Does Changes in Characteristics of a Fixed Exchange Rate Regime Impact Conditional Volatility? Evidence from the Case of Morocco

Hamza Bouhali [1] | *Mohammadia School of Engineering (EMI), Rabat, Morocco*
Mohammed Salah Chiadmi [2] | *Mohammadia School of Engineering (EMI), Rabat, Morocco*
Fouzia Ghaiti | *Mohammadia School of Engineering (EMI), Rabat, Morocco*

Abstract

This article aims to exhibit and study the impacts that changing characteristics of a fixed exchange rate regime has on conditional volatility. To do so, using the U.S. dollar dirham (USDMAD) daily closing rates over 23 years, we compare the GARCH model results of four segmented sub-periods to each other and then to the global period of the study to detect disparities. The main result is that changes in exchange rate regime characteristics do impact the conditional volatility. Therefore, we recommend that the study of conditional volatility should use periods with no changes in the characteristics of the exchange rate regime to avoid bias. Otherwise, the use of segmented sub-periods should be adopted to take account of these changes. Finally, we present some key results about the impacts of these changes in Morocco's exchange rate regime on the conditional volatility.

Keywords	***JEL code***
Exchange rate, conditional volatility, fluctuation bands	*F31, C58*

INTRODUCTION

The volatility analysis of emerging countries' currencies has gained interest in the work of academics lately due to its importance in the domestic economic growth, the competitiveness, and the attraction of foreign investments for these countries. Most of these studies include a panel involving several countries and uses a continuous time series without taking into account changes in the exchange rate regime as they

[1] Team of Analysis, Optimization and Control of Systems, Mohammed V University, Rabat, Morocco. Corresponding author: e-mail: hamzaelbouhali@gmail.com.
[2] Team of Analysis, Optimization and Control of Systems, Mohammed V University, Rabat, Morocco. E-mail: salah.chiadmi@gmail.com.

considered that the global fixed exchange regime did not change. However, we have reasons to believe that this methodology may be biased because it doesn't take into account the impact of changes in exchange rate regime parameters such as peg compositions and the size of fluctuation bands.

To address this problem, we will study the impact of these changes in the exchange rate regime on conditional volatility using the case of Morocco's fixed exchange rate regime. Morocco is the third biggest partner of the European Union in Africa[3] and one of the most essential non-oil countries in the MENA region. Its close location to Europe, its climate, and its affordable workforce made him an important hub of offshoring services and industries since the early '90s. Due to its growing importance in the MENA and the Mediterranean region, many researchers have conducted studies about the conditional volatility of Moroccan dirham (MAD) to assess its impact on trade and growth. However, all of them used a continuous-time series ignoring the fact that the country has undergone structural changes in its exchange rate regime over the years. This behavior makes the use of its case suitable for our study.

Our article will start with a literature review in Section 1 that will be followed by a presentation of the data used and the theoretical framework in Section 2. We will then give in Section 3 a brief presentation of the Moroccan's exchange rate regime and the evolutions that it undergoes. After that, we will present our empirical findings in Section 4 before ending with conclusion and some recommendations in the last section.

1 LITERATURE REVIEW

Since the early '90s, studies based on the works of Engle (1982), and Bollerslev (1986) start to be more and more present in the literature, most of them focusing on conditional volatility of economic aggregates such as inflation, trade flows or foreign exchange rates. The data used in these studies is usually continued and contains a significant number of observations to ensure the convergence and the positivity constraint of GARCH models (Hwang and Pereira, 2006).

In the case of exchange rates, the majority of the literature confirms the critical relationship between the exchange rate regime and exchange rate volatility. We cite as an example of studies demonstrating this relationship the works of Baxter and Stockman (1989), Aizenman (1992), Flood and Rose (1995), Hasan and Wallace (1996), Bayoumi and Eichengreen (1998), Bleaney and Fielding (2002), Levy-Yeyati and Sturzenegger (2005), Schnabl (2008), Katusiime, Agbola, Shamsuddin (2015), Alagidede and Ibrahim (2016), Calderon and Kubota (2017), and Phiri (2018). Therefore, the study on conditional volatility over a period containing different exchange rate regimes may have introduced biased results and failed to capture the volatility patterns.

As an example, one of the rare studies using a fragmented period accordingly with changes in exchange rate regime is the one of Rose (1996), the main results are that the widening of EMS's[4] fluctuation bands in 1993 resulted in a higher exchange rate volatility. Meanwhile, if we look at studies like Kearney and Patton (2000), which use data from 1979 to 1997, we find that it failed to capture the impact of this change on the conditional volatility and its transmission between the EMS's major currencies. Another example of studies using fragmented periods is Kocenda and Valachy (2006), who studied the transition from fixed to floating exchange rate regimes in the Visegrad countries. Their main results were that the switch to a floating regime tends to increase conditional volatility and that the width of fluctuation bands has a direct impact on exchange rate volatility.

