Journal of Ekonomi 06 (2021) 119–127

Ekonomi
journal homepage: https://dergipark.org.tr/ekonomi

Economic policy uncertainty and exchange rates before and during the COVID-19 pandemic

[a*] Nagmi Moftah Aimer

[a] Higher Institute of Marine Sciences Techniques Sabratha, Libya

ARTICLE INFO

Keywords:

COVID-19
Exchange rate
EPU
Bound test
Volatility index (VIX)

ABSTRACT

Recently, the extent to which economic policy uncertainty (EPU) affects exchange rate movements has been an important research question. Therefore, this paper examines the effects of both economic policy uncertainty (EPU) and the volatility index (VIX) on exchange rates for the case of four countries, which recorded the highest number of deaths due to the COVID-19 pandemic. Furthermore, we use the bounds testing approach to cointegration and error correction model, developed within an ARDL model. The findings show that: (i) during the pre-pandemic period, the co-integration tests showed that there is a positive effect of the VIX index on the Brazilian real in the long run. Likewise, there is a positive effect of the volatility index on the exchange rates of both the Indian rupee and the Swedish krona during the pandemic period, as well as between the volatility index and the Indian rupee before and during the COVID-19. Regarding the effect of EPU on the exchange rates, we found that during the pre-pandemic period there was no statistically significant effect for the four countries, while during the pandemic period, there is a positive relationship between the EPU and the Brazilian reals. While the case of the before and during the COVID-19, we find that there is a positive relationship between the EPU index and the exchange rates of both the Indian rupees and Mexican new pesos. (ii) we note that the error correction coefficients for the period before the outbreak of the epidemic are lower than during the pandemic period. Specifically, the exchange rate correction in the epidemic period is faster than in the period preceding the outbreak of the epidemic. This indicates that before a pandemic period is more vulnerable to fundamental shocks. (iii) the impact of the VIX shock is greater than the EPU shock. Our results offer practical implications for policymakers and investors.

I. Introduction

Since Keynes (1937), interest in the economic effects of uncertainty has increased dramatically as it has been recognized as an important determinant of the business cycle. When COVID-19 appeared in China on December 31, 2019, the world has been preoccupied with its new spread, which has become a global pandemic and attracted great interest from the international community (Spiteri et al., 2020; Liu et al., 2020 & Özçatalbaş, 2020).

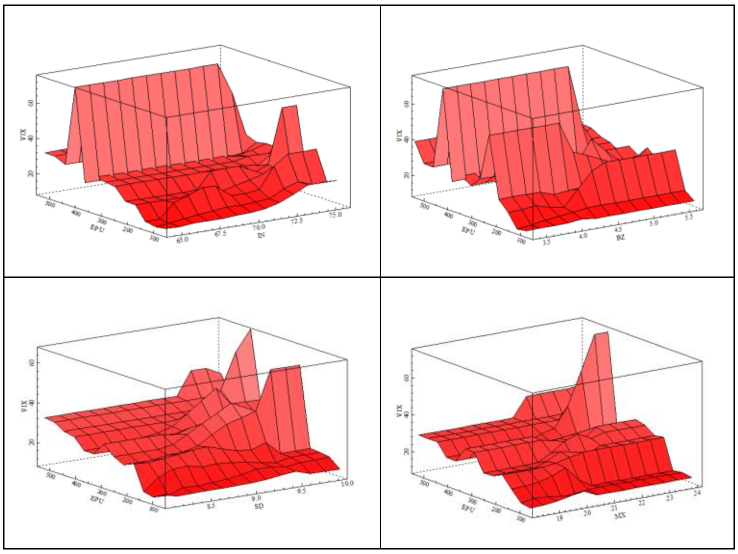
During the recent COVID-19 outbreak, the financial markets experienced massive price fluctuations. Many of those interested have pointed out that the observed volatility in financial markets is unprecedented and immediately attributed to COVID-19 due to its destructive nature.

The global spread of the COVID-19 pandemic is a human tragedy that is still unfolding in various parts of the world (Lombardi et al., 2021). There are complications in the process of quantifying its economic impact, which creates a great deal of uncertainty about the outlook for the economy and the associated adverse developments. Baker et al. (2020) uncover evidence that levels of uncertainty during the 2008 financial crisis are lower than in recent years. Moreover, this sudden increase in uncertainty threatens economic growth and financial stability. In addition to targeted economic policies and fiscal measures, the right policies to achieve monetary and financial stability will be critical in helping to support the global economy.

In fact, the uncertainty affects investment, consumption, imports and exports. First, there is a negative impact on fixed-asset investment, which is also the main way to affect the macroeconomic. Under the impact of economic policy uncertainty, companies will adopt a wait-and-see attitude, tentatively or reduce investment and employment, overall investment and output will fall (D'Mello & Toscano, 2020). Secondly, it may cause a decline in consumption (Basu & Bundick, 2017). Third, it will also have an impact on trade. In recent years, theoretical research on trade policy uncertainty and both positive and negative experiences have shown that uncertainty will hinder international trade and reduce economic policy. In terms of economic volatility, the degree of uncertainty is often related to the depth of a recession and the strength of the recovery. Macro-uncertainty has a strong counter-cyclical feature, that is, it rises during a recession and falls during a boom (Ranasinghe et al., 2012). According to (Thaqeb et al., 2020) the economic slowdown after 2019 is also caused by increased EPU index due to the outbreak of the COVID-19.

Theoretically, the shocks of the EPU and VIX indices have direct and indirect effects on exchange rate fluctuations. Figure 1 shows the weekly averages of EPU and VIX and the exchange rates for the four countries. For the EPU index as it rose from 36 points on November 23, 2018, to 576 points on March 27, 2020, until it reached its highest value in March 2020. Likewise for the volatility index, where it reached its highest value at 74 points on March 20, 2020.

Figure 1. Surface from scatter exchange rate, EPU and volatility index (VIX) are vectors



The newspaper-based EPU index and the one-month VIX index are also showing huge spikes in the wake of the COVID-19 shock due to response to the epidemic and its economic fallout (see Altig et al., 2020; Baker et al., 2020).

* Corresponding author. E-mail address: najmimuftah@gmail.com (N. M. Aimer).
Received: 21 March 2021; Received in revised from 26 June 2021; Accepted 28 June 2021

In addition, the two indicators of uncertainty appear to be heading in the same direction. Although there are significant differences between countries in the degree of economic development and exchange rate policies, understanding the heterogeneity of responses to economic uncertainty shocks is important. Indicators of uncertainty and some other unobservable factors such as economic policy uncertainty influence market expectations, therefore, it should be explicitly included in the analysis of economic models to determine exchange rates.

Therefore, our study contributes to the following: First, we link different strands of literature review that separately included: i) Poor empirical performance of macroeconomic variables on exchange rate fluctuations, ii) studies on possible omissions of fundamentals and unobserved factors can explain such weaknesses, iii) studies on the link between macroeconomics and economic policies. Second, we consider two uncertainty indicators as a proxy for unobservable variables. Third, we provide a coherent picture of not only the short- and long-term dynamics between the variables, but we also appreciate the impulse response functions that explain how the exchange rate responds to the EPU and VIX shock.

Anticipating and tracking exchange rate fluctuations has always been an important topic. In this paper, we use the ARDL approach for co-integration developed by Pesaran and Shin (1998) to study the effect of both the Economic Policy Uncertainty Index (EPU) and the Volatility Index (VIX) on an exchange rate for the four countries (India, Brazil, Sweden and Mexico), which have the highest mortality rates due to the COVID-19 pandemic. Moreover, to accurately determine the specific causes of exchange rate changes, we use weekly data where analysis is carried out on a country-by-country basis for the weekly data for the period from 8/1/2017 to 8/1/2021. Specifically, we divide our study into three periods, where the first period is before the emergence of COVID-19, the second period is during the pandemic, while the third period is before and during the outbreak of the pandemic. To the best of our knowledge, applying the ARDL model, our study is not only the first to use the ARDL approach but also one of the rare approaches based on the ARDL approach to quantification. Importantly, our study features a comparison of four countries (India, Brazil, Sweden and Mexico) and simultaneously for three different periods. We also include control variables for economic differences, namely EPU, VIX because these variables measure volatility and uncertainty. However, the volatility indices are a better suitable barometer of the fragility of the markets and the economy. Moreover, our hypothesis is that uncertainty has a noticeable effect on exchange rate volatility (e.g. Nilavongse et al., 2020). For this purpose, the remainder of this paper is organized as follows: The second section briefly introduces the methodology used and the data analysis. In the third section, we discuss the results of the ARDL and IRFs estimation and review the impact of uncertainty on the exchange rate. The last section concludes the paper.

