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The euro exchange rate's resistance to the exogenous shock caused by COVID-19

Suzana Balaban
Alfa BK University, Faculty of Finance, Banking and Audit, Belgrade
https://orcid.org/0000-0001-8132-9120

Ivan Milenković
University of Novi Sad, Faculty of Economics in Subotica, Subotica
https://orcid.org/0000-0002-2947-8118

Marijana Joksimović
Alfa BK University, Faculty of Finance, Banking and Audit, Belgrade
https://orcid.org/0000-0002-5939-5137

Abstract

Background: The COVID-19 pandemic represents the greatest exogenous global shock in the last few decades, which has deeply affected the macro-economic aggregates around the world. Bearing in mind that COVID–19 pandemic is an exogenous shock; its effect on the macro-economic aggregates will take time to be analysed, while it has a persistent impact on the financial markets.

Purpose: One-third of the transactions worldwide includes the euro. Hence, the main objective of this study is to estimate the euro exchange rate's resistance to the exogenous shock caused by the COVID-19 pandemic.

Study design/methodology/approach: This paper employs the General AutoRegressive Conditional Heteroskedasticity (GARCH) model to examine the EUR/USD exchange rate's resistance to the global exogenous shock caused by the COVID–19. In other words, the authors try to find an answer to question whether the COVID–19 pandemic affects the EUR/USD exchange rate volatility.

Finding/conclusions: The results show that the COVID–19 pandemic has no effect on the EUR/USD exchange rate volatility in the long run. These results may confirm our assumption of the resistance of the financial market to the exogenous shock and are useful for anyone needing forecasts of the exchange rate futures movements. The obtained results produce pragmatic expertise in order to manage exchange rate risk and should support policymakers to advance exchange rate policy.

Limitations/future research: As a limitation of this study, the authors state the estimation of the euro exchange rate`s resistance to only one exogenous shock, caused by COVID-19. Bearing in mind that in the considered period was also the world economic crises which might have caused a higher volatility then COVID-19, for further research the authors propose an examination of the detailed estimation of the euro exchange rate`s resistance to different exogenous shocks.

Keywords
COVID–19, GARCH, EUR/USD volatility, Financial market, Shock resistance

Introduction

It can already been argued that the COVID-19 pandemic inevitably led to the decline in GDP, increase in the unemployment rate and general government deficit in almost all economies around the world. It caused a high uncertainty that has destabilized global markets. The COVID-19 pandemic led to severe modification in the way people work (Szeiner et al., 2021) and had a significant impact on supply chains and almost all aspects of government and business activities (Ubi et al., 2021; Zečević et al., 2022) (Joksimović et al., 2021)

Bearing in mind that COVID–19 was an exogenous shock, its effect on the macro-economic aggregates will take time to be analysed, while it had a persistent impact on the financial markets. There is a common belief that the global crises lead to a sharp depreciation of all currencies (Barro, 2006; Gabaix, 2012). However, during the 21st century, the exchange rate volatility has been decreasing among the G3 currencies. Was this stability maintained through the COVID–19 pandemic? The authors' main objective is to estimate the euro exchange rate's resistance to the exogenous shock caused by the COVID-19 pandemic.

The influence of the COVID-19 pandemic on the exchange rate markets was usually realised through the channel of changing the relative expectations of the future economic growth. In this paper, the authors focus on the euro's stability. Revealed that during the COVID-19 pandemic the euro (EUR) had strengthened in relation to the United States dollar (USD). According to OECD database, the European Union's debt was lower than that of the United States and Japan, the European Union gravitated to sustain account surpluses and one third of the transactions worldwide included the euro. Eichengreen & Gros (2020) considered that the European Union should to strengthen the attractiveness of the euro as a reserve currency. However, the political divergences were leading to the euro not being considered as a safe haven currency. To become even more attractive in international payments and considered as a safe currency, the euro should be stable in the long run. The authors assume the hypothesis H_{01}: The COVID-19 pandemic did not influence the euro exchange rate's resistance to the shock, and H_{02}: The GARCH (1,1) is an optimal model for an estimation of this influence.

