The impact of COVID 19 on Foreign Exchange Market Volatility: Evidence from Latin America

Nouria Bouriche*[1], Mohamed Benbouziane[2]

[1]MIFMA Laboratory, Faculty of Economics and Management, University of Tlemcen, Algeria, nouria.bouriche@univ-tlemcen.dz

[2]MIFMA Laboratory, Faculty of Economics and Management, University of Tlemcen, Algeria, mohamed.benbouziane@univ-tlemcen.dz

Received:30/10/2021 Accepted:14/12/2021 Published:15./09/2022

Abstract:

The study investigates the impact of COVID 19 on the volatility of exchange rate returns in Latin America. GARCH and EGARCH models are used to conduct the analysis with the inclusion of COVID 19 as an exogenous variable in the conditional mean and variance equations. The results of our study indicate a significant negative effect of COVID 19 on exchange rate returns in Brazil, The volatility of the BRL/USD and MXN/USD returns is positively influenced by corona virus. A leverage and asymmetric effects are found in the markets, that means they react differently to positive and negative shocks of the same magnitude, bad news tend to have a higher effect on the conditional volatility of the Brazilian and Mexican exchange rate markets. EGARCHX (1, 1) is the best model to capture the volatility of the returns of BRL/USD and MXN/USD exchange rates.

Keywords: COVID 19, exchange rate, volatility, GARCH, EGARCH, BRL/USD, MXN/USD.

*** Auteur expéditeur**

1. INTRODUCTION:

Corona virus is an infectious disease that causes respiratory problems and serious damage to the lungs. It spreads through saliva and nose discharge, infected people with chronic disease and other medical problems can experience critical illness. The virus first outbreak was in the city of Wuhan in china. 44 patients were suffering from an unknown pneumonia and reported to the world health organization on the 3rd January 2020. Some patients were working in the Huanan seafood market, which led the Chinese authority to close the Wuhan market immediately on 1st January 2020 (WHO, 2020). Government authorities around the world had to take serious prevention measures to stop the spread of the virus (social distancing, public gathering ban, lockdowns, mask wearing and sanitization).

The response of financial markets to COVID 19 has been investigated in the literature. Alawadhi, Al-Saifi, Al-Awadhi, & Alhammadi (2020) use panel data analysis to investigate the effect of corona virus on all companies included in Hang Sang Index and Shanghai Stock Exchange Composite. They find significant negative impact of COVID 19 daily growth in cases and deaths on stock returns in Chinese market. Bahrini & Filfilan (2020) find that stock returns in the GCC responded negatively to COVID 19 daily new and total deaths while daily COVID confirmed cases is found to be insignificant. The increase of COVID deaths caused a decline in stock prices in the area. Liu, Manzoor, Wang, Zhang, & Manzoor (2020) analyze the effect of COVID outbreak on stock market indices in different countries. Their results indicate that COVID 19 outbreak has a significant negative impact on stock returns. Asian markets are found to be the most affected by the pandemic with a slight recovery later. The study revealed that the reaction of stock returns to COVID 19 confirmed cases is significant and adverse. Sansa (2020) finds a significant positive relationship between Chinese and US stock indices and confirmed cases of COVID using a simple linear regression during March 2020. The results of regression analysis and granger causality test in Sapkota (2020) reveals that daily changes in COVID cases has a huge impact on stock returns in Asia and Middle East while daily change in deaths is insignificant. Lee, Lee, &

Wu (2021) show that change in COVID 19 explosion causes an increase in the exchange rate which in turn results in a decline in stock market returns in china, specifically the hospitality industry. The impact of COVID-19 on stock market is also found to be inconsistent. Technology, healthcare, manufacturing and education industries are more flexible to the corona virus than other industries He, Sun, Zhang, & Li (2020) investigate the effect of daily COVID 19 cases and deaths on the conditional mean and volatility of returns of Dow Jones and S&P 500 indices using GARCH (1, 1) model. The results show that total COVID cases and deaths in the US have no impact on the US stock market returns in the conditional mean and conditional variance equations but when using cases reported in China, a negative effect is detected on the US stock returns. In Italy, the coefficients of total cases and deaths are found to be significant and positive in the conditional variance equation. Chaudhary, Bakhshi, & Gupta (2020) examine the impact of COVID 19 on the top 10 world stock indices. GARCHX (1, 1) model is used with COVID 19 as an exogenous variable represented by a dummy variable. The results confirm that COVID 19 has a significant positive influence on the conditional variance of all the indices. The coefficients of the mean equation are non-significant. The sum of the ARCH and GARCH coefficients is less than 1 in all the markets which indicate a mean reversion process. Apergis & Apergis (2020) study the impact of COVID 19 total daily cases and deaths on the conditional mean and variance of Chinese stock returns. The findings show a significant negative impact of COVID 19 on stock returns and a positive significant effect on the returns volatility. GARCHX (1, 1) yields better prediction performance than GARCH (1, 1), this indicates the predictive power of COVID 19 factors in the out of sample forecast.