That said, these articles only fragmented the periods of study into a fixed regime period and a floating one. Meanwhile, the fixed exchange rate period of Visegrad countries in the study of Kocenda and Valachy

[3] Source: European Commission, Eurostat (Comext, statistical regime 4).
[4] European Monetary System.

(2006) had also many changes in peg composition and into the size of fluctuation bands. However, the impacts of these changes remain unknown as the authors choose to consider the fixed regime period as one uniform continuous period. As of 2019, IMF (2019) finds that 66.6% of the world countries are still using a de facto fixed exchange rate regime, which makes these changes even more important as it's affecting the majority of the world's countries.

Thus, the original contribution of this article will be to exhibit and study the impacts of these changes on conditional volatility. To achieve our goal, we will use the case of Morocco, which is a country whose regime undergoes many changes since its independence. However, the central studies working on this country's conditional volatility, presented in Table 1, uses continuous times series, which make it a perfect benchmark for our study.

Table 1 Main studies using GARCH models to analyze Moroccan exchange rate volatility

	DATA Range	Country of study	Methods used
Rey (2006)	Quarterly data from 1970–2002	Algeria, Egypt, Tunisia, Israel, Morocco, and Turkey	GARCH, I-GARCH
Selmia, Bouoiyour, Ayachi (2012)	Quarterly data from 1972–2010	Morocco and Tunisia	GARCH, E-GARCH, T-GARCH, TS-GARJI, GJR-GARCH, GARCHK, P-GARCH
Abdalla (2012)	Daily data from 2000–2011	United Arab Emirates, Bahrain, Djibouti, Algeria, Egypt, Iraq, Jordan, Kuwait, Lebanon, Libya, Morocco, Mauritania, Oman, Qatar, Saudi Arabia, Somali Syria, Tunisia, and Yemen	GARCH, EGARCH
Bouoiyour and Selmi (2014)	Quarterly data from 1996–2009	Morocco and Tunisia	GARCH, N-GARCH, T-GARCH, E-GARCH, GARCH-M
Abed, Amor, Nouira, Rault (2016)	Daily data from 2001–2015	Tunisia, Morocco, Egypt, Jordan, United Arab Emirate, Qatar and Saudi Arabia	GARCH, GJR-GARCH
Azzouzi and Bousselhami (2019)	Annual data from 1990–2017	Morocco and Turkey	GARCH-M, ARDL
Bahmani-Oskooee and Arize (2019)	Quarterly data from 1973–2015	Algeria, Cameroon, Ethiopia, Ghana, Kenya, Mauritius, Morocco, Nigeria, South Africa, Tanzania, Tunisia, Uganda, Zambia	GARCH-based Model

Source: Own construction

2 DATA AND METHODOLOGY

2.1 Data

Our first step was to choose a data set containing periods with a high number of observations to ensure both the convergence of the GRACH model and the integrity of our study. We chose to use the daily USDMAD official closing rates from June 3, 1996, to August 30, 2019, available on the website of the Central Bank of Morocco (Bank Al-Maghrib – BKAM).[5]

[5] *<http://www.bkam.ma/Marches/Principaux-indicateurs/Marche-des-changes/Cours-de-change/Cours-de-reference>.*

Table 2 Summary statistics of USDMAD rates and yields

	USDMAD Rates	USDMAD Yields
Mean	9.20715	6.93E-06
Median	9.16045	0.0
Maximum	12.0616	0.021079
Minimum	7.2088	–0.02157
Std. Dev.	0.967046	0.00211
Skewness	0.532087	–0.10255
Kurtosis	3.011696	9.255492
Jarque-Bera	284.9911	9 855.336
Probability	0.0	0.0
Sum	55 601.98	0.041852
Sum Sq. Dev.	5 646.604	0.02687
Observations	6 038.0	6 038.0

Source: Own construction

Table 2 shows that the USDMAD rates and yields are leptokurtic, which means the presence of more massive tails in the distribution. Regarding symmetry, the USDMAD yields are relatively symmetric, while the USDMAD rates are positively skewed, which means rates are more likely to be above average than below.

Figure 1 USDMAD official closing rates (Bank Al Maghrib)

Source: Own construction

The plotted series of USDMAD closing rates in Figure 1 shows the presence of volatility clusters over most of the studied period, which makes it a good fit for a GARCH's volatility model.