In the Introduction section, the authors define the main objective of this paper and the hypotheses the authors estimate. In Literature review section, there are presented the relevant theoretical and practical works that deal with exchange rate volatility during the COVID-19 pandemic. The underlying model and data set are shown in the second section. The third section describes the used methodology and empirical results, while the last section concludes.

1. Literature review

According to Handoyo (2020), Franz (2021), Umar, M (2021), Hung et al. (2022), Aloui (2021), Abedin et al. (2021) the COVID-19 pandemic caused worldwide economic, investment and trade crisis. Devpura (2021), Iuga et al. (2022), Wei et al. (2020) showed that the COVID-19 pandemic had a significant influence on the global financial system. Simion and Mihai (2021) agreed with this opinion adding that the governments around the word had to react in completely unforeseen circumstances and make unusual decisions. To remain stable and survive throughout the time of the COVID-19 pandemic, a lot of companies made an attempt to invent innovative options and transform their activities (Youssef et al., 2022; Adekoya et al., 2021; Ozturk et al., 2021).

However, one of the most unexpected characteristics of the COVID–19 pandemic shock was the stability in the exchange rates, in spite of a global recession. Dias and Santos (2020) concluded that the exchange rate markets had persistence and long memories, while Park et al. (2020) revealed more stability in the exchange rate worldwide throughout the first three months of the COVID-19 pandemic. Ilzetzki et al. (2020) found that the rising G3 currencies' (dollar, euro and yen) stability over the COVID–19 pandemic shock was an acceleration of a long–term trend. Following the authors' opinion the G3 currencies' exchange rate volatility reached its lowest values since the Bretton Woods agreement. Benzid & Chebbi (2020) showed that an increase in the new cases and deaths caused by the COVID-19 pandemic in the United States had a positive effect on the daily stability of the USD/EUR, USD/Yuan and USD/LivreSterling calculated by GARCH (1,1) model. Njindan Iyke (2020) analysed the COVID–19 upsurge channel of the exchange rate return predictability. The author showed that the COVID–19 pandemic had better prognostic power over the exchange rate volatility than over returns for a one–day in advance prognosis horizon, while it tended to lean returns more than volatility over a five–day in advance prognosis horizon. Ratho et al. (2020); Salehi et al. (2021); Moussa et al. (2021) considered that forex market interventions, inclusive of other monetary and regulatory measures upheld contributed to the exchange market stability and reduced the possible risks to the financial stability. Garg and Prabheesh (2021) showed that the interest rate differentials intensify the predictability of the exchange rate movement in the BRICS countries during the pandemic.

On the other hand, Barro et al. (2020), Das (2021), Cauwenberge et al. (2021) and Sim et al. (2022) claimed that the growing volatility in the financial market around the world had been caused by the high level of uncertainty. Employing wavelet coherence and partial wavelet coherence model, Singh et al. (2021) found the high degree of correlation between exchange rate movement and the pandemic in G7 countries during the period from January 4, 2021 to July 31, 2021. Using a regression analysis, Gongkhonkwa (2021) drew a similar conclusion for Thailand covering the period from January 2, 2020 to December 15, 2020. Based on an examination of twenty countries Feng et al (2021) showed that a growth in new cases of COVID–19 remarkably increased the exchange rate instability in twenty observed countries covering the period from January 13, 2020 to July 21, 2020. Koç (2021) came to the similar conclusion for Turkey. Namely, using the MS–ARCH model on the USD/TRY exchange rate return the author found that the COVID-19 pandemic had significant impact on the exchange rate stability during the period from March 2020 to Octobar 2021. Furthermore, the author concluded that this impact is permanent. Olasehinde-Williams et al. (2021) argued that the financial system stability should be considered as a main goal of economic policy during the COVID-19 pandemic.

