

MANAGING EXCHANGE RATE VOLATILITY DURING POLITICAL CRISES

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Abstract: *The goal of this paper is to show how the exchange rate volatility could be managed during political crises, using as a case study the fragile political relationship between USA and Turkey between 2014-2019. The Turkish Lira has dramatically dropped against the US dollar to a record low level in August 2018. The Turkish president accused the American president of economic war, insisting that his country would survive an economic assault, but neglecting to comfort financial markets (worried about the breakdown of the national currency of a crucial emerging economy). Meanwhile, investors feared that a financial crisis could spread throughout Europe. Fears of contagion remained high, although the central bank of Turkey pledged to provide liquidity for Turkish banks. On this background, this paper tries to find if different specifications of univariate GARCH models can anticipate volatility in the foreign exchange market. Our study uses estimates from a symmetric GARCH model, namely GARCH (1,1) for TRY/USD exchange rate. The data set was obtained from “Investing.com” and covers the period January 2014 – October 2019. This study shows that GARCH (1, 1) can be successfully applied in modelling and forecasting the volatility trend of the currencies and so in exchange rate administration.*

JEL classification: O16, G1, G17

Key words: *exchange rate administration, modelling and forecasting exchange rate volatility, TRY/USD, GARCH (1, 1) model*

1. Introduction and Objectives

Managing the foreign exchange rate and forecasting and modelling its volatility represent important issues of research in financial markets (Gökbulut and Pekkaya, 2014). As defined by Investopedia (2019), volatility is a statistical measure of the dispersion of returns for a given security or market index. A lot of studies stress the significance of volatility in the financial markets, such as Scott (1991), Alexander (2001), Poon and Granger (2003) or Knight and Satchell (2007).

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Volatility is mostly measured as the standard deviation between returns from the same security or market index and Emmer et al. (2015) described it as the most frequently approach to investigate the risk of an investment. However, the standard deviation has its limitations as a measure of risk (Tache and Darie, 2019a; Tache and Darie, 2019b): the main disadvantage of making use of standard deviation to measure the risk is the absence of suitable weightings that occur at a specific time ascribed to the errors. In other words, the weightings of the errors that occur nearer the present time (t_0) have the same impact and significance as the weightings of errors arising at (t_{12}). Calvet and Fisher (2008), who present a powerful, new technique for volatility forecasting that draws on insights from the use of multifractals in the natural sciences and mathematics, show that using standard deviation as a measure of risk provides little response on skewed datasets. The mean can be influenced substantially by outliers in the data, which would imply that the datasets are skewed. Therefore, standard deviation depends considerably on outliers from the datasets.

The historic volatility (the statistical measure of the dispersion of returns for a given security or market index over a given period of time) is built on the weighted average of squared returns. This is the reason why most of the financial classical theories have to be based on the primary assumption of multivariate normal independent identically distributed (i.i.d) return distributions. Considering the main hypothesis of most financial classical theories, the volatility does not depend on time. Therefore, when volatility remains constant over a certain period of time, all the modifications attributed to estimations of volatility become white noise. Indeed, traditional models assume that the variance of the residual or error term is constant over a period of time, this meaning that the error term does not change much as the value of the predictor variable varies, and this is known as homoscedasticity. But, as shown by Engle (2012), the variance of errors does not remain constant over a period of time, which reveals that the volatility actually depends on the time period in most of the financial markets. This process being known as heteroscedasticity. In other words, heteroscedasticity happens when the standard errors of a variable, monitored over a specific amount of time, are non-constant.

Most of the financial markets indicate that volatility depends on the time period. In order to solve these problems, there were introduced the GARCH (General Autoregressive Conditional Heteroskedasticity) model by Engle (1982) and the ARMA (Autoregressive Moving Average) model by Whittle (1951). In this paper, we will use GARCH, the statistical model that can be used to analyse a number of different types of financial data, for instance, macroeconomic data. Financial institutions typically use this model to estimate the volatility of returns for stocks, bonds, and market indices.