The second step was to determine the right segmentation of our time series to capture all the changes in the exchange rate regime. The segmentation selected is presented below with the main events delimiting its start and end:

- **Period 1**: this period starts from the opening of the Moroccan foreign exchange market in June 1996 and ends the day before the change of the basket composition on April 25th, 2001;
- **Period 2:** this period starts from the change in basket composition on April 25th, 2001, and ends in the day preceding the change in the basket weights on April 13th, 2015;
- **Period 3:** this period starts from the change of basket weights on April 13th, 2015, and ends the day before the widening of fluctuation bands on January 12th, 2018;
- **Period 4:** this period starts from the widening of fluctuation bands on January 15th, 2018, to August 30th, 2019.

In order the use GARCH models, the stationarity condition is required. To determine the stationarity of our data over every period, we will use the Augmented Dickey-Fuller test (ADF). We list the results of this test over all the study periods in Table 3.

Table 3 Results of Augmented Dickey-Fuller test of USDMAD closing rates in level and first difference

		Level data	1st difference	Stationarity
The global period 06/04/96–08/30/19	ADF test result	–1.661224	–83.66349	I(1)
	P-value	0.4511	0.0001	
1st period 06/04/96–04/24/01	ADF test result	–0.995442	–43.70107	I(1)
	P-value	0.7568	0.0001	
2nd period 04/25/01–04/10/15	ADF test result	–1.791138	–62.48813	I(1)
	P-value	0.3853	0.0001	
3rd period 04/13/15–01/12/18	ADF test result	–1.887809	–26.94473	I(1)
	P-value	0.3382	0.0000	
4th period 01/15/18–08/30/19	ADF test result	–1.763837	–19.23175	I(1)
	P-value	0.3983	0.0000	

Source: Own construction

The stationarity is present in the first difference. Therefore, we will use the USDMAD yields which we define as:

$$Y_t = R_t - R_{t-1}\ , \tag{1}$$

where: R_t is the USDMAD exchange rate of the date t.

2.2 ARCH and GARCH

Engle (1982) introduced as part of its analysis of the inflation variance in the United Kingdom, the heteroskedastic ARCH model (Autoregressive conditional heteroskedasticity), this model shows a conditional variance dependent on past observations. We formulate the ARCH model of order q in the following form:

$$
\begin{aligned}
& r_t = \mu + y_t \; et \; y_t = \varepsilon_t \cdot \sigma_t \,, \\
& \sigma_t^2 = \alpha_0 + \sum_{i=1}^{q} \alpha_i \, y_{t-i}^2 \,, \; \alpha_0 > 0 \text{ and } \; \alpha_i > 0 \text{ for evry } i \in \{1, \dots, q\} \,, \\
& y_t | \psi_{t-1} \sim N(0, \sigma_t^2) \,,
\end{aligned}
\tag{2}
$$

where: y_t – the error terms of the mean equation,
r_t – logarithmic yields at the moment t,
μ – an average of the logarithmic yield,
ε_t – Gaussian process i.i.d such that $\varepsilon_t \sim N(0,1)$ (White noise),
σ_t – the volatility of the asset,
ψ_{t-1} – information available at t–1,
α_0 – can be considered as the minimum volatility since it is always strictly positive, the other parameters α_i represent shocks from prior periods.

Although the ARCH model is easy to estimate, it remains minimal due to the difficulties of determining the q order and the non-negativity constraint of the parameters. To address this problem Bollerslev (1986) introduces GARCH (Generalized Autoregressive conditional heteroskedasticity), which adopts a generalization similar to the extension of a model A.R. (p) to an ARMA (p, q). Conditional volatility materializes in the GARCH model materializes as follows:

$$
\sigma_t^2 = \alpha_0 + \sum_{i=1}^{q} \alpha_i y_{t-i}^2 + \sum_{j=1}^{p} \beta_i \sigma_{t-j}^2 \,,
\tag{3}
$$

p and q are positive integers, $\alpha_0 > 0$,

$\alpha_i \geq 0 \;\forall\; i \in \{1, \dots, q\}, \;\; \beta_j \geq 0 \;\forall\; i \in \{1, \dots, p\}.$

This model is widely used in the study of the financial series because it incorporates the impact of past volatility through the autoregressive term. β_i.