FOREX markets have also been affected by the pandemic, (Rai & Garg (2021) find a significant risk transfer between stock and exchange rate markets in the BRIICS economies. COVID 19 causes a decline in stock returns which leads to capital outflow and eventually depreciation in the local currency. Iyke (2020) use GARCH and EGARCH models to forecast exchange rate volatility. Reported cases of COVID 19 have a positive predictive power on exchange rates volatility for USD–CAD and USD–EUR over 1 day forecasting horizon, while USD–SEK and USD–GBP volatility is negatively affected by COVID. With regards to 5 days forecast period, COVID 19 has more impact on exchange rates returns than the volatility. EGARCH (1, 1) generates better prediction performance comparing to GARCH (1, 1) model. Kutu & Ngalawa (2016) test the impact of global economic shocks on the Brazilian currency. Oil prices and federal funds rates are included in GARCH, EGARCH and APARCH models as exogenous variables. The findings reveal a significant impact of global shocks on the exchange rate volatility in Brazil. Campani & Durães (2018) employ implied and realized volatility of USD/BRL as exogenous variables in EGARCH model to forecast the USD/BRL currency volatility. The results indicate a better prediction ability of the models with implied and realized volatility compared to standard GARCH and EWMA models.

The Brazilian Real witnessed a devaluation of 26.48 % by the end of June 2020 due to the large fiscal deficit and lower interest rates implemented by the Central Bank of Brazil as a response to the pandemic. The Mexican Pesos in other hands depreciated in the first half of 2020 by 17.68%.

From the discussion above, our study attempts to investigate the following issue: Is the depreciation of the Brazilian Real and Mexican Pesos a clear result of the impact of corona virus on the exchange rate markets? Does the pandemic affect both market returns and volatilities? If so, how is the impact reflected in the markets?

Our analysis relies on GARCH approach to model the variations in the exchange rate markets and to show evidence on the existence and nature of the COVID 19 effect if detected. We have developed three main hypotheses to support our analysis:

H_1: COVID 19 has an impact on both FOREX markets

H_2: COVID 19 affects exchange rate returns and volatility

H_3: there is a similar effect of COVID 19 on exchange rate returns and volatility.

2. Methodology:

The goal of the study is to investigate the effect of COVID 19 on the BRL/USD and MXN/USD exchange rates returns. GARCH models are used in our analysis with the inclusion of COVID 19 as an exogenous variable in the conditional mean and variance equations of the models.

2.1. GARCH Models:

Generalized Autoregressive Conditional Heteroscedasticity models (GARCH) are uses to model the volatility of financial data. When error terms are heteroscedastic, observations do not follow a linear pattern instead they exhibit clustering. ARCH models allow the time changing volatility unlike homoscedastic models. ARCH process was first introduced by Engle (1982) and further extended by Bollerslev (1986) to GARCH. The Model is a combination of lag residual error terms generated from the mean equation and the lags of the variance.

A standard GARCH model is defined as:

$$\gamma_t = \mu_t + \varepsilon_t \quad (1)$$

$$\sigma_t^2 = \omega + \sum_{i=1}^{q} \alpha_i \, \varepsilon_{t-i}^2 + \sum_{j=1}^{p} \beta_j \, \sigma_{t-j}^2 \quad (2)$$

Where:

γ_t: Conditional mean, σ_t^2: conditional variance , ε_t : error term, μ_t and ω : constants, p: lags of the variance, q: lags of the residual errors, α_i: ARCH term coefficient, β_j: GARCH term coefficient. ω ,α_i, β_j >0

$\alpha_i+\beta_j < 1$

The GARCH (1, 1) model with p =1 and q =1 is written as:

$$\sigma_t^2 = \omega + \alpha_1 \, \varepsilon_{t-1}^2 + \beta_1 \, \sigma_{t-1}^2 \quad (3)$$