The Turkish Lira has dramatically dropped against the US dollar to a record low level in August 2018. The Turkish president Recep Tayyip Erdoğan lashed out at the president of the United States of America, accusing him of economic war. Furthermore, he insisted that his country would endure and survive an economic assault but neglected to comfort financial markets worried about the breakdown of the national currency of a strategically crucial emerging market economy and the world's 17th largest one (The Guardian, 2018a). The Turkish president's words failed to calm down investor's fears that a financial crisis would not spread throughout Europe as well. In other words, fears

of contagion to the European banking sector remained induced to investors although the Turkey's central bank pledged to provide liquidity for Turkish banks and cut foreign currency reserve requirements in order to ease up the Turkish financial sector (The Guardian, 2018b). Companies that had borrowed heavily in foreign currencies became concerned that the 45% decrease in the value of the Turkish Lira prompted the sell-off of his currency and increased the cost of aiding Turkey's budget deficit. Even though the corporate debt of Turkey is approximately \$300bn of dollars-denominated which makes the country particularly vulnerable, currency speculators have begun to investigate the possible damage done to Europe and to discover other emerging markets countries that also provide opportunities of low interest rates. However, these countries could find themselves accumulating foreign currency debt in the future (The Guardian, 2018a). The Turkish president reaffirmed that the country's economy was stable and criticized the US president for imposing sanctions over the purchase of Russian S-400 missile system and doubling tariffs on Turkey's aluminum and steel imports due to the fact that an American pastor was being under house arrest over terrorism charges. The evangelical Presbyterian missionary Andrew Brunson became indeed the cause of an international diplomatic and economic crisis which has seen Turkey's currency go into freefall and led its president to accuse the US of trying to stab his country in the back (The Guardian, 2018c).

The political tensions between the US and Turkey started three years before, in 2014, when the Turkish police raided Gülen's media to detain over 30 people and to draw national and international condemnation. Furthermore, the Turkish court issued an arrest warrant for Fethullah Gülen, a Turkish Islamic scholar based in the US that marked a new milestone in the government's war on its ally-turned rival after the massive corruption investigation. (Hurriyetdailynews, 2015)

The conflict between the Turkish president and the Turkish Islamic scholar Gülen persisted throughout the following years and climaxed in July 2016, when authorities detained thousands of judges and soldiers on suspicion of involvement in a coup attempt. Furthermore, dozens of media outlets including sixteen TV channels were shut down by the Turkish government during a continuous attack in the confrontation of the failed coup attempt. (BBC, 2019a)

The Turkish inflation increased above 25%, a record annual rate since 2004. Turkey's central bank increased its key interest rates to 24% in September 2018 in order to control the rising inflation through aggressive monetary contraction (CNBC, 2018). The central bank of Turkey stated the commitment to bring further monetary contraction if needed as it prolonged its interest rate pause to seven months. The Turkish Lira plunged to its lowest since October 2017. The Governor of the Monetary Policy Committee (MPC) declared that his actions would be determined by the movements of the inflation, bearing the idea that he would not let inflation exceed the targeted path (Bloomberg, 2019a). Although the Turkish lira significantly dropped in April 2019 due to the MPC Governor's announcement to hold the same interest rate, two months later the Governor reaffirmed the pledge to maintain a tight monetary attitude until the inflation outlook shows a significant improvement. The Turkish lira traded stronger against the US dollar after the rate decision. Investors acknowledged that the Turkish lira would remain among the world's most volatile currencies. (Bloomberg, 2019b)