2. Literature review

Many researchers have asserted that the COVID-19 pandemic has significantly affected regulatory and political uncertainty (Sharif et al., 2020; Hitt et al, 2021; Padhan & Prabheesh, 2021). Also, the daily announcements regarding the number of infections and deaths have positive effects on EPU index levels (see, Albulescu, 2020). Many researchers have repeatedly pointed out that uncertainty is a major factor in economic stagnation. Nonetheless, uncertainty about economic forecasts has prompted companies to delay spending projects until the outlook for economic activity clears. In particular, uncertainty not only has an impact on an economic recession but also a transmission and amplification mechanism (Aimer, 2016, 2017). In addition, the EPU index has a strong negative impact on economic growth, investment, employment, income and consumption in the short term, increases in the uncertainty index lead to lower demand for tourism (Işık et al., 2020; Günay et al., 2020; Payne et al, 2021), forming a secondary impact on the economy. After the financial crisis of 2007-2008, most of the global markets were exposed to danger, as countries immediately adjusted their monetary, tax and trade policies, the uncertainty index in economic policies has risen due to the frequent change in economic policies applied in the country, which leads to exchanging rate movements (Longstaff, 2010).

In the context of exchange rates, Basu and Bundick (2017) analysis based on the dynamic stochastic general equilibrium model found that monetary policy, as a stable economy will amplify the negative effects of uncertainty when the zero interest rate lower limit is constrained. Based on simulations and empirical evidence, Bloom et al. (2018) believe that macro-uncertainty shocks caused a 3% reduction in US GDP from 2008 to 2009, accounting for a third of the total changes over the period.

Phan et al. (2021) found a negative impact of the EPU index on financial stability, where an increase in EPU by one unit leads to a decrease in financial stability by between 2.7% - 7.3% of the sample average. This effect is stronger for countries with small financial systems, lower regulatory capital, and higher competition. Nonetheless, the characteristics of a country's financial system affect the correlation between the uncertainty index and financial stability.

According to Albulescu (2021), the impact of the EPU index on financial volatility was not significant during the COVID-19 crisis and that the continuation of the crisis, and the associated uncertainty, increase the volatility of the US financial markets, which affects the global financial cycle.

Bush and Noria (2021) examine the impact of uncertainty on peso exchange rates in Mexico. They noted that the peso exchange rate fluctuations decreased during the period 1999-2018 due to uncertainty measures that capture political, domestic, economic and international uncertainty. However, higher Knightian uncertainty leads to higher exchange rate fluctuations. In addition, domestic and international measures affect exchange rate volatility, international uncertainty measures based on text and financial data (the VIX and the global EPU) and Knightian uncertainty dominate. They also found evidence that during recessions the effect of amplifying domestic economic uncertainty on exchange rate fluctuations.

Naqvi (2021) revealed that the effect of general economic uncertainty on fluctuations in the exchange rate of the dollar against the rupee of Pakistan is stable only when the economy is performing poorly while negative economic growth increases to exchange rate fluctuations. Also, found that uncertainty in economic policy has a significant impact on the volatility of the exchange rate of the dollar against the rupee.

The role of uncertainty in economic fluctuations still requires further theoretical analysis and empirical evidence by scholars. To analyze the relationship between uncertainty and economic variables, studies define uncertainty in various ways, among which is the researcher Baker et al. (2016) where he measures uncertainty using news articles related to uncertainty and defines this as the EPU index. Krol (2014) analyzed the effect of EPU in developing countries on their own exchange rate volatility and showed that an increase in EPU increased exchange rate volatility. As in previous studies, EPU has an influence on macro and financial variables, and an increase in EPU can lead to an economic downturn. Although the literature review explores the heterogeneous effects of EPU or causes of exchange rate volatility. On the other hand, researchers also examined the factors affecting exchange rate volatility in the international economy (Asari et al., 2011; Grossmann et al., 2014; Aimer, 2019; Chen et al., 2020). However, there are few studies on the effect of the EPU and VIX indicators on exchange rate volatility.

However, we find that the variables used in the above literature are mostly monthly and annual data, which may ignore important structural features of the sample variables. Although higher frequency data such as weekly data can obtain more accurate and reliable information in the analysis. Some researchers have demonstrated that the inclusion of high-frequency data can improve prediction accuracy (e.g., Yu et al., 2018; Zhang & Wang, 2019). To bridge this gap, we discuss the autoregressive distributed lag (ARDL) and impulse response functions (IRF) approach to examining the impact of economic policy uncertainty on the exchange rates of the four countries, which recorded the highest number of deaths due to the COVID-19 pandemic.

3. Methodology and data

This paper uses the recently developed ARDL bounds testing approach for co-integration developed by Pesaran et al. (2001). Although there is no need to test the unit root but to ensure the suitability of the ARDL method, we check the stability level of each variable. Therefore, this paper uses the unit root tests to test the integration level by Dickey and Fuller (1981) (ADF), Phillips and Perron (1988) (PP) and Kwiatkowski et al. (1992) (KPSS). The ARDL technology is suitable for situations where the degree of integration does not exceed the I(0) and I(1) levels. However, the major limitation of traditional cointegration methods was that all variables are stationary at the same order (Engle and Granger, 1987). Also, the ARDL-Bounds technique proposed by Pesaran et al. (2001) is more effective than other methods in testing the long-term relationship of the integrated variable I(0) or I(1). It can give both small and large samples efficient and reliable test results. Moreover, by applying, ARDL bounds testing based on F statistics and the error correction term (ECM). Where the null hypothesis states $H_0: \lambda_r = 0$ that there is no co-integration relationship between the variables, while the alternative hypothesis states $H_1: \lambda_r \neq 0, r = 1,2, \ldots$, that there is a co-integration relationship. The delay coefficient suitable for the ARDL model is selected as Akaike information criterion (AIC) or Schwarz criterion (SC). Eq. (1) can be presented at the following the ARDL form:

$$\Delta \ln(EX)_t = \alpha_0 + \sum_{i=1}^{m} \beta_i \Delta \ln(EX)_{t-i} + \sum_{j=0}^{n} \theta_j \Delta \ln(EPU)_{t-j} + \sum_{i=0}^{P} \theta_i \Delta ln(VIX)_{t-i} + \lambda_1 \ln(EX)_{t-1} + \lambda_2 ln(EPU)_{t-1} + \lambda_3 ln(VIX)_{t-1} + \eta_t \quad (1)$$

where η_t the first difference, and Δ is the white noise term.

If there is a co-integration between the variables in the long run, then Eq. (2) is represented by the following formula:

$$EX_t = \alpha_0 + \sum_{i=1}^{m} \beta_i EX_{t-i} + \sum_{j=0}^{n} \theta_j EPU_{t-j} + \sum_{k=0}^{p} \theta_k VIX_{t-j} + \eta_t \quad (2)$$

If there is co-integration between the variables in the short run, then it is represented by Eq. (3):

$$\Delta EX_t = \alpha_0 + \sum_{i=1}^{q} \beta_i \Delta EX_{t-i} + \sum_{j=0}^{s} \theta_j \Delta EPU_{t-j} + \sum_{k=0}^{w} \theta_k \Delta VIX_{t-j} + \emptyset ECT_{t-1} + \xi_t \quad (3)$$

Where $\emptyset$ is the coefficient of the error correction term and it should a negative sign and statistically significant and it shows how quickly the variables converge in the equilibrium state.

In particular, we analyze three standard models, so that the first model relates to the first period (before the pandemic), the second model to the second period (during the pandemic) and the third model to the third period (before and during the pandemic). In this context, we try to present two variables (EPU, VIX) as explanatory variables of exchange rate volatility in the ARDL model specifications. In addition, for further inferences, we adopt innovation accounting through the impulse response functions (IRF). This method serves as a tool for evaluating the dynamic interactions between variables in the system.

This empirical investigation focuses on the exchange rate fluctuations of the four countries (India, Brazil, Sweden, and Mexico) with the highest number of deaths due to the COVID-19 pandemic as we perform the analysis on a country-by-country basis for the weekly data for the period from 1/8/2017 to 8/1/2021. These data are defined as shown in Table 1.

Table 1. Variables definition

Variable	Symbol	Source
INR/USD India/U.S. foreign exchange rate, Indian Rupees to one U.S. dollar	INR	FRED[1]
BRL/USD Brazil/U.S. foreign exchange rate, Brazilian Reals to one U.S. dollar	BRL	
SEK/USD Sweden/U.S. foreign exchange rate, Swedish Kronor to one U.S. dollar	SEK	
MXN/USD Mexico/U.S. foreign exchange rate, Mexican new pesos to one USD	MXN	
Economic policy uncertainty index for United States	EPU	FRED[1]
CBOE volatility index	VIX	FRED[1]

Note: The Federal Reserve Bank of Saint Louis (FRED). The measure of U.S. EPU is the Baker et al. (2016)'s index, which is a daily coverage of newspaper articles containing terms related to "uncertainty", "policy" and "economy".

4. Empirical Results and Discussion

According to the ARDL approach, the study of cointegration consists of two steps: the first is the determination of the optimal delay using the AIC. The second is to examine all the possible combinations of the lags of each variable to determine the optimal ARDL model and then test for cointegration. To study the relationship of cointegration between variables, we examine the stability of the variables based on ADF, PP and KPSS tests as shown in Table 2.