EGARCH model (Nelson 1991) captures the leverage effect of shocks on stock returns. It tests for the asymmetry in the market which allows the variance to react differently based on the positive or negative news. It demonstrates the effect of the same magnitude of bad and good news on the volatility of returns.

$$\text{Log}(\sigma_t^2) = \omega + \sum_{i=1}^{q} \alpha_i |\eta_{t-1}| + \sum_{i=1}^{q} \gamma_i \, \eta_{t-1} + \sum_{j=1}^{p} \beta_j \log(\sigma_{t-j}^2) \quad (4)$$

Where: $\eta_{t-1} = \varepsilon_{t-1}/\sqrt{\sigma_{t-1}^2}$

ω: $constant$, α: ARCH effect, γ: asymmetry effect, β: GARCH effect

There are no constraints on the parameters on the conditional variance equation in EGARCH model unlike GARCH models where the parameters of the conditional variance have to be positive.

If γ_i<0 and significant than there is a leverage effect in the return series

We estimate GARCH with exogenous variable GARCHX including the COVID 19 in the conditional mean and variance equations as a dummy variable. The mean and variance equations of GARCHX (1, 1) become:

$$\gamma_t = \mu + \lambda_1 \, COVID + \varepsilon_t \qquad (5)$$

$$\sigma_t^2 = \omega + \alpha_1 \, \varepsilon_{t-1}^2 + \beta_1 \, \sigma_{t-1}^2 + \delta_1 COVID_t \qquad (6)$$

2.2. Data:

We used daily closing prices of the BRL/USD and MXN/USD exchange rates from 1st January 2019 to 1st June 2020. We then add a dummy variable that takes values of 0 and 1 (D=0 before the COVID 19 outbreak and D=1 after the COVID 19 outbreak). Exchange rate data are collected from Yahoo Finance. The returns for the BRL/USD and MXN/USD markets are calculated as:

R= LN (R_t / R_{t-1})

3. Results and Discussion:

3.1. Summary statistics:

Table 1 shows the descriptive statistics of the return series. The mean of the BRL/USD and MXN/USD returns is negative which indicates the negative reaction of exchange rate markets to the COVID 19. The Brazilian exchange rate market has higher returns and risks than the Mexican market as described in the mean and standard deviation values. The Jarque-Bera probability indicates that the returns are not normally distributed, negative values of Skewness show that returns have a fat left tail and their distribution is leptokurtic since the kurtosis value is greater than 3.

Table 1. Summary Statistics

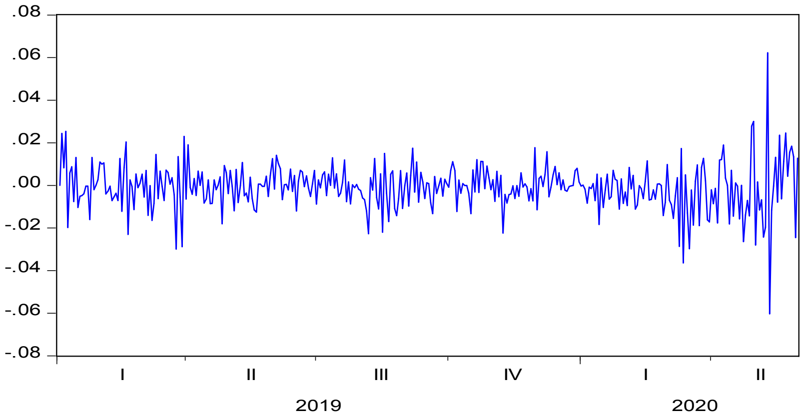
	R_BRL/USD	**R_MXN/USD**
Mean	-0.000901	-0.000335
Median	-0.000352	0.000402
Maximum	0.062243	0.032640
Minimum	-0.060246	-0.060841
Std.Dev	0.010903	0.009505
Skewness	-0.070670	-1.121970

Kurtosis	8.203360	10.10804
Jarque-Bera	416.5845	854.2270
Probability	0.000000	0.000000