Inflation decreased from approximately 25% in September 2018 to approximately 9.26 in September 2019. Slowing Turkish inflation provides the opportunity for rate cuts. Thus, the Turkish central bank reduced rates below 20%, emphasizing the first easing move since the currency crisis started in 2014. In other words, the Turkish central bank cut its benchmark one-week repo rate by 425 points from 24% to 19.75%, where it has remained since September 2018 (Reuters, 2019a). After the drop-in rates, the Turkish lira improved to 5.68 against the US dollar after initially tumbling when the policy announcement was made. Also, the inflation rate decreased from approximately 25% to approximately 15%. Nearly two months later, the Turkey's central bank continues to reduce its rate by 3.25 points from 19.75% to 16.50% in a second easing move (Reuters, 2019b). Furthermore, due to the cancellation of the US sanctions over the Turkish military intervention in Syria, Turkey's currency has stabilized followed by the Turkey's central bank to slash the benchmark one-week repo from 16.5% to 14% since inflation decreased to 9.26%. This dynamic improves the economic activity and contributes to better inflation outlook (Aljazeera, 2019a).

However, as of 16th December 2021, the Turkish Lira dropped approximately 40% of its value against the U.S. dollar so far this year. Turkey's experiment of cutting interest rates in order to fight inflation has sent its currency crashing to record low levels. President Erdogan is trying to prop up the lira with a raft of new unorthodox economic measures. Erdogan said the government would try to protect Turkish savers worried about the tumbling value of their nest eggs by compensating them for the impact of the depreciation of the lira on their deposits (CNN, 2021).

The objective of this study focuses the exchange rate administration by analyzing the fluctuations of the TRY against the US dollar from January 2014 to October 2019 (Investing.com, 2019) in order to model and forecast the volatility of the Turkish lira during a major political crisis between the USA and Turkey. The study uses only forecasts from a symmetric GARCH model, namely the GARCH (1, 1) model introduced by Engle (1982), for the TRY/USD exchange-rate pair.

In order to attain this objective, the paper is organized as follows: the next section is dedicated to the methodology and data, more exactly to presenting the nature of GARCH models, both from a statistical and financial perspective; the third section contains the empirical results and analysis; and, finally, the last section concludes.

2. Methodology and Data

This paper adopts, from the different mathematical interpretations of the GARCH (1, 1) model, Alexander (2001) version, which facilitates the numerical estimations and which is, in general, an authoritative guide to financial data analysis, especially as regards GARCH volatility term structure forecasting.

The leverage effect (captured by asymmetric GARCH) and volatility clustering are both part of the GARCH model by basically extending the linear regression model with another equation known as the conditional equation. In a generalized autoregressive conditional heteroscedasticity (GARCH) model, returns are assumed to be generated by a stochastic process with volatility varying according to the time at which it is measured.

A GARCH model introduces more detailed assumptions about the conditional distributions instead of modelling the data after they have been collapsed into a single unconditional distribution. Alexander (2001) emphasizes that since the conditional variance is an autoregressive process, these conditional distributions change over time in an auto-correlated manner.

As already mentioned in the Introduction, this paper will make use of only symmetric GARCH, namely the GARCH (1, 1) model in order to investigate the characteristics of volatility. According to Tache and Darie (2019a) and Tache and Darie (2019b), a symmetric GARCH model means that a symmetric response of volatility to both negative and positive shocks will be seen when a shock occurs, while the asymmetric GARCH models allow for an asymmetric response showing that positive shocks will lead to lower volatility than negative shocks.

In this paper we use the following symmetric GARCH (1, 1) equation:

$$\sigma_t^2 = \omega + \alpha u_{t-1}^2 + \beta \sigma_{t-1}^2$$

$$\omega > 0; \alpha, \beta \geq 0$$

where ω is the constant, α is the GARCH error coefficient, β is the GARCH lag coefficient and σ_t^2 is the conditional variance since any past information considered to be relevant is included in the one period ahead estimation of the calculated variance. While the unconditional variance of GARCH model is constant and concerned with long-term behaviour of time series, the conditional variance relies on the past information. Here is the formula for unconditional variance of the GARCH (1, 1) model:

$$\text{Var}(u_t) = \frac{\omega}{1 - (\alpha + \beta)}$$

The coefficient measures the degree to which today's volatility shock is encompassed within the volatility of the next period; in other words, it is related to the long-run volatility. The unconditional variance remains constant as long as $\alpha + \beta$ is strictly lower than 1.