Table 2. Unit root estimation

variable	$I(0)$			$I(1)$		
	ADF	PP	KPSS	ADF	PP	KPSS
INR	-2.375	-2.082	1.380[a]	-10.820[a]	-10.896[a]	0.050
BRL	-2.688	-2.278	1.483[a]	-9.597[a]	-9.106[a]	0.050
SEK	-0.326	-0.205	0.853[a]	-7.158[a]	-11.118[a]	0.080
MXN	-3.108	-2.618	0.905[a]	-8.283[a]	-8.113[a]	0.046
EPU	-2.798	-3.189[c]	0.953[a]	-5.714[a]	-13.014[a]	0.041
VIX	-4.088[a]	-3.706[b]	0.784[a]	-7.809[a]	-10.586[a]	0.029

Notes: a, b, and c indicate statistical significance at levels of 1%, 5% and 10%, respectively. The optimal lag selection is based on Akaike Information Criteria (AIC) with constant and trend.

The results of the unit root tests show that none of the variables are integrated with an order greater than one and that they are not all integrated with the same order. From two characteristics we deduce that to test the cointegration between the variables selected, the model best suited to our case is the ARDL model.

4.1. Long-run dynamics

We verify the co-integration for the three models using the bounds testing by Pesaran et al. (2001) approach as shown in Table 3.

The results show that there is a cointegration relationship between the exchange rate and both the EPU and VIX indicators for each country and in the three mentioned periods. With the exception of the exchange rate in Mexico during the pandemic where the F statistics exceed the minimum as in the second model in Table 3. Therefore, the null hypothesis was accepted that there is no co-integration. In the case of the Mexican exchange rate, that is, there is no co-integration relationship between the Mexican exchange rate and both the EPU and VIX index. Regarding the third model (before and during the COVID-19 pandemic), we found that there is a long-term positive relationship between the Mexican exchange rate and both the EPU and VIX indicators, this result is consistent with the study (Bush & Noria, 2019).

Table 3. Results of the bounds test of cointegration.

	Model 1: 8/1/2017 /to 27/12/2019			
Model 1	INR	BRL	SEK	MXN
F-stat.	17.37[a]	16.61[a]	4.36[b]	8.92[a]
LM	0.64	0.43	0.11	0.71
ARCH	0.50	0.35	0.59	0.96
R^2	0.21	0.26	0.33	0.23
	Model 2: 3/1/2020 to 8/1/2021			
Model 2	INR	BRL	SEK	MXN
F-stat.	5.57[a]	6.88[a]	3.88[b]	1.81
LM	0.69	0.55	0.94	0.14
ARCH	0.69	0.44	0.53	0.20
R^2	0.79	0.59	0.85	0.83
	Model 3: 8/1/2017 to 8/1/2021			
Model 3	INR	BRL	SEK	MXN
F-stat.	38.5[a]	19.01[a]	7.97[a]	4.74[b]
LM	0.68	0.27	0.85	0.11
ARCH	0.57	0.59	0.37	0.82
R^2	0.18	0.27	0.38	0.49
Critical Values		I(0)	I(1)	
1%		4.13	5	
5%		3.1	3.87	
10%		2.63	3.35	

Notes: a, b, and c indicate statistical significance at levels of 1%, 5% and 10%, respectively. LM is Breusch-Godfrey Lagrange multiplier test. ARCH is Heteroskedasticity test.

The results R2, as shown in Table 3, showed an interesting explanatory power in the long term for the EPU and VIX indicators on the exchange rates for each country during the COVID pandemic compared to the pre-COVID-19 period that ranged between 0.59 and 0.85 during the epidemic. While it ranged between 0.18 and 0.49 during the first and third periods. This reflects the inflexible nature of these indicators. The results of the ARDL approach developed by Pesaran et al. (2001) as shown in Table 4.

Table 4. Results of long-term cointegration test

Country	Model 1		
	Variable	Coefficient	t-Sta.
INR	EPU	0.010	1.10
	VIX	0.003	0.58
	C	0.016	0.87
BRL	EPU	-0.195	-1.23
	VIX	0.058*	1.96
	C	0.194	1.32
SEK	EPU	-0.018	0.065
	VIX	0.025	0.016
	C	0.048	0.059
MXN	EPU	0.005	0.896
	VIX	0.001	0.122
	C	0.016	0.432
Country	*Model 2*		
	Variable	Coefficient	t-Sta.
INR	EPU	0.006	0.246
	VIX	0.037*	2.002
	C	-0.013	-0.877
BRL	EPU	0.479***	3.535
	VIX	0.027	0.262
	C	0.091	0.678
SEK	EPU	0.004	0.079
	VX	0.100***	3.187
	C	-0.165***	-4.890
MXN	EPU	0.009	0.425
	VIX	0.209***	4.479
	C	-0.071	-1.1111
Country	*Model 3*		
	Variable	Coefficient	t-Sta.
INR	EPU	0.016***	3.207
	VIX	0.008***	3.184
	C	0.011	0.834
BRL	EPU	0.080	0.610
	VIX	0.083	1.305
	C	0.173	1.221
SEK	EPU	0.005	0.096
	VIX	0.055	1.490
	C	-0.015	-0.292
MXN	EPU	0.015*	1.839
	VIX	0.091**	2.576
	C	-0.021	-0.472

Notes: ***, **, and * indicate statistical significance at levels of 1%, 5% and 10%, respectively.

In the long term, as shown in Table 4, the results of the co-integration tests for the first period (before COVID) showed that there was a statistically significant positive relationship between the VIX index and BRL, which means that when increasing the VIX one unit, BRL will increase by 6%. While there is a positive statistically significant relationship between the VIX index and the INR at 4%, SEK at 9% during the pandemic. As well as in INR at 1% the before and during the pandemic while its impact on the rest of the countries is not statistically significant.

Regarding the effect of EPU on the exchange rate of the four countries, we find that during the first period (before the pandemic) there is no statistically significant effect between the EPU index and the exchange rate of the four countries. Interestingly and perhaps surprisingly, during the epidemic there is a positive statistically significant relationship between the EPU index and the BRL, which means that when increasing the EPU index by one unit, will lead to an increase in the BRL at 48%, while its effect on the rest of the countries is not statistically significant. While the case of the third model (before and during the pandemic), we find that there is a positive statistically significant relationship at a 2% level between the EPU index and the INR and MXN with the same amount of effect. This means when increasing the EPU index by one unit, will lead to an increase in the exchange rate is 2%. As for its effect on the exchange rates of the rest of the sample countries, it has no statistical significance. In particular, in the three models (the three periods), where there were positive effects of both uncertainty and volatility indicators on the exchange rate of these countries.

4.2. Short-run dynamics

As in Table 5, that the error correction coefficients (ECT) in the three models are negative and statistically significant, ensuring the long-run equilibrium relationship of the three models. However, we note that the error correction coefficients for the period before the outbreak of the epidemic are lower than during the pandemic period. During the period leading up to the outbreak of the epidemic, it indicates a correction of 75%, 68%, 67% and 91% of any imbalance between exchange rates and explanatory variables respectively in India, Brazil, Sweden and Mexico is corrected within a week. While in the case of the period during the outbreak of the Covid-19 epidemic, the error correction indicates that approximately 104%, 158%, 145% and 102% of any imbalance between exchange rates and explanatory variables respectively in India, Brazil, Sweden and Mexico is corrected within a week. Specifically, the higher the error correction factor, the faster the adjustment, the faster the exchange rate adjustment in the pandemic period than in the period before the outbreak of the pandemic. This indicates that before a pandemic period is more vulnerable to fundamental shocks than the latter period (see Abid, 2020).

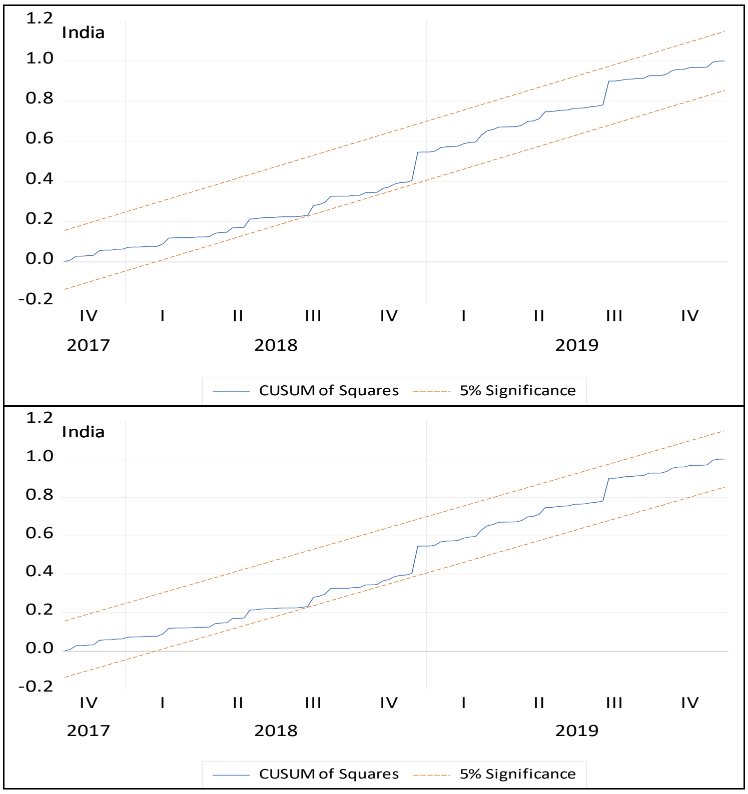
After estimating the short and long run and to ensure the reliability of the statistical models to checking the stability of the CUSUM and CUSUMSQ parameters developed by Brown et al. (1975). However, all the graphs of Figures 2, 3 and 4 confirmed that the parameters are stable.

