 1.383 during the time period of 10 consecutive years which means that around the end of 2016 or beginning of 2017, €1 = $1.05 and before the beginning of 2015, €1 = $1.38. This shows that Euro has generally been higher in value than US Dollar. There is no particular trend visible with this time series but at some points, seasonal variation is visible. Even the seasonal variation does not follow any trend, so it is quite random. Figure 2 shows the boxplot of the data which shows the seasonal variation in the time series, and it looked like the observations were somewhat spread-out. Also, this time series is neither mean stationary nor variance stationary as the magnitude is fluctuating throughout the time period. The most drop of the exchange rate was experienced probably in 2015 looking at the figure where US dollar value in comparison to Euro fell down significantly.

**Holt Winters:**

Exponential smoothing is a special case of Holt Winters method while forecasting a time series. As seen in Figure 1, the time series isn’t mean or variance stationary and the magnitude is changing as well so I used multiplicative decomposition for smoothing out the parameters. After running multiplicative decomposition on the time series, I got the Figure 3.

Chart, line chart, histogram

Description automatically generated

Figure 3

R chose following smoothing parameters and gave us Figure 3 which would minimize the sum of squared predictions:

Alpha = 0.842976

Beta = 0.01459774

Gamma = 1

The sum of squared prediction obtained with these parameters is 0.07933007.

According to this model, it seems that gamma has the most weight (100%) to observe the current data compared to the past data (0%). 84.29% weight for calculating a new value for alpha is coming from the most recent data observed and the previous values of alpha gets 15.71%, whereas for beta 1.46% information is coming from the most recent observations and 98.54% data is coming from the previous observations.

I want to forecast the U.S. Dollar to Euro Exchange Rate 5 years into future based on Holt Winters method. So, using Holt Winters, I got the following results:

Chart, histogram

Description automatically generated

Figure 4

Figure 4 shows the exchange rate being forecasted to 5 years in future using the Holt Winters method. The forecast seems to be mean and variance stationary, following a little bit of the downward trend.

**ARIMA:**

The series in Figure 1 is not stationary so first I took the first difference to make it mean stationary and got the below diagram:

Chart, line chart

Description automatically generated

Figure 5

To make the series variance stationary, I took the log transformation of its first difference and got the following figure:

Chart, line chart

Description automatically generated

Figure 6

The best ARIMA model is ARIMA(1,1,2)

|  |  |  |  |
| --- | --- | --- | --- |
| Best Model | ARIMA(1,1,2) | | |
|  | ar1 | ma1 | ma2 |
|  | -0.6575 | 0.9704 | 0.3908 |
| Standard Error | 0.2383 | 0.2200 | 0.0832 |
| AIC | -606.6 | | |

ACF of residuals of the best ARIMA model

Chart

Description automatically generated

Figure 7

PACF of residuals of the best ARIMA model

Chart, box and whisker chart

Description automatically generated

Figure 8

Figure 7 displays the correlogram of the residuals for the best version of and Figure 8 displays the PACF correlogram of the residuals for the best version of . The best version of is which means that non-seasonal part of the model has AR=4, MA=1, and Seasonal = 0. In both the figures, the residuals of the model look like white noise as all the lags are within the dotted lines (confidence interval) and there is no autocorrelation visible at all. Also, there is no specific seasonal variation visible in the diagram.

Chart

Description automatically generated

Figure 8

In the forecast shown in figure 8, there is 95% predictability that the forecast will be within the gray area and 80% predictability that the forecast will be within the purple area in the next 5 years. According to the ARIMA model, it looks like there is more chance that U.S. Dollar to Euro Exchange rate could be within the 80% confidence interval as there needs to be a drastic change in the economy for the exchange rate to be outside the 80% level and within the 95% level.

**ARDL:**

Chart, histogram

Description automatically generated

Figure 9

Figure 9 shows the comparison of change in Inflation rate and Exchange rate from 2012 to 2022. It looks like there is some sort of correlation but not completely correlated i.e., change in inflation is not completely influencing the U.S. Dollar to Euro Exchange Rate.

Text

Description automatically generated with medium confidence

Figure 10

Here U.S. Dollar to Eura exchange rate is the dependent variable (y-axis), and Inflation rate is the explanatory variable (x-axis). When the Inflation rate is at 0, the U.S. Dollar to Exchange rate is 0.86%. Also, when Inflation rate increases by one unit, exchange rate increases by 0.16776 units. The p-value for this data is 1.507e-14 which is quite closer to 0, so the variable is highly significant. In this model, 0.3875 adjusted R-square shows that there are 38.75% variation in Exchange rate is explained only by a single variable (Inflation rate).

I tried running the ARDL model with couple of different combinations of p and q and the one model that had the smallest AIC was of ARDL(1,2). As seen in Figure 11, only one is quite significant so probably Inflation is not the best independent variable to determine Exchange rates as it doesn’t seem to have a great long-term relationship.

Table

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Figure 11

Chart, box and whisker chart

Description automatically generated

Figure 12

Chart, box and whisker chart

Description automatically generated

Figure 13

Figure 12 displays the correlogram of the residuals for the best version of the ARDL model and Figure 13 displays the PACF correlogram of the residuals of the best version of the ARDL model. Both the correlograms have lags outside of the dotted lines which displays that it is not completely uncorrelated. Lag 3 in both the figures is crossing the 95% confidence interval which means that the model is autocorrelated at that point. Figure 13 states that even after controlling all the variables before lag 3, it looks like there is an autocorrelation at that lag.

Chart, line chart

Description automatically generated

Figure 14

Figure 14 shows the forecast of U.S. Dollar to Euro Exchange Rate 5 years into future. It looks quite constant i.e., taking Inflation rate into consideration, the exchange rate is not changing much for the next 5 years.

**Conclusion:**

Looking at all three different forecasts, I believe that is the best forecast for U.S. Dollar to Euro Exchange Rate in the nest five years. Holt Winters produced a result that was quite mean and variance stationary, and when I added Inflation rate to the exchange rate model as an independent variable, it turned out to be quite insignificant. Also, the ACF and PACF diagrams for the model turned out to be white noise which suggests that residuals of that model are not autocorrelated at any point in time. The ARDL model forecasted the exchange rate to be constant for the next 5 years taking Inflation as the independent variable, which seems like an incorrect assumption. We would need to add some other variables to explain the forecast of the U.S. Dollar to Euro Exchange rate because Inflation rate alone is not able to identify the correct forecast. A variable that I believe would be of greater importance is correlation between interest rates of both the countries and then looking how is it influencing the exchange rates.

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