According to Alexander (2001), GARCH models are frequently estimated on intraday and daily data in order to capture volatility clustering effects in the returns of financial assets as it disappears when returns are observed over long time periods. The estimation of GARCH parameters is realized by maximizing the value of the log likelihood function using time varying mean and variance. Thus, maximizing the GARCH (1, 1) likelihood arrives to solving the maximization problem:

$$\ln L(\theta) = -\frac{1}{2} \sum_{t=1}^T (\ln(\sigma_t^2) + \left(\frac{u_t}{\sigma_t}\right)^2)$$

where the parameters of conditional variance equation are represented by θ .

Maximization of the log likelihood function for univariate GARCH models should meet few convergence problems. Modifications in the coefficient estimates will be induced by modifications in the data. However, unless there are real structural breaks in the data generation process, the parameter estimates should not change significantly as new data arrive.

A certain minimum amount of data is needed in order to have a well-defined log likelihood function. A lot of years of daily data are often needed to ensure proper convergence of the model. This is the reason why the data within this study covers the period from January 2014 to October 2019, meaning a total of 1482 daily observations.

Following again Alexander (2001) recommendations, in any GARCH model the estimate of the GARCH volatility at the end of the sample period is the 1-day-ahead volatility forecast on that day. However, the GARCH long-term volatility can be very different from the 1-day-ahead. More explicitly, the GARCH parameter estimates can be used to generate the term structure volatility forecasts and forward daily volatility forecasts. Generally, the formula used to find the forward daily variance day T+S to day T+S+1 is the following one:

$$\widehat{\sigma_{T+S+1}^2} = \widehat{\omega} + (\widehat{\alpha} + \widehat{\beta})\widehat{\sigma_{T+S}^2}$$

Using this formula, the forward daily variance forecasts can be determined and using these forward daily variance forecasts, a forecast for the GARCH term structure of volatilities can also be found. So, a forecast for the average volatility over different time periods can be obtained. The average volatility falls as the forecast time horizon rises. GARCH volatility term structure forecast converges to its long-term average (i.e., unconditional) volatility. However, the long-term volatility for the estimated unconditional volatility from a GARCH model is not very accurate as it is very difficult to forecast exactly the long-term volatility.

3. Empirical Results and Analysis

Autocorrelation is the early evidence to support the use of ARCH/GARCH models. Therefore, the Box-Pierce or the Q test was used to identify whether autocorrelation within the dataset exists (Alexander, 2001). The test is applied to the residuals of the time series after fitting an ARCH (p, q) model to the data. The formula used to identify autocorrelation is presented below:

$$Q = n \sum_{k=1}^h r_k^2$$

where Q represents the Box-Pierce statistic, n represents the total number of observations, m is the number of parameters and h represents the maximum lag considered.

Generally, the Box-Pierce test is defined as:

H₀: Prices do not have any significant historic dependence

H₁: Prices do have significant historic dependence

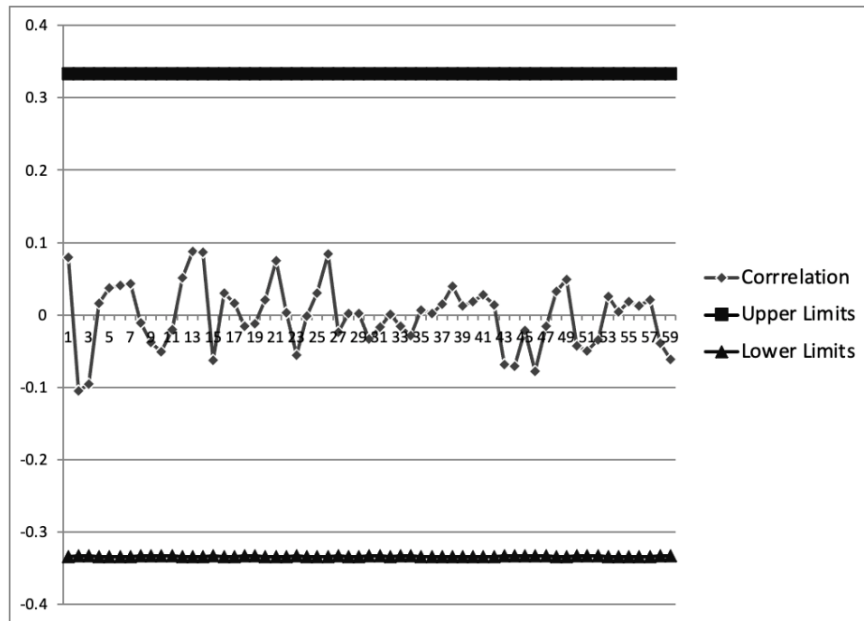


Fig. 1. TRY/USD Autocorrelation for the period January 2014 to October 2019 (elaborated by the authors)

Figure 1 presented above shows that autocorrelation or better said serial correlation in returns does exist for the TRY/USD exchange-rate for the period January 2014 to October 2019. As illustrated in Figure 1, the residuals for TRY/USD exchange-rate pair show significant signs of serial correlation. Furthermore, in order to be certain that serial correlation exists, the application of the Box-Pierce test or the Q test is also made.

Essentially, the Q test statistic shows that in case that residuals are white noise, the Q statistic follows a χ^2 distribution with $(h-m)$ degrees of freedom. In case each r_k value is close to 0 then Q statistic is very small; otherwise, in case some r_k values are large then Q test result is relatively large. Then a comparison between the Q statistic with χ^2 distribution will be made.

Since sixty lags were plotted, this paper only focuses on the r_k^2 values for the sixty correlations. As a result, the full Q test process for the TRY/USD exchange-rate pair between January 2014 to October 2019 is presented below:

$$Q = 1482 \sum_{k=1}^{60} r_k^2 = 174.02$$

As a result, the Q statistic for the above-mentioned period is compared with Chi-squared critical value of 79.08 for a 5% significance level. Thus, the Q statistic is much higher than 79.08 for a 5% significance level, leading to the conclusion that returns do have significant historic dependence. Therefore, H_1 is the accepted hypothesis.

Serial correlation can be referred to as lagged correlation as it measures the relationship between the current value of the Turkish lira against the US dollar and its past value. Since the TRY/USD exchange rate exhibits serial correlation of the residuals, an investor could believe that the trend seen in the serial correlation of the residuals might also be the trend of the Turkish lira against the US dollar value. In other words, since serial correlation is present, an investor could characterise it as a momentum decline in value of the TRY/USD exchange-rate since the past values seem to influence the future value. Thus, investors can take advantage of the serial correlation and speculate the future trend of the TRY/USD exchange rate.

Table 1 below shows how the likelihood function was calculated and how to maximize the log likelihood function using Excel Solver.

Table 1 (elaborated by the authors)

Caption for the table

TRYUSD	GARCH
Jan 2014 - Oct 2019	
ω	1.03E-06
α	0.094455869
β	0.905544131
$\alpha + \beta$	1
LT Vol	1114769.283
LogL	11147.69283
Unconditional Vol (i.i.d)	10.27%

Note: $\sigma_t^2 = \omega + \alpha u_{t-1}^2 + \beta \sigma_{t-1}^2$ – was used for parameter estimation

Table 1 presents the parameter estimates for TRY/USD exchange-rate using the GARCH (1, 1) model in the period January 2014 - October 2019. Note that since the unconditional volatility calculated using an equally weighted average of all squared returns significantly differs from the long-term volatility provided by the GARCH (1, 1) model. Parameters within the GARCH models are optimally estimated using the maximum likelihood function. Furthermore, the persistence and reaction coefficients are estimated separately. Thus, a high persistence in volatility after a market shock is not automatically associated with a low reaction to market shocks. However, it can be identified from Table 1 that there is a high persistence and low reaction to volatility fluctuations since tensions between the US and Turkey began in 2014. The lack of reaction to such fluctuations might be that investors got used to swings in the value of the Turkish lira since this currency is one of the world's most volatility currencies. Parameters within the GARCH (1, 1) model are optimally estimated using the maximum likelihood function. Furthermore, the persistence coefficient β shows a value that illustrates high persistence in volatility since Turkey is very close to Syria, Irak and Iran,

countries where political instability and wars persist. Surprisingly, the α parameter seem to illustrate a relatively stable market.