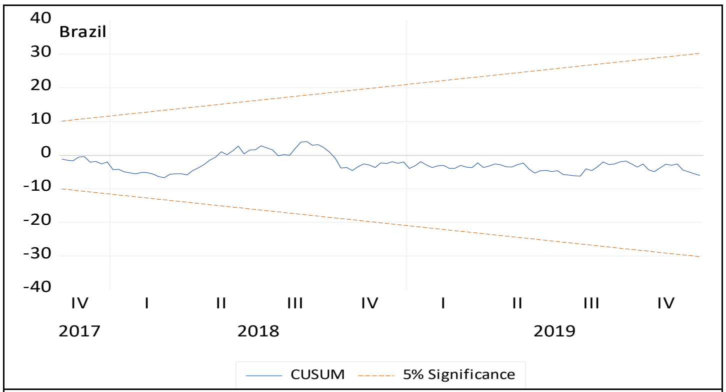
Table 5. Short-run Dynamics

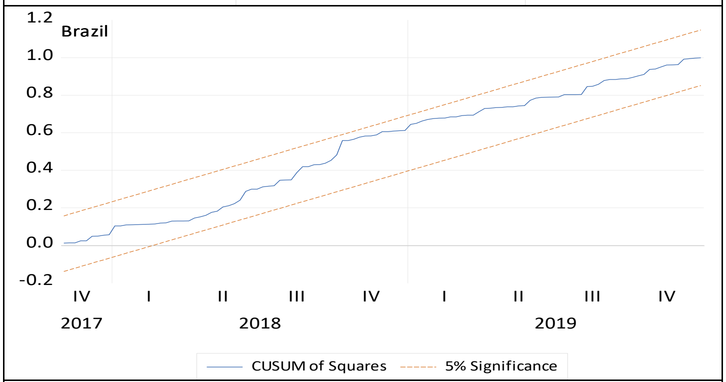
	Model 1: 8/1/2017 /to 27/12/2019			
	INR	BRL	SEK	MXN
ECT_{t-1}	-0.75[a]	-0.68[a]	-0.67[a]	-0.91[a]
	Model 2: 3/1/2020 to 8/1/2021			
	INR	BRL	SEK	MXN
ECT_{t-1}	-1.04[a]	-1.58[a]	-1.45[a]	-1.02[a]
	Model 3: 8/1/2017 to 8/1/2021			
	INR	BRL	SEK	MXN
ECT_{t-1}	-0.81[a]	-0.66[a]	-0.67[a]	-0.78[a]

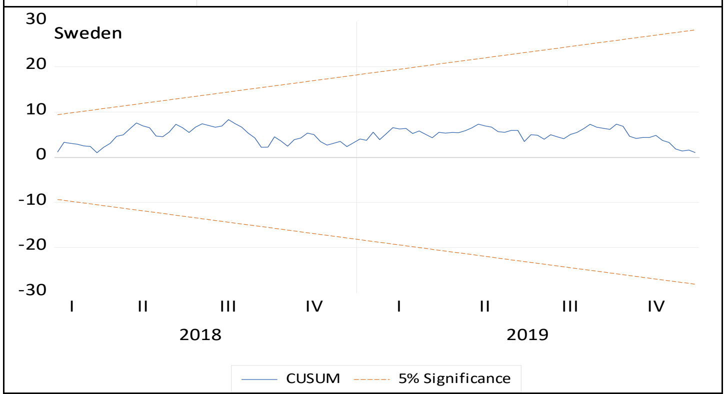
Note: a, indicate statistical significance at levels of 1%.

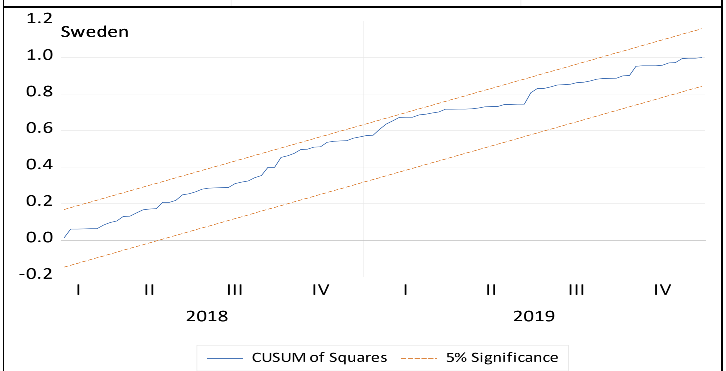
Fig. 2. CUSUM and CUSUMQ test for structural change of the first model (1/8/2017 /to 27/12/2019).

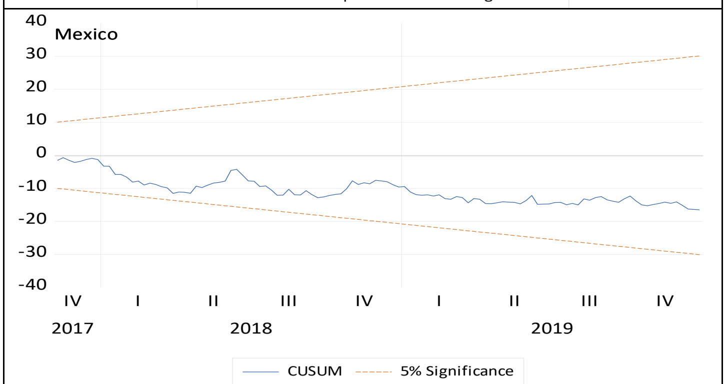












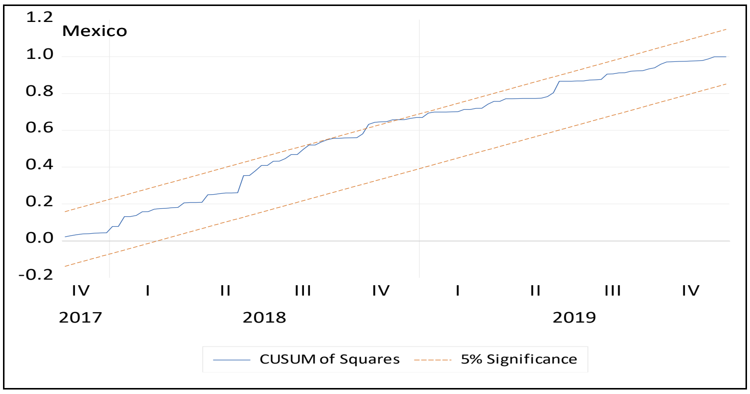
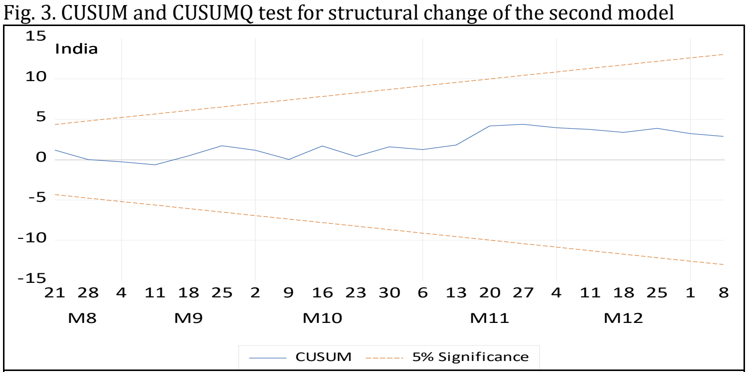
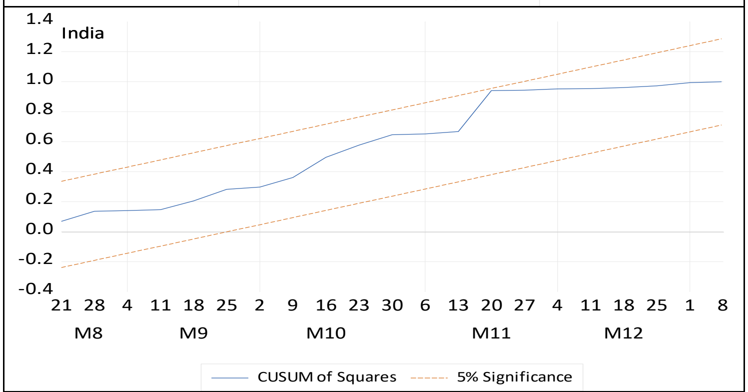
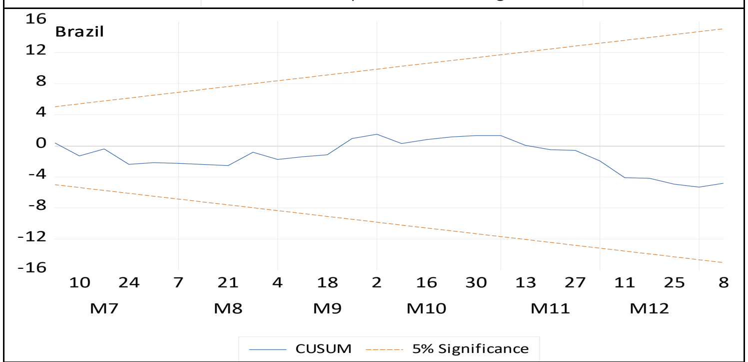
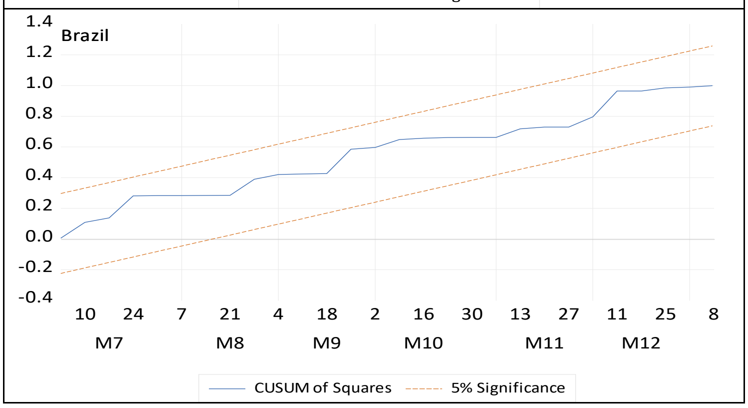