3 MOROCCAN EXCHANGE RATE REGIME TIMELINE

Since independence in 1956, Morocco has adopted a fixed exchange rate regime with a hard peg to the French franc (FFR). After the collapse of Bretton Woods in the early '70s, Morocco switched its peg to a basket of currencies containing major world currencies. In 1996, the Moroccan authorities created a local foreign exchange market where banks are the main actors and where the capital movements are very restricted and controlled. Since 1997, the dollar raised sharply due to the Asian and Russian crisis, which pushed the Moroccan authorities in 2001 to operate a 5% devaluation of the local currency to preserve the country's competitiveness. This devaluation was materialized by a change in the composition of the peg basket to contain exclusively 80% EUR and 20% USD, dropping out significant currencies such as JPY and GBP. After the economic crisis in 2008, the U.S. and Europe experienced a contrasted recovery, which impacted the EURUSD exchange rate and, therefore, the USDMAD. In 2014, the dollar raised 23% again dirham in one year, urging the Moroccan authorities to change the weights of currencies composing the basket on April 13th, 2015. Since 2017, the Moroccan central bank (Bank Al-Maghrib) has communication about its intention of making the exchange rate regime more flexible. On January 15th, 2018, Morocco switched to the new exchange rate regime with fluctuation bands eight times larger moving them from ±0.3% to ±2.5%.

Table 4 Results of GARCH modelling of USDMAD yield over all periods

	1st period 06/04/96–04/24/01	2nd period 04/25/01–04/10/15	3rd period 04/13/15–01/12/18	4th period 01/15/18–08/30/19
$\alpha_0 10^6$	0.343303	0.018037	0.004508	0.029610
	0.1215	0.0560	0.6060	0.2802
α_1	0.081756	0.033899	0.012065	0.028068
	0.0173	0.00000	0.0464	0.0748
β_1	0.846255	0.962413	0.984976	0.949713
	0.00000	0.00000	0.00000	0.0000
$\alpha_1 + \beta_1$	0.92801	0.99631	0.99704	0.97778
Log-likelihood	6063.14	17318.9	3654.22	2134.85
Unconditional variance	4.76884	4.89041	1.52345	1.33269

Source: Own construction

Table 5 Results of USDMAD GARCH modelling in the literature and the global period of our study

	Rey (2006)	Selmia, Bouoiyour, Ayachi (2012)	Abdalla (2012)	Bouoiyour and Selmi (2014)	Abed, Amor, Nouira, & Rault (2016)	Azzouzi and Bousselhami (2019)	Bahmani-Oskooee and Arize (2019)	Our global period
$\alpha_0 10^6$	0.0002	0.00118	0.002149	0.00305	0.0074	0.00	0.004	**0.018133**
α_1	0.3540	0.0406	0.039420	0.01100	0.0494	–0.19	–0.05	**0.038852**
β_1	0.4378	0.4316	0.959707	0.98000	0.9034	0.86	1.03	**0.957930**
$\alpha_1 + \beta_1$	0.7918	0.4722	0.999127	0.99100	0.9528	0.67	0.98	**0.99678**
Log-likelihood	Quarterly data from 1970–2002	Quarterly data from 1972–2010	Daily data from 2000–2011	Quarterly data from 1996–2009	Daily data from 2001–2015	Annual data from 1990–2017	Quarterly data from 1973–2015	**Daily data from 1996–2019**

Source: Own construction

4 EMPIRICAL FINDING

The results of the GARCH model presented in Table 4 show a big difference in the GARCH model results for all the sub-periods. We believe these differences are due to the changes operated on the exchange rate regime in Morocco. To verify this supposition, we compute the GARCH model for the global period from 1996 to 2019 and present its results in Table 5 alongside with the ones of the studies presented earlier in the literature review as they are using GARCH model too in the case of Morocco.

By comparing the different results, we observe a vital contrast in GARCH parameters between the different studies. As an example, Trey (2006), and Selmia, Bouoiyour, Ayachi (2012) share 30 years of same frequency data but still have a very different parameters. The disparity is even bigger as we compare the results of Bahmani-Oskooee and Arize (2019), and Selmia, Bouoiyour, Ayachi (2012), all GARCH model results are contrasted even though they share the same frequency and more than 88% of the data set (37 years of data in stock). We observe the same phenomenon when we compare the results of Abdalla (2012), and Abed, Amor, Nouira, Rault (2016), who share more than 78% of their global data. These findings confirm our earlier supposition about the impacts of changes in characteristics of the exchange rate regime on the conditional volatility. Therefore, the study periods shouldn't be considered as continuous and should be segmented in sub-periods containing the same regime characteristics.