Any GARCH (1, 1) parameter estimate, especially the estimate of the GARCH constant (ω), is very sensitive to the historic dataset used for the model. In this case, the sample covers approximately five years during which some extreme market movements were recorded due to tensions between the US and Turkey. The estimate of the GARCH (1, 1) constant (ω) is 0. If this political argument between the two large economies persists, a long-term currency war might have been triggered. There is a trade-off between having too much data and enough data for parameter estimates to be stable so that the long-term GARCH forecasts reflect as good as possible the current market condition, but not exactly.

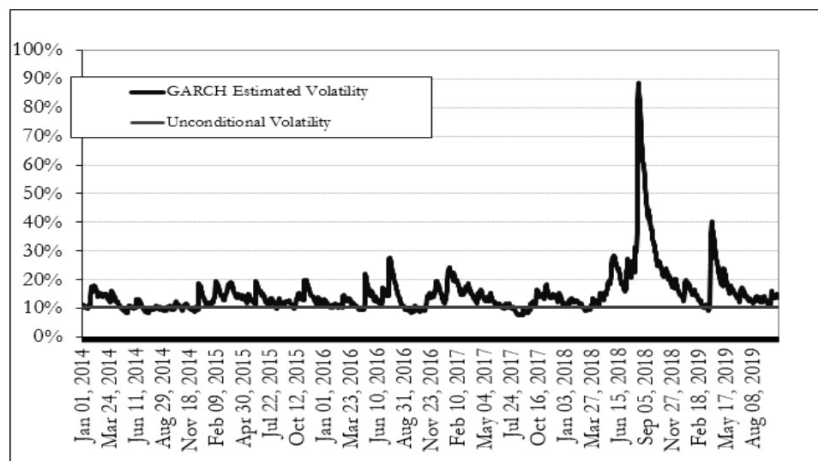


Fig. 2. Comparison between GARCH (1.1) Estimated Volatility vs. Unconditional Volatility for the TRY/USD exchange – rate from January 2014 to October 2019 (elaborated by the authors)

Figure 2 presents that the i.i.d unconditional volatility estimate of 10.27% is very different from the unconditional GARCH (1, 1) average volatility of 15.06%. However, it is not unusual to find differences between the i.i.d volatility and the average or long-term GARCH (1, 1) volatility since the GARCH (1, 1) model does not assume that returns are i.i.d. Figure 2 also illustrates that between January 2014 to October 2019, the fluctuations of the TRY/USD exchange-rate volatility was not very unusual except the two massive spikes in volatility of the TRY/USD exchange-rate that occurred during and after the failed coup attempt against the Turkish president and Istanbul's mayoral election. (BBC, 2019b)