Employing the autoregressive distributed lag model Chuanjian et al. (2021) found the short and long run negative impact of the pandemic on the exchange rate stability in the United States and China during the time from January 22, 2020, till May 7, 2021. Contrary to that, using the error correction model, Gbadebo (2022) found that the COVID-19 pandemic caused an increase in Nigerian exchange rate instability cover the period from February 29, 2020 to March 31, 2021. At the same time, the author concluded that the COVID-19 pandemic had an impact on all macroeconomic indicators in Nigeria. Beckmann and Czudaj (2022) draw a similar conclusion for fifty currency pairs (twenty nine major currencies and thirty three minor currencies) during the different time horizons. Employing the panel autoregressive distributed lag model Jamal and Mudaser (2022) revealed that the COVID-19 pandemic significantly affected the exchange rate movements in the countries most affected by the COVID-19 pandemic (Brazil, China, India, Italy, Turkey, and the United Kingdom) during the period from March 11, 2020 to December 31, 2020. Moreover, the authors concluded that the COVID-19 pandemic modified the market expectations about the future exchange rate movements.

Aquilante et al. (2022) showed that the COVID-19 pandemic induces a depreciation of the domestic currencies relative to currencies of the trading partners confirming that the exchange rate reacted quickly to the exogenous shocks. Conducting an analysis on nine exchange rates of European countries, Klose (2022) revealed that the COVID-19 pandemic caused the depreciation of the domestic currencies relative to euro.

Li et al. (2022) tried to answer a question whether the relationship between oil prices and observed exchange rates (CAD/USD, EUR/USD, JPY/USD, and GBP/USD) differed during the COVID-19 pandemic. Using a shock spillover index, the authors estimated the significance of return and volatility spillover before and during the COVID-19 pandemic. They find that observed effect was more powerful during the COVID-19 pandemic time. Yildirim et al. (2022) showed that real effective exchange rate and commodity prices volatility transmission significantly differed in periods of crisis compared to the stable periods in Mexico, Indonesia and Turkey. Employing DECO-GARCH and transfer entropy approaches, Hung et al. (2022) showed that the risk caused by the COVID-19 pandemic from one exchange rate market had been very quickly and easily transferred to other markets around the world. Yilmazkuday (2022) partially confirmed these claims analysing the spillover effects of United States monetary policy on the movements of exchange rates of twenty three emerging and developed economies. Konstantakis et al. (2023) claimed that during the COVID-19 pandemic there is higher EUR/USD volatility than in the period before the pandemic. That should be very important information for making investment decisions during the periods of crisis.

2. Data and model

The most of recent studies recommended the GARCH for modelling the exchange rate volatility (see Balaban et al., 2019; Simion and Mihai, 2021; Almisshal and Emir, 2021; Basma and Mustafa, 2021; Rakshit and Neog, 2022; Charfi and Mselmi, 2022). In accordance with these studies, the authors measure the EUR/USD volatility using the conditional variance (h_t) of the daily nominal exchange rate return derived from the following GARCH model that the authors assume as the most appropriate:

$$h_t = \alpha_0 + \alpha_1 \varepsilon_{t-1}^2 + \beta_1 h_{t-1} + \gamma_1 Z_t^{'} + Dummy \quad (1)$$

where

α estimates the ARCH effect,

β estimates the GARCH effect,

Z_t' presents the new cases of COVID–19 – a standardized variable calculated using a following formula $z = \frac{X-\mu}{\sigma}$, where μ is a mean, σ is a standard deviation,

ε_t is the stochastic term,

Dummy variable included in the model takes a value 1 during the COVID–19 pandemic time, a value 0 in another case.

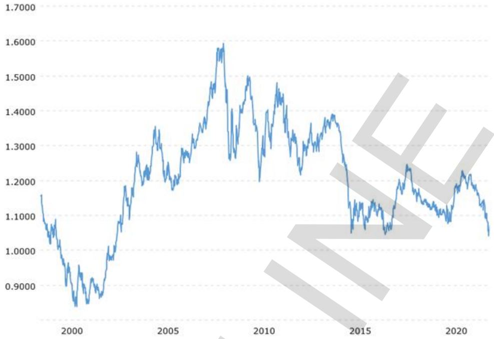

Chart 1 Euro-Dollar exchange rate – Historical Chart
Source: the authors' calculation based on data https://www.macrotrends.net

The modelled variable is the logarithmic exchange rate return. The GARCH model is employed in order to the authors examined whether the COVID–19 influences the EUR/USD volatility. The authors cover the period from January 1, 1999 to March 31, 2022.