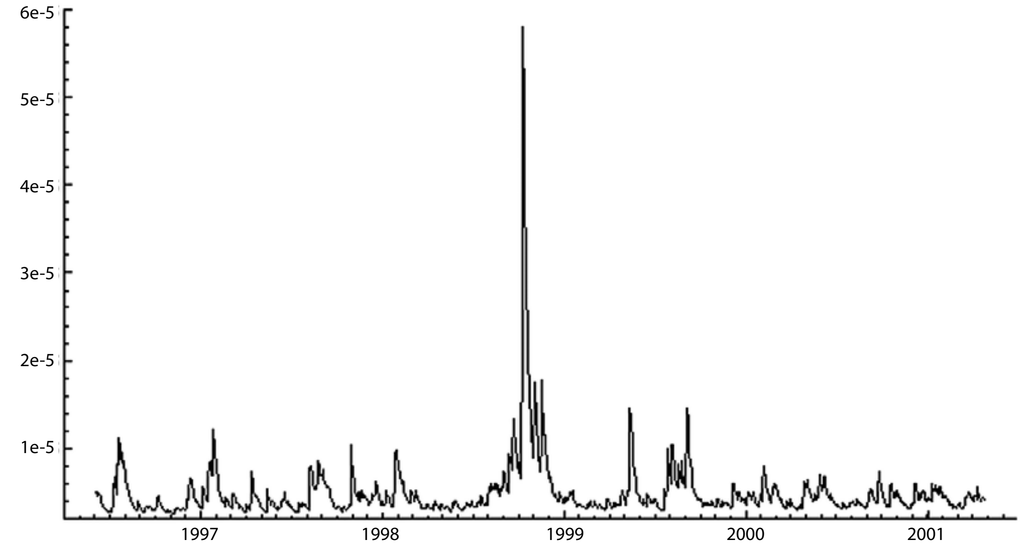
To test this assumption more in detail, we compare the results of our four sub-periods, presented in the DATA section, with the ones of our global period. We observe an important difference between the parameters of the global period and three of the sub-periods. Also, we notice that the 2nd sub-period, which is the largest among sub-periods, have approximately the same results as the global period. These observations confirm our assumption about the necessity of period fragmentation to avoid bias and capture the dynamics triggered by changes in the exchange rate regime's characteristics. To present examples of these dynamics, we will analyze the impact of these changes in the case of Morocco and show their importance in assessing the development of conditional volatility.

Going back to Table 4, we discern that the 1st sub-period is characterized by high minimal volatility due to the presence of major crises such as the Asian crisis and the internet bubble, which are identifiable in Figure 2 by their spikes. The minimal volatility tends to decrease after the devaluation of 2001 even though we observe some significant spikes in conditional volatility in Figure 3 linked primary to the financial crisis of 2009 and the Eurozone debt crisis in 2011–2012. We also observe that the impact of past volatilities, initially low in the first period, increase gradually after the change in peg composition. This change in is mainly caused by the peg composition as the presence of many interconnected major currencies offset the volatility effect.

On the other hand, a peg composed exclusively of EUR and USD is directly impacted by the EURUSD volatility as it's the case after 2001. However, this impact decreases significantly after the widening of fluctuation bands in 2018, as we can see in Figure 5. This decrease is caused by the domestic market, which becomes more active and got more leeway to face and absorb high volatility on the EURUSD parity. This last finding doesn't corroborate the results of Baxter and Stockman (1989), who consider that volatility is more important in a flexible regime than in a fixed one. It also contradicts the results of Rose (1996), and Kocenda and Valachy (2006), who suggests that more full fluctuation bands promote the volatility. We believe that the difference in capital movement policy may have a significant role in explaining these contradicted results. As a matter of fact, Edwards and Rigobon (2009) found in their study that strict control of capital movement, like the one in Morocco, could offset the external shocks and lower volatility.

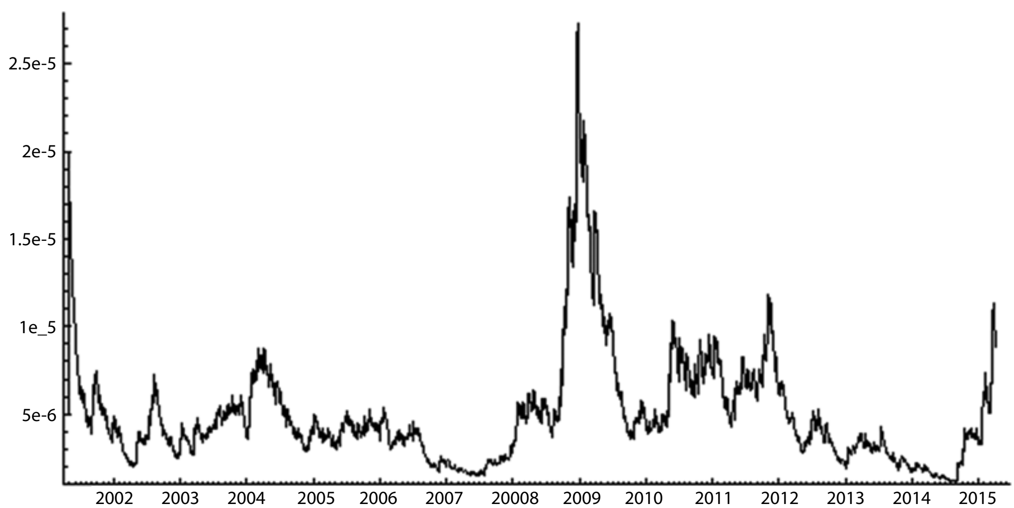
Our last observation is that the plot of conditional volatility in a global period makes it very hard to spot the spikes in periods with different degrees of volatility. As an example, the spikes in the first two sub-periods are easy to detect as they are corresponding to the global crisis in the financial market. However, it's a lot more challenging to spot the spikes of the 4th sub-periods in the global graph presented in Figure 6 as the volatility drops significantly. Presenting a segmented plot for every sub-period allows us to detect more efficiently the small crisis and, more importantly, the endogenous crisis as it's the case for this last sub-period.