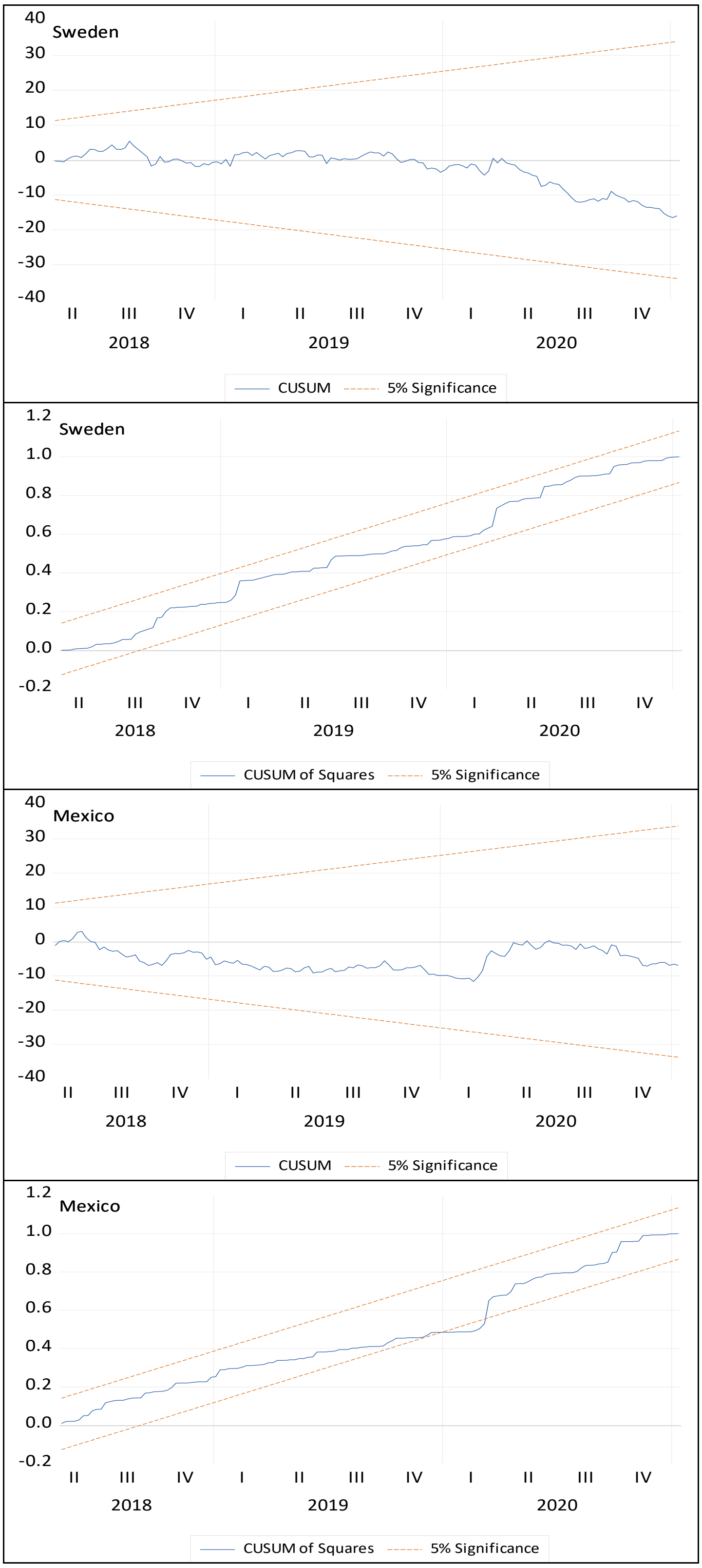
Fig. 3. CUSUM and CUSUMQ test for structural change of the second model











4.3. The impulse response functions

To illustrate the direction and extent of the impact of the shock we use impulse response functions (IRFs) to test the effect of one standard deviation shock on the endogenous variables and their future values. Furthermore, the results of the IRFs within 10 weeks to internal variables that explain the extent of the exchange rate response to a shock of one standard deviation for the two variables, EPU and VIX index as shown in Figures 5 to 7.

Fig. 5. Illustrates the exchange rate responses to structural innovations in EPU and the VIX index.

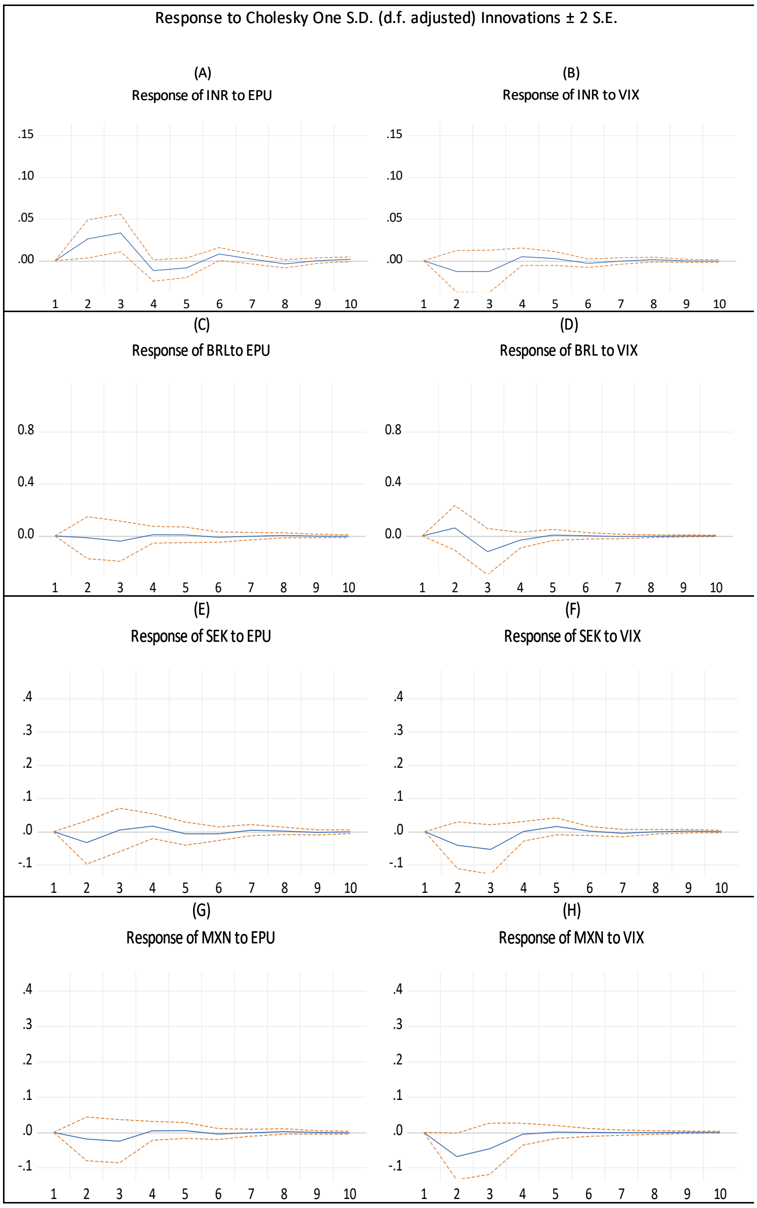
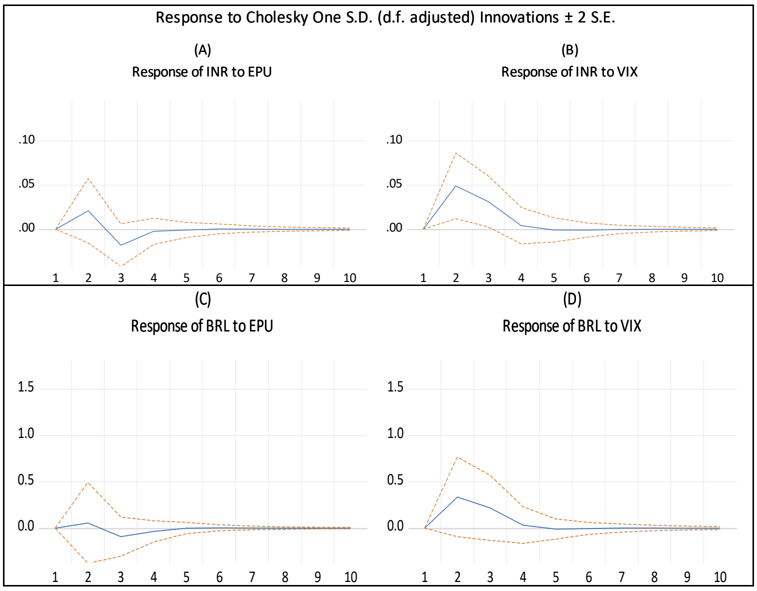