In the Chart 1 the horizontal axis represents the observed period, while the vertical axis represents the daily values of EUR/USD. As Chart 1 shows the euro's fluctuations were high at the first period, while they decreased later. It is worth mentioning that the euro had been strengthened against both currencies through the COVID-19 pandemic. This fact may strengthen the role of euro bearing in mind that a "multipolar" structure is increasingly visible in the financial system worldwide. The OECD Statistics reveal that the euro has been the second most significant global currency through the last year, while the euro is the most used invoicing currency in the international trade.

3. Methodology and results

The GARCH model takes into account several common characteristics of financial time series. One of them is the grouping of volatility, which can be clearly seen in the Chart 2. In the Chart 2 the horizontal axis represents the observed period, while the vertical axis represents the value of the estimated daily nominal exchange rate returns.

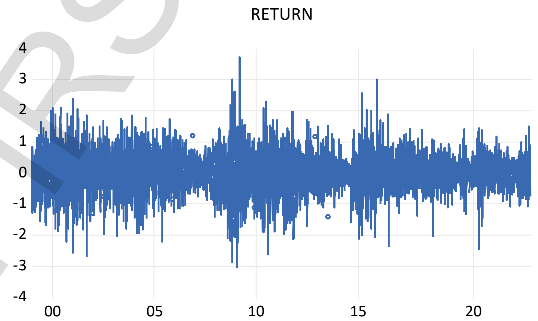

Chart 2 Nominal EUR/USD EXR return – historical data
Source: the authors` calculation based on OECD data, EViews 12 software package

Following the descriptive statistics presented in Table 1, the authors may conclude that the EUR/USD have a leptokurtic distribution (high kurtosis). Jarque-Bera (JB) statistics also suggest that obtained variable is not normally distributed which is confirmed with Quantile-Quantile (QQ) plot given in the Chart 3. Hence, the estimated GARCH model may follow the student *t*-distributions rather than normal one.

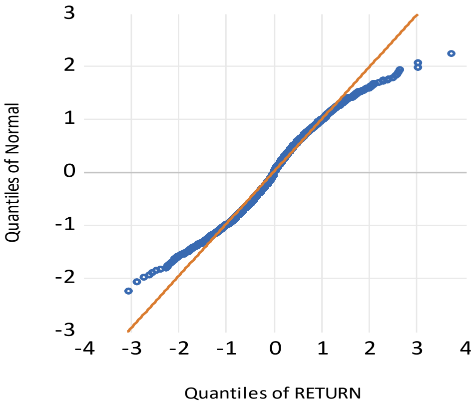

Chart 3 Nominal EUR/USD return QQ plot - - historical data
Source: Author`s calculation based on OECD.stat, EViews 12 software package

To detect the structural breaks, the authors apply Bai and Perron procedure, which estimates the multiple break points based on the Quandt-Andrews structural fracture test. Following Schwarz and LWZ criterion selected breaks; the authors may conclude that in the EUR/USD return series there is no structural break, while in COVID-19 series data there is one structural break. Hence, in the case of the first series we apply two complementary tests; the Augmented Dickey-Fuller (ADF) test and Kwiatkowski–Phillips–Schmidt–Shin (KPSS) test while for the second series we apply the ADF test. The tests show the stationarity of all observed variables (see Table 2). Ljung-Box Q statistics and Breusch-Godfrey Largange Multiplier (LM) test are used to detect autocorrelation. According to the findings in the Table 2, the authors may conclude that there is no autocorrelation.

Table 1 Descriptive statistics

	Mean	Median	Max	Min	Std. Dev.	Skewness	Kurtosis	JB
EUR/USD	0.001034	0.000000	3.725359	3.056473	0.593815	0.008835	5.068595	1097.844
COVID-19	438.9109	0.000000	2817.330	0.000000	215.2557	8.624968	88.16214	1937243

Source: Authors' calculation based on OECD.stat and OurWorldInData, Eviews 12 software package

Table 2 Unit Root tests, Ljung-Box statistics, LM test and heteroskedasticity test