Source: Eviews outputs

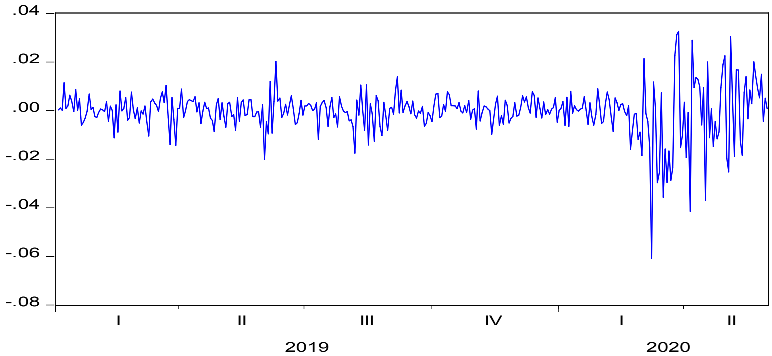
Figure 1 and 2 show that the returns of BRL/USD and MXN/USD exhibit volatility clustering. Higher periods of volatility are followed by higher periods of volatility which indicates the turbulence in the markets and lower periods of volatility are followed by lower periods of volatility (calm periods). We can notice from the graphs that the volatility in both the Brazilian and Mexican exchange rate markets is higher in the time of COVID 19. That shows the impact of the pandemic on exchange rate returns.

Fig.1. Volatility of R_BRL/USD



Source: Eviews outputs

Fig.2. Volatility of R_MXN/USD



Source: Eviews outputs

3.2. Unit Root Test:

To check the stationarity of the return series Augmented Dickey Fuller Test is used. The test checks for the existence of a unit root as described in the following equations:

$$\gamma_t = \mu + \sum_{i=1}^{p} \varphi_i \gamma_{t-i} + \varepsilon_t \quad (8)$$

$$\Delta\gamma_t = \mu + \delta\gamma_{t-1} + \sum_{i=1}^{p} \beta_i \gamma_{t-i} + + \varepsilon_t \quad (9)$$

The null hypothesis of the test H_0 states that there is a unit root in the series when δ=0. If δ<0 then the return series have no unit root which confirms the stationarity alternative hypothesis H_1.

The results of the Augmented Dickey Fuller test are shown in Appendix 1. The ADF statistics of the R_BRL and R_MXN series is less than the critical values at 1%, 5% and 10% level of significance. The ADF P-values are less than 5% which means that we reject the null hypothesis H_0. The return series are found to be stationary at level.

3.3. ARCH Effect in return series:

To test for the presence of ARCH effect in the return series the AR process of the squared residuals is given as:

$$\varepsilon_t^2 = \omega + \sum_{i=1}^{p} \alpha_i \varepsilon_{t-i}^2 + \epsilon_t \quad (10)$$

The null hypothesis of the test indicates no ARCH effect in the series when α_i =0. The presence of conditional volatility exists when the equation parameter $\alpha_i \neq 0$.

The results in Table 2 confirm the presence of an ARCH effect in both the BRL/USD and MXN/USD return series. The LM statistics is statistically significant at 1% level of significance; consequently, we reject the null hypothesis of no arch effect in the series. The return series have an ARCH effect in both markets.

Table 2. The Results of Heteroscedasticity Test: ARCH

	R_MXN/USD	R_BRL/USD
F-statistic	29.52483	83.07131
Obs*R-squared	27.46497	68.04089
Prob. F(1,365)	0.0000	0.0000
Prob. Chi-Square(1)	0.0000	0.0000

Source: Eviews outputs

3.4. GARCH Model Estimation Results :

We estimate four GARCH family models: GARCH (1, 1), GARCHX (1, 1), EGARCH (1, 1) and EGARCHX (1, 1). The results of the estimated parameters and the statistics of the models are described in Appendix 2 and 3.

3.4.1. The Conditional Mean Equation Parameters:

μ: is non-significant in all the models except for the EGARCH of the Brazilian market where it is significant and negative. The model was excluded from the analysis since the positivity constraint on the conditional mean parameters is not met.

λ: is significant and negative in BRL/USD market which indicates that COVID 19 has a negative effect on exchange rate returns. An increase in COVID spread results in a decline in BRL/USD returns.

3.4.2. The Conditional Variance Equation Parameters:

ω: is significant and positive in all GARCH models thus, the positivity condition of the parameters is achieved.

α: is significant and positive in all the models except EGARCHX in BRL/USD market.

β: is significant and positive in all the models.

δ: is significant and positive in the MXN/USD market. No significance is found using the GARCHX in Brazilian market.