Fig. 6. Illustrates the exchange rate responses to structural innovations in EPU and the VIX index during the pandemic.



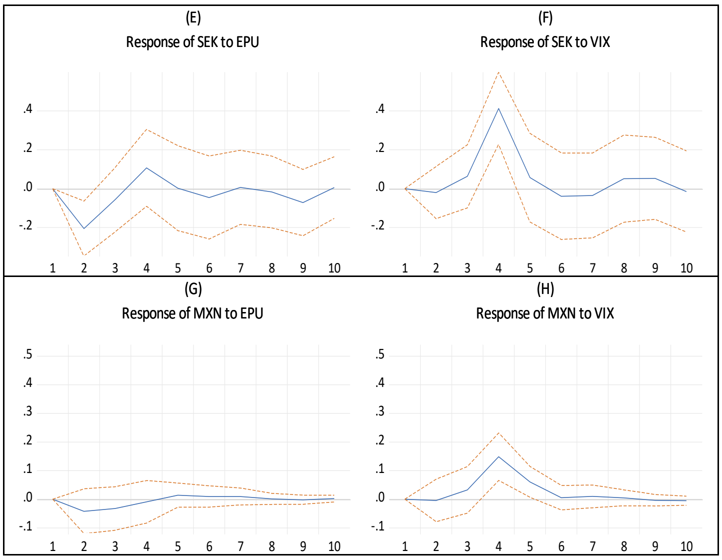
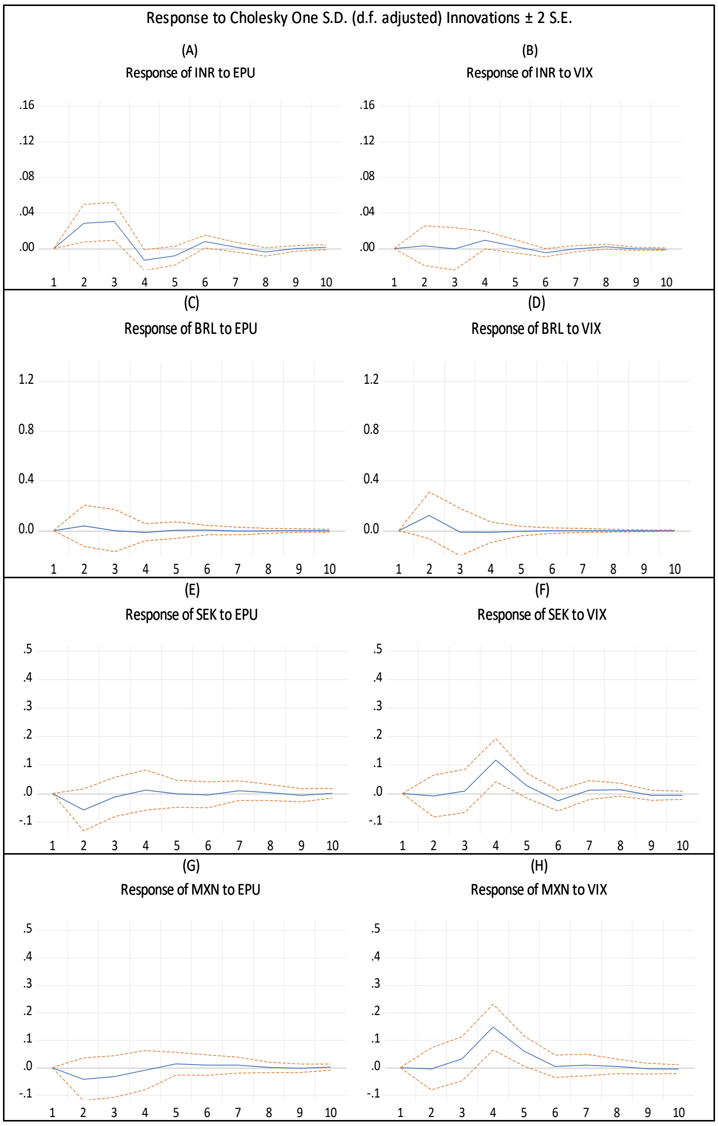


Fig.7. Illustrates the exchange rate responses to structural innovations in EPU and the VIX index

(Before and during the pandemic)



Figures 5 to 7 show impulse response functions (IRFs) to an unexpected shock of EPU and VIX Indices.

Fig.5A shows that during the pre-pandemic period related to INR/USD, that a positive shock of one standard deviation in the EPU has a positive effect on the INR, and reaches the maximum at the third week. After that, the effect becomes negative starting from the fourth week by -2% until it fades. Fig.5B, the positive shock to the VIX index has a negative impact on the INR at the first three weeks, after which its effect stabilizes at 0.1%. Interestingly, a rise in the EPU shock is offset by a decrease in a volatility shock and vice versa.

In Fig.5C, the results show that a positive shock of one standard deviation in the EPU has a positive effect on BRL and lasts for 2 weeks. The positive response then gradually weakens and is followed by a weak negative response, before finally converging steadily. Further, in Fig.5D, a positive shock of one standard deviation in the VIX index has a positive impact on the BRL during the first and second weeks until this effect stabilizes and approaches zero.

Regarding Swedish Kronor, Fig. (5E and 5F) depict the response of Swedish Kronor to VIX index shocks and EPU, respectively. That the occurrence of a positive shock of one standard deviation in the two variables, EPU and VIX index, has a relatively small effect, fluctuating between negative and positive.

Fig.5G, the occurrence of a positive shock of EPU has a negative impact on the MXN, starting from the second week to the third week. Then it turns positive during the fourth and fifth week at a rate of 0.7% until it fades. Fig.5H, a positive shock of VIX has a slight negative impact on the MXN from the second week and until the fourth week. In particular, the results during the before pandemic period showed that the impact of the EPU shock and the VIX shock of the exchange rate response of four countries was negative during the first four weeks, except for its effect on the INR was positive. In addition, the impact of the shock of the VIX is greater than the impact of the shock of EPU, and the biggest impact of the VIX shock on the BRL, where the exchange rate fell around -12%, followed by the MXN, where it decreased around -6%. Likewise, the largest negative impact of the EPU shock of the response of the BRL, as it declined around -0.05%, while the largest positive effect of this shock was the response of the INR around 3%. A high level of economic uncertainty increases fundamentals expectations and as a result, exchange rates show increased volatility (Krol, 2014).

The results show Fig.6A during the epidemic period that the occurrence of a positive EPU shock has a positive effect on the INR at the second week, then negative from the third week to the fifth week. The impulsive response in Fig.6B shows that when a unit of positive affects the volatility index, the exchange rate response is immediately negative. The response speed increases sharply in the second period and then slows down, gradually increasing to the maximum value in the fourth period. Finally, it converges gradually. However, in Fig.6C, the occurrence of a positive shock of EPU has a positive effect on the BRL during the first and second weeks, and then this effect turns into a slight negative that starts from the third week and continues until the end. Whereas Fig.6D, a positive shock of VIX has a positive effect on the BRL until the fourth week and reaches a maximum of 34% at the second week, and finally converges to a steady state at zero.

Fig.6E, In the case of the SEK, that the occurrence of a positive shock of EPU has a negative effect that continues until the third week and declines at the second week around -20% and turns positive at the fourth week by 10%, after which the simple effect fluctuates between negative and positive until the end of the period. On the other hand, in Fig.6F, a positive VIX shock had a negative effect in the second week of about -2%. Then it turns positive until the fifth week and reaches its maximum range at the fourth week of 41%.

Concerning the MXN / USD, Fig.6G, the results show that the occurrence of a positive shock of one standard deviation in EPU has a negative impact on the MXN, starting from the second week and retreating around -4% to the fourth week at -0.8%. Then this effect turns positive starting from the fifth week by 1% and after that, the impact of the shock is slight until the long run. Additionally, in Fig.6H, the occurrence of a positive shock of VIX has a positive effect on the MXN, starting from the third week to the eighth week, and reaching its maximum at the fourth week by 14%.