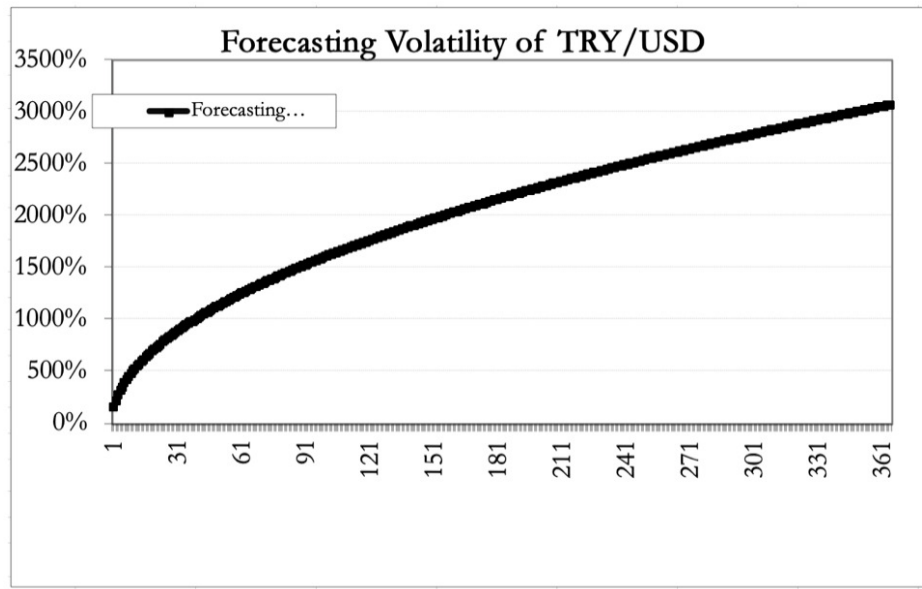


Fig. 3. *Forecasting the volatility of the TRY/USD exchange-rate pair for the next 365 days*
(elaborated by the authors)

Figure 3 presents the forecast of the TRY/USD exchange-rate until 31 October 2020. Realistic forecast should only be done for short periods of time such as days or few weeks in order to capture the estimated value as close as possible to the real value. However, the purpose of figure 3 is to capture the trend of the TRY/USD exchange-rate volatility for the year 2020. It can be seen that the volatility of the TRY/USD exchange-rate will increase in 2020 and investors should be cautious when speculating the trend of the future value of the currency.

4. Conclusions

The economic-war between the US and Turkey can be considered over as the United States of America lifted the sanctions for Turkey. The reason behind this decision was Turkey's promise to make ceasefire permanent in northern Syria - as Turkey began combat offensive just after the USA troops had been withdrawn from that region in October 2019. Thus, many accused the president of the USA of abandoning Kurdish forces who had been one of the US's main allies against the Islamic State of Iran and the Levant (Aljazerra, 2019b).

The political tensions between the USA and Turkey had a major impact on the Turkish Lira during the period January 2014 - October 2019 as its value abruptly decreased to a record low level in August 2018. Our analysis identifies that the serial autocorrelation

between the US dollar and Turkish Lira provides to investors the ability to speculate on the future value of the TRY/USD exchange-rate since investors could believe that the trend seen in the serial autocorrelation of the residuals might also be the trend of the Turkish Lira against the US dollar value.

Also, according to the GARCH (1, 1) parameters, there is high persistence and low reaction to volatility fluctuations. The lack of reaction and high persistence in volatility of the Turkish Lira is connected to the fact that investors are aware that it is one of the world's most volatile currencies and also of the geographical position of Turkey being surrounded by countries where political instability and wars persist such as Syria, Irak and Iran.

Although the forecasting of the TRY/USD exchange-rate was done over the following 365 days, it shows the estimated trend of the TRY/USD exchange-rate. More specifically that the volatility of the TRY/USD exchange-rate will increase in the future. In this case, the estimated trend proved to be accurate. However, realistic forecasts should only be done for short periods of time such as days or few weeks in order to capture the estimated value as close as possible to the real value. Using Excel to determine the GARCH (1, 1) model instead of other sophisticated software provides an in-depth analysis of each variable of the model and the most cost-effective manner to identify the volatility of the currencies. Even though Excel might not be the most precise software to use when forecasting volatility, in our analysis it proved to support a clear indication of the volatility trend in the future, helping indeed to manage the exchange-rate fluctuations.

Our investigation shows that the GARCH (1, 1) model could be successfully applied to predict and forecast the volatility of the currencies, and so the exchange rate administration, especially during political crises, and could help investors/savers manage or protect their finances - knowing that a period of volatility of the currency will occur.

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CODE AVAILABILITY: Not applicable.

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