γ: is significant and negative in both markets.

$\alpha + \beta$ coefficients are high and <1, this indicates that Brazilian and Mexican exchange rate markets have higher level of volatility persistence and exhibit mean reversion process.

3.5. Discussion of Results:

The significant positive value of the COVID 19 parameter δ reveals that the pandemic has a positive impact on exchange rate volatility; an increase in the COVID 19 variations produces higher volatility in both markets. The EGARCHX model better captures the effect of COVID 19 on conditional volatility in BRL/USD market since the GARCHX model gives non-significant δ parameter. The asymmetry and leverage effect is investigated using EGARCH models, in (Nelson, 1991) leverage and asymmetry effects were not given regularity conditions. Following (Chang & McAleer, 2017) asymmetry exists when $\alpha \neq 0$, our results show evidence of asymmetry effect in both the Mexican and Brazilian exchange rate markets. Leverage effect also exists in the markets with negative γ values, a decline in returns leads to greater volatility than an increase in returns. We find evidence that the EGARCHX models are the best in modeling volatility of exchange rates. Schwartz criterion has the lowest values in the asymmetric models along with the highest values of Log Likelihood.

4. CONCLUSION:

The aim of our study is to investigate the impact of COVID 19 on the volatility of exchange rate markets in Latin America. We use daily data from the BRL/USD and MXN/USD closing prices, we than incorporate COVID 19 as an exogenous variable in the conditional mean and volatility equations of GARCHX (1,1) and EGARCHX (1.1) models. Our results indicate a significant and negative impact of COVID 19 on stock returns and a significant positive effect on the returns volatility. The findings confirm that higher spread of the pandemic leads to a decline in exchange rate returns and an increase in the market volatility. Asymmetry and leverage effects are detected in the Mexican and Brazilian markets, positive and negative news of the same magnitude have different impact on the returns volatility. Negative bad news in both the BRL/USD and MXN/USD markets affect the conditional volatility more than positive shocks.

EGARCH with exogenous variable models are the best among EGARCH and GARCH models to capture the volatility of exchange rate returns in Brazilian and Mexican markets. Further analysis on the current investigation should include other exogenous variables that affect the exchange rate markets as inflation, oil prices and international factors. The analysis may also be conducted in developed markets.

5. Bibliography List:

Alawadhi, A., Al-Saifi, K., Al-Awadhi, A., & Alhammadi, S. (2020). Death and contagious infectious diseases: Impact of the COVID-19 virus on stock market returns. *Journal of Behavioral and Experimental Finance, 27*, 100326. doi: 10.1016/j.jbef.2020.100326

Apergis, N., & Apergis, E. (2020). The role of Covid-19 for Chinese stock returns: evidence from a GARCHX model. *Asia-Pacific Journal of Accounting & Economics*, 1-9. doi: 10.1080/16081625.2020.1816185

Bahrini, R., & Filfilan, A. (2020). Impact of the novel coronavirus on stock market returns: evidence from GCC countries. *Quantitative Finance and Economics, 4*, 640-652. doi: 10.3934/qfe.2020029

Bollerslev, T. (1986). Generalized autoregressive conditional heteroskedasticity. *Journal of Econometrics, 31*(3), 307-327. doi: https://doi.org/10.1016/0304-4076(86)90063-1

Campani, C., & Durães, A. (2018). Forecasting USD-BRL Currency Rate Volatility using Realized and Implied Volatilities Data. *Estudos Econômicos (São Paulo), 48*, 687-719. doi: 10.1590/0101-41614845cca

Chang, C.-L., & McAleer, M. (2017). The Fiction of Full BEKK. *SSRN Electronic Journal*. doi: 10.2139/ssrn.2995461

Chaudhary, R., Bakhshi, P., & Gupta, H. (2020). Volatility in International Stock Markets: An Empirical Study during COVID-19. *Journal of Risk and Financial Management, 13*(9), 208.