In general, we notice that from Fig.6, the impact of the EPU shock is negative on both the SEK and MXN at the beginning of the period, while its effect is positive and convergent on the INR and BRL. As for the impact of the shock of the VIX index on the exchange rate, it is positive at the beginning of the period, and its effect diminishes in the end. The positive impact of the VIX shock on SEK at 41%, BRL at 33% and MXN at 14%. By comparing the exchange rates of the four countries, we find that the impact of the EPU shock on the exchange rate is unstable (fluctuating) in the short term. The results also confirmed that its impact is negative and significant by -20% of the SEK during the beginning of the period and then turns into a positive by 10% within four weeks. However, in the long term, the results showed that the impact of the EPU shock on the SEK is not stable over the period, while for the rest of the countries its effect is stable. Additionally, in terms of the impact of the VIX shock on the exchange rate of the countries concerned, the results also confirmed that there is a positive impact on the exchange rate of all four countries. We also found that the largest statistically significant positive effect by this shock is on the SEK by 41%, followed by the BRL at 33%.

Also as in Fig.7A (before and during the epidemic) regarding the INR, the occurrence of a positive shock of one standard deviation in EPU has a positive impact on the INR during the first three weeks. Then this effect turns into a slight negative during the fourth and fifth week, and after that, the shock effect starts to tbe positive until it fades. Moreover, Fig.7B, the occurrence of a positive shock of the VIX index has a slightly positive impact on the INR starting from the first week to the second week by about 1%, and the effect of the two shocks is unstable and opposite in direction over the length of the study period.

Fig.7C shows that the positive shock to EPU has a slight positive effect on the BRL since the beginning and until the third week, after which the effect fluctuates and approaches zero between negative and positive. Whereas Fig.7D, a positive shock of VIX has a positive affect the BRL until the fourth week and reaches a maximum of 12% at the second week and finally converges to a steady-state at zero.

As Fig.7E depicts, a shock to one standard deviation in the EPU has a negative impact on SEK, which lasts until the third week and the maximum decline in the second week of -6%. Then this slight effect fluctuates between negative and positive until the end of the period. Additionally, in Fig.7F, a shock of one standard deviation in the VIX has a negative effect, declining by -0.8% in the second week. Then it turns to positive until the fifth week and retreats to the lowest in the fourth week by 12%.

As Fig.7G depicts, the EPU response to the Mexican exchange rate shock declines in the second period and returns to the previous level in the next period, and eventually weakens at a slower rate than the decrease, which means that a sudden increase in the Mexican exchange rate shock can largely suppress the lack of Certainty in economic policy. It is counterintuitive that economic policy uncertainty responds negatively to positive changes in exchange rates. Similarly, Fig.7H, during the same period, a shock of VIX leads to a decline in the exchange rate in the second week, as it fell by -0.5%. Then its effect becomes positive until the eighth week, and its extent at the fourth week reaches about 14%, after which the effect approaches zero at the end of the period. The impulse response in Fig.7 shows that the effect of the EPU shock on the exchange rate is negative for all sample countries except for its effect on the INR. It was positive during the before pandemic in the short term. The impact of EPU is negative on the SEK, where it declined by -5%, and the MXN declined by -3%, while for the rest of the countries the impact of the shock is positive on the BRL at 3% and the INR at 3%, that is, their effect is almost close. While the impact of the VIX index shock on the exchange rate positively for all sample countries (MXN at 14%, BRL at 12%, SEK at 11%, and India at 1%). Looking at the three periods, we find that the impact of the EPU shock on the SEK declined during the period of the emergence of the pandemic, where it declined by -20%, while before the outbreak of the pandemic it decreased by -2%.

Conversely, we find an improvement in the impact of EPU shock on the exchange rate of the countries India, Brazil and Mexico. The figures (5-7) show that regarding the impact of the shock of the VIX index compared to the three periods, the results also confirmed that the impact of the shock is positive on the exchange rate when the pandemic began. When using the whole period, we find an improvement in the impact of the positive EPU shock on the exchange rate of the four countries, despite its impact in the before pandemic period negatively on the exchange rate of the four countries. It also appears that the shock effect of both the EPU and the VIX index on the exchange rate stabilizes after the sixth week and for each country concerned, with the exception of the SEK. The response of all involved variables is statistically significantly over the period length for the three models. In fact, exchange rate fluctuations are altered by changes in economic policy (Alesina & Wagner, 2006) and changes in fundamental expectations (Beckmann & Czudaj, 2017). Of course, the higher the EPU level increases the expectations of the fundamentals. As a result, currencies show increased volatility (Krol, 2014).

5. Conclusion

This paper examined the effects of both US economic policy uncertainty (EPU) and the volatility index (VIX) on the exchange rates of a sample of four countries, which recorded the highest death rate due to the COVID-19 pandemic. For this purpose, we used the ARDL bounds test approach for the weekly period from 1/8/2017 to 1/8/2021. Our main findings are as follows: (1) during the pre-pandemic period, the co-integration tests showed that there is a statistically significant positive effect of the VIX index on the Brazilian real in the long run. Likewise, there is a statistically significant positive effect of the volatility index on the exchange rates of both the Indian rupee and the Swedish krona during the pandemic period, as well as between the volatility index and the Indian rupee before and during the COVID-19.

Regarding the effect of EPU on the exchange rates, we found that during the pre-pandemic period there was no statistically significant effect for four countries, while during the pandemic period, there is a positive statistically significant relationship between the EPU and the Brazilian reals. While the case of the before and during the COVID-19, we find that there is a positive statistically significant relationship between the EPU index and the exchange rates of both the Indian rupees and Mexican new pesos. As for its effect on the exchange rates of the rest of the sample countries, it has no statistical significance. (ii) The results of the IRFs also showed the following: First, before the pandemic that the impact of the EPU and VIX shocks on the exchange rate response of four countries was negative during the first four weeks, except for the Indian rupees responding positively to indicators of uncertainty. In addition, the impact of the shock of the VIX index is greater than the EPU shock. Second, we also found that the effect of uncertainty shocks is only present during a pandemic, and has no significance during regular periods. This may mean that economic policy stability plays a more important role in limiting the extremely negative impact of major crisis events. The empirical results of this study provide policymakers with a better understanding of the uncertainty and exchange rate interrelationships of fiscal policy formulation in these countries. In addition, the governments of these countries must take into account the economic phases (situation) when implementing relevant fiscal policies.

References

Abid, A. (2020). Economic policy uncertainty and exchange rates in emerging markets: Short and long runs evidence. Finance Research Letters, 37, 101378.

Aimer, N. (2016). Conditional Correlations and Volatility Spillovers between Crude Oil and Stock Index Returns of Middle East Countries. Open Access Library Journal, 3(12), 1.

Aimer, N. (2017). The role of oil price fluctuations on the USD/EUR exchange rate: an ARDL bounds testing approach to cointegration. EUR Exchange Rate: An ARDL Bounds Testing Approach to Cointegration (October 11, 2017).

Aimer, N. (2019). The Impact of Exchange Rate Volatility on Stock Prices: A Case Study of Middle East Countries. Asian Development Policy Review, 7(2), 98–110.

Al-Thaqeb, S. A., Algharabali, B. G. and Alabdulghafour, K. T. (2020). The pandemic and economic policy uncertainty. International Journal of Finance & Economics.

Albulescu, C. (2020). Do COVID-19 and crude oil prices drive the US economic policy uncertainty? ArXiv Preprint ArXiv:2003.07591.

Albulescu, C. T. (2021). COVID-19 and the United States financial markets volatility. Finance Research Letters, 38, 101699.

Alesina, A. and Wagner, A. F. (2006). Choosing (and reneging on) exchange rate regimes. Journal of the European Economic Association, 4(4), 770–799.

Altig, D., Baker, S., Barrero, J. M., Bloom, N., Bunn, P., Chen, S., ... others. (2020). Economic uncertainty before and during the COVID-19 pandemic. Journal of Public Economics, 191, 104274.

Asari, F., Baharuddin, N. S., Jusoh, N., Mohamad, Z., Shamsudin, N. and Jusoff, K. (2011). A vector error correction model (VECM) approach in explaining the relationship between interest rate and inflation towards exchange rate volatility in Malaysia. World Applied Sciences Journal, 12(3), 49–56.

Baker, S. R., Bloom, N. and Davis, S. J. (2016). Measuring economic policy uncertainty. The Quarterly Journal of Economics, 131(4), 1593–1636.

Baker, S. R., Bloom, N., Davis, S. J. and Terry, S. J. (2020). Covid-induced economic uncertainty.

Basu, S. and Bundick, B. (2017). Uncertainty shocks in a model of effective demand. Econometrica, 85(3), 937–958.

Abid, A. (2020). Economic policy uncertainty and exchange rates in emerging markets: Short and long runs evidence. Finance Research Letters, 37, 101378.

Aimer, N. (2016). Conditional Correlations and Volatility Spillovers between Crude Oil and Stock Index Returns of Middle East Countries. Open Access Library Journal, 3(12), 1.