	Unit root tests			
	ADF test		KPSS test	
	Intercept	Trend and intercept	Intercept	Trend and intercept
EUR/USD	-80.51522	-80.50971	1.960212	1.800062
	Augmented DF test			
COVID-19	-14.12566	-15.17059		
		Autocorrelation tests		
	Ljung-Box Q statistics			LM test
	Q(10)	Q(20)	Q(30)	
COVID-19→EUR/USD	-0.026	-0.003	0.967	1438554
	Heteroskedasticity test – ARCH effect			
COVID-19→EUR/USD	90.34863			

Note: ADF – Lag length: Schwarz Info Criterion, KPSS – Bandwith: Newey-West Bandwidth

Source: the authors' calculation based on OECD.stat, Eviews 12 software package

Table 3 Selection of the optimal GARCH model – the value of Schwarz criterion (SIC)

Estimated models	Value of SIC				
	GARCH	TGARCH	EGARCH	PGARCH	CGARCH
COVID-19→EUR/USD	1.624163	1.625194	1.627748	1.625561	1.625039

Source: the authors' calculation based on OECD .stat, Eviews 12 software package

In order to answer whether the GARCH model is adequate for modeling EUR/USD volatility, the authors estimate the residual fluctuation. In Chart 4, the horizontal axis represents the observed period, while the vertical axis represents the value of the estimated residuals. It is noticeable from the Chart 4 that periods of low/high EUR/USD volatility are followed by periods of low/high EUR/USD volatility for a prolonged period. Hence, the authors conclude that GARCH model will be adequate for EUR/USD volatility modelling.

The heteroskedasticity tests (see Table 2) show that in all observed models the ARCH effects are detected; hence the some type of GARCH models should be used for answering the question whether the COVID–19 affects euro's exchange rate resistance to the shock caused by COVID-19.

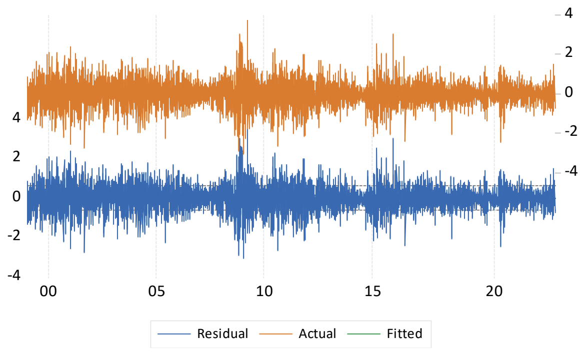

Chart 4 Residual fluctuation
Source: the authors' calculation based on OECD.stat, Eviews 12 software package

To select the optimal type of GARCH model the authors use the lowest Schwarz criterion (see Penezić et al., 2020). Besides the GARCH model in the Table 3, we estimate the following models:

TGARCH (Threshold GARCH) model

$$\sigma_{e,t}^2 = C + (\alpha_e + \gamma_e I_{t-1})\varepsilon_{e,t-1}^2 + \beta_e \sigma_{e,t-1}^2 + \sum_{i=1}^{k} \tau_e V_{e,i} + Z_t' \qquad (2)$$

EGARCH (Exponential GARCH) model

$$ln(\sigma_{e,t}^2) = C + \beta_e ln(\sigma_{r,t-1}^2) + \alpha_e(\varepsilon_{r,t-1}) + \sum_{i=1}^{k} \tau_e V_{e,i} + Z_t' \qquad (3)$$

$$\alpha(\varepsilon_{e,t-1}) = \psi_{e,1}\varepsilon_{e,t-1} + \psi_{e,2}\left(|\varepsilon_{e,t-1}| - \sqrt{2/\pi}\right) \qquad (4)$$

PGARCH (Power GARCH) model

$$\sigma_{e,t}^{\delta} = C + \alpha_e\left(|\varepsilon_{e,t-1}| - \mu_e \varepsilon_{e,t-1}\right)^{\delta} + \beta_e \sigma_{e,t-1}^{\delta} + \sum_{i=1}^{k} \tau_e V_{e,i} + Z_t' \qquad (5)$$

CGARCH (Component GARCH) model

$$\sigma_{e,t}^2 = \overline{w} + \alpha_e\left(\varepsilon_{e,t-1}^2 - \overline{w}\right) + \beta_e\left(\sigma_{e,t-1}^2 - \overline{w}\right) + \sum_{i=1}^{k} \tau_e V_{e,i} + Z_t' \qquad (6)$$

where α estimates the ARCH effect, β estimates the GARCH effect, γ measures asymmetric effect in the TGARCH model, ψ_1 and ψ_2 measures asymmetric effect in the EGARCH model, μ and δ measures asymmetric effect in the PGARCH model, while τ estimates the dummy variables (V) that are introduced when the structural breaks are detected.