Engle, R. F. (1982). Autoregressive Conditional Heteroscedasticity with Estimates of the Variance of United Kingdom Inflation. *Econometrica, 50*(4), 987-1007. doi: 10.2307/1912773

He, P., Sun, Y., Zhang, Y., & Li, T. (2020). COVID–19's Impact on Stock Prices Across Different Sectors—An Event Study Based on the Chinese Stock Market. *Emerging Markets Finance and Trade, 56*, 2198-2212. doi: 10.1080/1540496x.2020.1785865

Iyke, B. (2020). COVID-19: The reaction of US oil and gas producers to the pandemic. *Energy RESEARCH LETTERS*. doi: 10.46557/001c.13912

Kutu, A. A., & Ngalawa, H. (2016). MONETARY POLICY SHOCKS AND INDUSTRIAL OUTPUT IN BRICS COUNTRIES. *SPOUDAI Journal of Economics and Business, 66*(3), 3-24.

Lee, C. C., Lee, C. C., & Wu, Y. (2021). The impact of COVID□19 pandemic on hospitality stock returns in China. *International Journal of Finance & Economics*, 10.1002/ijfe.2508. doi: 10.1002/ijfe.2508

Liu, H., Manzoor, A., Wang, C., Zhang, L., & Manzoor, Z. (2020). The COVID-19 Outbreak and Affected Countries Stock Markets Response. *International Journal of Environmental Research and Public Health, 17*, 2800. doi: 10.3390/ijerph17082800

Nelson, D. B. (1991). Conditional Heteroskedasticity in Asset Returns: A New Approach. *Econometrica, 59*(2), 347-370. doi: 10.2307/2938260

Rai, K., & Garg, B. (2021). Dynamic correlations and volatility spillovers between stock price and exchange rate in BRIICS economies: evidence from the COVID-19 outbreak period. *Applied Economics Letters*, 1-7. doi: 10.1080/13504851.2021.1884835

Sansa, N. (2020). The Impact of the COVID-19 on the Financial Markets: Evidence from China and USA. *SSRN Electronic Journal*. doi: 10.2139/ssrn.3562530

Sapkota, S. P. (2020). Impact of epidemic infectious disease and death on stock returns: Evidences from Asian stock markets with COVID-19. *Contemporary Research: An Interdisciplinary Academic Journal, 4*(1), 174-191. doi: 10.3126/craiaj.v4i1.32759

WHO. (2020). World Health Organization Timeline - COVID-19 Retrieved May 15, 2021, from https://www.who.int/news/item/27-04-2020-who-timeline---covid-19

6. Appendices

Appendix 1. Unit Root Test

R_BRL/USD

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-23.46723	0.0000
Test critical values:	1% level	-3.983192	
	5% level	-3.422082	
	10% level	-3.133875	

R_MXN/USD

Augmented Dickey-Fuller test statistic		-17.90497	0.0000
Test critical values:	1% level	-3.983192	
	5% level	-3.422082	
	10% level	-3.133875	

Source: Eviews outputs

Appendix 2. The Results of GARCH Models in the Brazilian Market

	R_BRL			
	GARCH	**GARCHX**	**EGARCH**	**EGARCHX**
μ_t	-0.000732	-0.000120	-0.00087***	-0.000141
λ COVID	-	-0.00229**	-	-0.00306**
ω	8.49E-06**	5.31E-06***	-0.48408**	-0.084161*
α	0.179133**	0.137079**	0.179979*	-0.037289
β	0.742990*	0.803066**	0.962932**	0.989372*
δ	-	4.05E-06	-	0.044957*
γ	-	-	-0.10269*	-0.087908*
Schwarz criterion	-6.40531	-6.390841	-6.401064	**-6.425316**
Log likelihood	1193.602	1196.842	1195.773	**1206.159**

*: 1% level of significance
**: 5% level of significance
***: 10% level of significance

Source: Eviews outputs

Appendix 3. The Results of GARCH Models in the Mexican Market

	R_MXN			
	GARCH	**GARCHX**	**EGARCH**	**EGARCHX**
μ_t	0.000164	0.000162	-0.000254	-9.60E-05
λ COVID	-	6.36E-05	-	-0.001059
ω	2.53E-06**	2.37E-06**	-0.427023*	-0.479960**
α	0.178471*	0.163407*	0.144493*	0.000865
β	0.787034*	0.787952*	0.967969*	0.954546**
δ	-	3.51E-06***	-	0.093577**
γ	-	-	-0.15135*	-0.138272**
Schwarz criterion	-7.08661	-7.064165	-7.103608	**-7.118452**
Log likelihood	1319.302	1321.071	1325.393	**1334.042**

*: 1% level of significance
**: 5% level of significance
***: 10% level of significance

Source: Eviews outputs