Aimer, N. (2017). The role of oil price fluctuations on the USD/EUR exchange rate: an ARDL bounds testing approach to cointegration. EUR Exchange Rate: An ARDL Bounds Testing Approach to Cointegration (October 11, 2017).

Aimer, N. (2019). The Impact of Exchange Rate Volatility on Stock Prices: A Case Study of Middle East Countries. Asian Development Policy Review, 7(2), 98–110.

Al-Thaqeb, S. A., Algharabali, B. G. and Alabdulghafour, K. T. (2020). The pandemic and economic policy uncertainty. *International Journal of Finance & Economics*.

Albulescu, C. (2020). Do COVID-19 and crude oil prices drive the US economic policy uncertainty? *ArXiv Preprint ArXiv:2003.07591*.

Albulescu, C. T. (2021). COVID-19 and the United States financial markets volatility. *Finance Research Letters*, *38*, 101699.

Alesina, A. and Wagner, A. F. (2006). Choosing (and reneging on) exchange rate regimes. *Journal of the European Economic Association*, *4*(4), 770–799.

Altig, D., Baker, S., Barrero, J. M., Bloom, N., Bunn, P., Chen, S., … others. (2020). Economic uncertainty before and during the COVID-19 pandemic. *Journal of Public Economics*, *191*, 104274.

Asari, F., Baharuddin, N. S., Jusoh, N., Mohamad, Z., Shamsudin, N. and Jusoff, K. (2011). A vector error correction model (VECM) approach in explaining the relationship between interest rate and inflation towards exchange rate volatility in Malaysia. *World Applied Sciences Journal*, *12*(3), 49–56.

Baker, S. R., Bloom, N. and Davis, S. J. (2016). Measuring economic policy uncertainty. *The Quarterly Journal of Economics*, *131*(4), 1593–1636.

Baker, S. R., Bloom, N., Davis, S. J. and Terry, S. J. (2020). *Covid-induced economic uncertainty*.

Basu, S. and Bundick, B. (2017). Uncertainty shocks in a model of effective demand. *Econometrica*, *85*(3), 937–958.

Beckmann, J. and Czudaj, R. (2017). Exchange rate expectations and economic policy uncertainty. *European J. of Political Economy*, *47*, 148–162.

Bloom, N., Floetotto, M., Jaimovich, N., Saporta-Eksten, I. and Terry, S. J. (2018). Really uncertain business cycles. *Econometrica*, *86*(3), 1031–1065.

Brown, R. L., Durbin, J., and Evans, J. M. (1975). Techniques for testing the constancy of regression relationships over time. *Journal of the Royal Statistical Society: Series B (Methodological)*, *37*(2), 149–163.

Bush, G. and Noria, G. L. (2019). Uncertainty and Exchange Rate Volatility: the Case of Mexico.

Bush, G. and Noria, G. L. (2021). Uncertainty and exchange rate volatility: Evidence from Mexico. *International Review of Economics \& Finance*.

Chen, L., Du, Z. and Hu, Z. (2020). Impact of economic policy uncertainty on exchange rate volatility of China. *Finance Research Letters*, *32*, 101266.

D'Mello, R., and Toscano, F. (2020). Economic policy uncertainty and short-term financing: The case of trade credit. *Journal of Corporate Finance*, *64*, 101686.

Dickey, D. A. and Fuller, W. A. (1981). Likelihood ratio statistics for autoregressive time series with a unit root. *Econometrica: Journal of the Econometric Society*, 1057–1072.

Engle, R. F. and Granger, C. W. J. (1987). Co-integration and error correction: representation, estimation, and testing. *Econometrica: Journal of the Econometric Society*, 251–276.

Grossmann, A., Love, I. and Orlov, A. G. (2014). The dynamics of exchange rate volatility: A panel VAR approach. *Journal of International Financial Markets, Institutions and Money*, *33*, 1–27.

Günay, F., Bayraktaroğlu, E. and Özkul, K. (2020). Assessing the short-term impacts of COVID-19 pandemic on foreign visitor's demand for Turkey: A scenario analysis. *Journal of Ekonomi*, *2*(2), 80–85.

Hitt, M. A., Holmes Jr, R. M. and Arregle, J.-L. (2021). The (COVID-19) pandemic and the new world (dis) order. *J. of World Business*, *56*(4), 101210.

Işık, C., Sirakaya-Turk, E. and Ongan, S. (2020). Testing the efficacy of the economic policy uncertainty index on tourism demand in USMCA: Theory and evidence. *Tourism Economics*, *26*(8), 1344–1357.

Keynes, J. M. (1937). The general theory of employment. *The Quarterly Journal of Economics*, *51*(2), 209–223.

Kilian, L. (1998). Small-sample confidence intervals for impulse response functions. *Review of Economics and Statistics*, *80*(2), 218–230.

Krol, R. (2014). Economic policy uncertainty and exchange rate volatility. *International Finance*, *17*(2), 241–256.

Kwiatkowski, D., Phillips, P. C. B., Schmidt, P. and Shin, Y. (1992). Testing the null hypothesis of stationarity against the alternative of a unit root: How sure are we that economic time series have a unit root? *Journal of Econometrics*, *54*(1–3), 159–178.

Liu, Y., Gayle, A. A., Wilder-Smith, A. and Rocklöv, J. (2020). The reproductive number of COVID-19 is higher compared to SARS coronavirus. *Journal of Travel Medicine*.

Lombardi, S., e Cunha, M. P. and Giustiniano, L. (2021). Improvising resilience: The unfolding of resilient leadership in COVID-19 times. *International Journal of Hospitality Management*, *95*, 102904.

Longstaff, F. A. (2010). The subprime credit crisis and contagion in financial markets. *Journal of Financial Economics*, *97*(3), 436–450.

Naqvi, S. M. J. (2021). Economic Policy Uncertainty and Dollar Rupee Exchange Rate Volatility. *Available at SSRN 3768239*.

Nilavongse, R., Michał, R. and Uddin, G. S. (2020). Economic policy uncertainty shocks, economic activity, and exchange rate adjustments. *Economics Letters*, *186*, 108765.

Özçatalbaş, O. (2020). Is Coronavirus the worst of the worst for the Human and Earth? *Journal of Ekonomi*, *2*(2), 98.

Padhan, R. and Prabheesh, K. P. (2021). The economics of COVID-19 pandemic: A survey. *Economic Analysis and Policy*, *70*, 220–237.

Payne, J. E., Topcu, M., Hajille, M. and Niroomand, F. (2021). Economic policy uncertainty shocks and US overseas travel. *The International Trade Journal*, *35*(1), 115–122.

Pesaran, M. H. and Shin, Y. (1998). An autoregressive distributed-lag modelling approach to cointegration analysis. *Econometric Society Monographs*, *31*, 371–413.

Pesaran, M. H., Shin, Y. and Smith, R. J. (2001). Bounds testing approaches to the analysis of level relationships. *Journal of Applied Econometrics*, *16*(3), 289–326.

Phan, D. H. B., Iyke, B. N., Sharma, S. S. and Affandi, Y. (2021). Economic policy uncertainty and financial stability--Is there a relation? *Economic Modelling*, *94*, 1018–1029.

Phillips, P. C. B. and Perron, P. (1988). Testing for a unit root in time series regression. *Biometrika*.

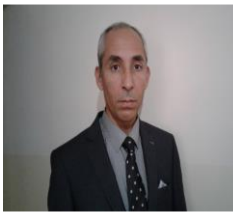
Ranasinghe, R., Callaghan, D. and Stive, M. J. F. (2012). Estimating coastal recession due to sea level rise: beyond the Bruun rule. *Climatic Change*, *110*(3), 561–574.

Sharif, A., Aloui, C. and Yarovaya, L. (2020). COVID-19 pandemic, oil prices, stock market, geopolitical risk and policy uncertainty nexus in the US economy: Fresh evidence from the wavelet-based approach. *International Review of Financial Analysis*, 101496.

Spiteri, G., Fielding, J., Diercke, M., Campese, C., Enouf, V., Gaymard, A., … others. (2020). First cases of coronavirus disease 2019 (COVID-19) in the WHO European Region, 24 January to 21 February 2020. *Eurosurveillance*, *25*(9), 2000178.

Yu, H., Fang, L. and Sun, W. (2018). Forecasting performance of global economic policy uncertainty for volatility of Chinese stock market. *Physica A: Statistical Mechanics and Its Applications*, *505*, 931–940.

Zhang, Y.-J. and Wang, J.-L. (2019). Do high-frequency stock market data help forecast crude oil prices? Evidence from the MIDAS models. *Energy Economics*, *78*, 192–201.



Nagmi Moftah Aimer (ORCID ID: 0000-0003-1739-2509) Ph.D. in Economics

I completed my undergraduate education at the Department of Economics at Kastamonu University. I completed my master's and Ph.D. degrees in Financial Planning Department at Planning Institute / Tripoli - Libya.

I am currently working as a lecturer in the Department of Management at the Higher Institute of Marine Sciences Techniques Sabratha, Libya.