According to the obtained findings in Table 3, as an optimal model, the authors select the GARCH (1,1) which is consistent with our hypothesis. Following the results presented in the Table 4 the COVID-19 does not affect euro exchange rate's resistance to the exogenous shock caused by the COVID-19 pandemic in the long-run time period; the obtained coefficients of COVID-19 and Dummy variable are not statistically significant. The diagnostic tests show that the models are well specified. Bearing in mind that $\alpha + \beta < 1$, the authors may claim that the estimated model is stable, while the obtained results of Q(20) suggest that there is no serious correlation. Heteroskedasticity test show that there is no ARCH effect in the residuals of the evaluated model. Pearson statistic shows that the estimated model is well specified.

Table 4 Estimated GARCH (1,1) models

Variable	Coefficient
C	0.002103
COVID–19	-5.48e-07
Dummy	-0.006139
Variance Equation	
C	0.001078
RESID(-1)^2	0.035656
GARCH(-1)	0.961523
Diagnostic Tests	
$\alpha + \beta$	0.997179
Q(20)	-0.009
ARCH	3.2684
Pearson	6.89

Source: the authors' calculation based on OECD.stat, Eviews 12 software package

Conclusion

The COVID-19 pandemic represents the greatest exogenous global shock in the last few decades that has deeply affected the macro-economic aggregates around the world. As an exogenous shock, its effect on the macro-economic aggregates will take time to be analysed, while it is expected to have a persistent impact on the financial markets. However, one of the most unexpected characteristics of the COVID–19 shock has been the stability in the majority of exchange rates, in spite of a global recession. The authors' main objective is to estimate the euro exchange rate's resistance to the exogenous shock caused by the COVID-19 pandemic. Using the GARCH (1,1) models the authors examine the euro exchange rate's resistance to the shock caused by the COVID–19 pandemic in the long run. According to the obtained results, the authors can draw a conclusion that the COVID-19 pandemic does not affect the euro exchange rate's resistance to the shock in the long-run. The obtained results confirm the authors' first assumption about the euro's resistance to the exogenous shock and the authors' second assumption that EUR/USD exchange rate volatility should be measured by GARCH (1,1) model. The euro was strengthened against the U.S. dollar during the COVID-19 pandemic. Following by the euro exchange rate's stability, these facts may strengthen the role of the euro considering that a multipolar structure has been necessary in the financial system worldwide.

The findings obtained in this study provide valuable information for policy makers and financial managers taking into account that high exchange rate volatility may cause growth of transaction costs and reduction of international trade. The obtained findings may make it easier for policy makers to improve the efficiency of exchange rate. In the authors' opinion, this study contributes to the literature explaining EUR/USD volatility during the COVID-19 pandemic. The obtained findings may be useful to anyone needing forecasts of the euro futures movements, especially for investors who desire to hedge exchange rate risk in their net foreign asset positions and researches who analyse the volatility in foreign markets.

As a limitation of this study, the authors state the estimation of the euro exchange rate's resistance to only one exogenous shock, caused by COVID-19. Bearing in mind that in the considered period the world was also in an economic crises which might have caused a higher volatility then COVID-19, for further research the authors propose an examination of the detailed estimation of the euro exchange rate's resistance to different exogenous shocks. It is worth to mentioning that the GARCH models can overestimate the estimated volatility in certain circumstances (Hamilton and Susmel, 1994). The obtained results produce pragmatic expertise in order to manage exchange rate risk and should support policymakers to advance exchange rate policy.

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✉ **Correspondence**

Marijana Joksimović

Alfa BK University, Faculty of Finance, Banking and Audit, Palmira Toljatija 3, 11000, Belgrade, Serbia

E-mail: marijana.joksimovic@alfa.edu.rs