Figure 2 Conditional volatility of USDMAD yields of the 1st period



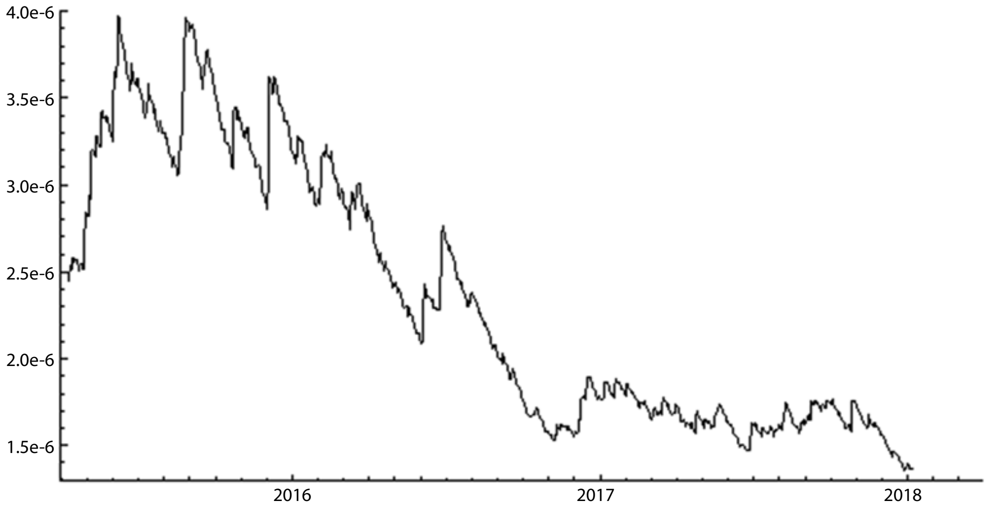
Source: Own construction

Figure 3 Conditional volatility of USDMAD yields of the 2nd period



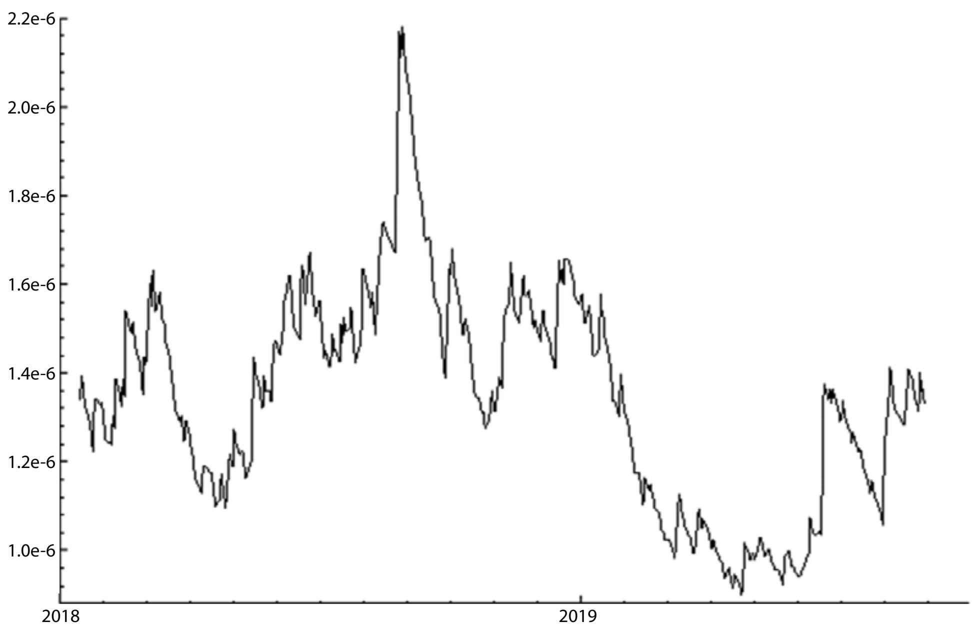
Source: Own construction

Figure 4 Conditional volatility of USDMAD yields of the 3rd period



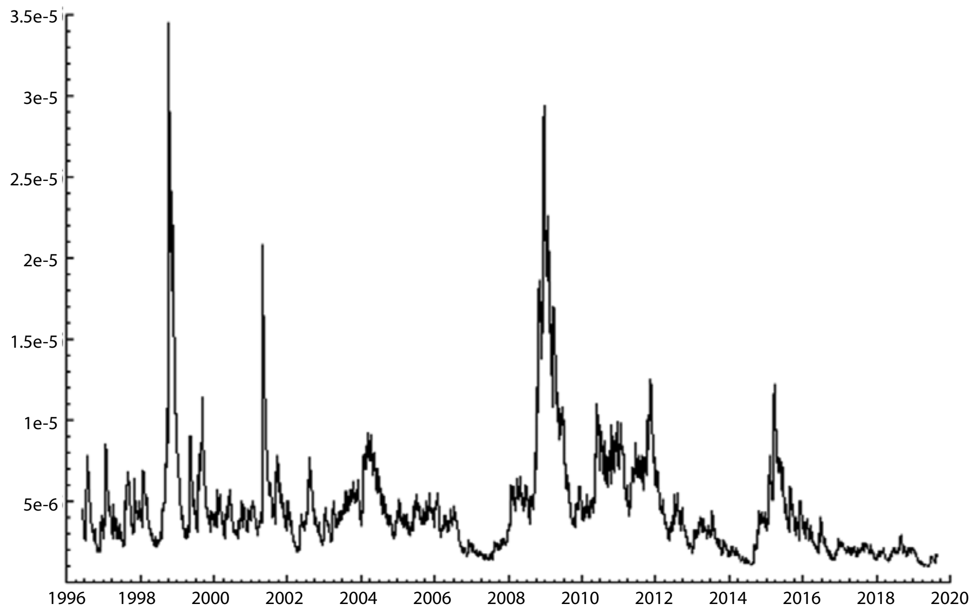
Source: Own construction

Figure 5 Conditional volatility of USDMAD yields of the 4th period



Source: Own construction

Figure 6 Conditional volatility of USDMAD yields of the global period



Source: Own construction

CONCLUSION AND RECOMMENDATIONS

In this study, we exploited the case of Morocco to exhibit and study the impacts of changes in the fixed exchange rate regime on conditional volatility. To achieve our goal, we proceeded to two-step analysis. In the first one, we compared the GARCH model results of the different articles presented in our literature review. This first step allowed us to exhibit significant dissimilarities between all the studies, even though most of them share essential common periods. The second step was meant to confirm the first finding and expose some of the benefits of using segmented sub-periods in conditional volatility study. To do so, we segment our time series of USDMAD yields into four sub-periods accordingly with the changes made in the exchange rate regime of the country. We then compared the GARCH model results of the four sub-periods to each other and then to the ones of the global period. This comparison yielded two majors results: the first one is a confirmation of our first finding concerning the significant difference between subperiods results and global ones. The second was that the changes in exchange rate characteristics have a significant effect on the evolution of conditional volatility. Therefore, to capture efficiently the dynamics caused by theses change, the period of study should be fragmented into sub-periods accordingly with the dates of the different changes in the fixed exchange rate regime.

Even though it wasn't the primary goal of our study, we come to some impressive results about the impacts of peg composition and the size of the fluctuation band on conditional volatility. We mainly found that a peg containing many major currencies amplifies the volatility but offset the impact of past volatilities. On the contrary, a peg composed exclusively of two currencies reduces the volatility but increases the impact of the past volatilities massively. The last results were that the widening of fluctuation bands reduced the volatility which contradicted the finding of Baxter and Stockman (1989), Rose (1996), and Kocenda and Valachy (2006). We attributed this contradiction to the difference in capital movement policies between the countries of the different studies, which is corroborated by the finding of Edwards and Rigobon (2009).

Based on our results, we strongly recommend that conditional volatility studies be made on periods with no changes in the exchange regime characteristics even though it is a fixed one. This segmentation will allow the researchers to avoid biased results and have a more detailed view of conditional volatility evolution. We also recommend, in the light of the results obtained, that further studies analyze the impact of peg compositions and the size of fluctuation bands to assess the exact effect of these characteristics on conditional volatilities. Finally, we believe that the use of structural breaks analysis as presented by Kocenda (2005), and the Markov Switching Model as used by Frömmel (2006), in the periods' fragmentation process can be an exciting extension of our study.

References

ABDALLA, S. Z. Modelling Exchange Rate Volatility using GARCH Models: Empirical Evidence from Arab Countries. *International Journal of Economics and Finance*, 2012, 4(3), pp. 216–229.

ABED, R. E., AMOR, T. H., NOUIRA, R., RAULT, C. Asymmetric effect and dynamic relationships between oil prices shocks and exchange rate volatility: evidence from some selected MENA countries. *Topics in Middle Eastern and African Economies,* 2016, 18(2), pp. 1–25.

AIZENMAN, J. Exchange Rate Flexibility, Volatility, and Domestic and Foreign Direct Investment. *Staff Papers,* International Monetary Fund, 1992, December, 39(4), pp. 890–922.

ALAGIDEDE, P. AND IBRAHIM, M. On the Causes and Effects of Exchange Rate Volatility on Economic Growth: Evidence from Ghana. *Journal of African Business*, 2016, 18(2), pp. 169–193.

AZZOUZI, A. AND BOUSSELHAMI, A. Impact of the Exchange Rate and Price Volatility on FDI Inflows: Case of Morocco and Turkey. *Applied Economics and Finance,* 2019, 6(3), pp. 87–104.

BAHMANI-OSKOOEE, M., AND ARIZE, A. C. On the Asymmetric Effects of Exchange Rate Volatility on Trade Flows: Evidence from Africa. *Emerging Markets Finance and Trade,* 2019, 56(4), pp. 913–939.

BAXTER, M. AND STOCKMAN, A. C. Business cycles and the exchange rate regime: Some International Evidence. *Journal of Monetary Economics*, 1989, 23(3), pp. 377–400.

BAYOUMI, T. AND EICHENGREEN, B. Exchange rate volatility and intervention: implications of the theory of optimum currency areas. *Journal of International Economics*, 1998, 45(2), pp. 191–209.

BLEANEY, M. AND FIELDING, D. Exchange rate regimes, inflation and output volatility in developing countries. *Journal of Development Economics,* 2002, 99(4), pp. 233–245.

BOLLERSLEV, T. Generalized autoregressive conditional heteroskedasticity. *Journal of Econometrics*, 1986, 31(3), pp. 307–327.

BOUOIYOUR, J. AND SELMI, R. Exchange volatility and trade performance in Morocco and Tunisia: what have we learned so far? *Macroeconomics and Finance in Emerging Market Economies*, 2014, 8(3), pp. 244–274.

CALDERON, C. AND KUBOTA, M. Does Higher Openness Cause More Real Exchange Rate Volatility? *Journal of International Economics*, 2017, 110(2), pp. 176–204.

EDWARDS, S. AND RIGOBON, R. Capital controls on inflows, exchange rate volatility and external vulnerability. *Journal of International Economics*, 2009, 78(2), pp. 256–267.

ENGLE, R. F. Autoregressive Conditional Heteroscedasticity with Estimates of the Variance of United Kingdom Inflation. *Econometrica*, 1982, 50(4), pp. 987–1008.

FLOOD, R. P. AND ROSE, A. K. Fixing exchange rates A virtual quest for fundamentals. *Journal of Monetary Economics*, 1995, 36(1), pp. 3–37.

FRÖMMEL, M. Volatility Regimes in Central and Eastern European Countries' Exchange Rates. In: HANNOVER, U. eds. *Diskussionsbeitrag No. 333,* 2006, October.

HASAN, S. AND WALLACE, M. Real exchange rate volatility and exchange rate regimes: evidence from long-term data. *Economics Letters*, 1996, 52(1), pp. 67–73.

HWANG, S. AND PEREIRA, P. L. Small Sample Properties of GARCH Estimates and Persistence. *The European Journal of Finance,* 2006, September–October, 12(6–7), pp. 473–494.

IMF. *Annual Report on Exchange Arrangements and Exchange Restrictions 2018.* Washington, D.C., 2019.

KATUSIIME, L., AGBOLA, F. W., SHAMSUDDIN, A. Exchange rate volatility–economic growth nexus in Uganda. *Applied Economics*, 2015, 48(26).

KEARNEY, C. AND PATTON, A. J. Multivariate GARCH Modeling of Exchange Rate Volatility Transmission in the European Monetary System. *The Financial Review*, 2000, 35(1), pp. 29–48.

KOCENDA, E. Beware of breaks in exchange rates: evidence from European transition countries. *Economic Systems*, 2005, 29(3), pp. 307–324.

KOCENDA, E. AND VALACHY, J. Exchange rate volatility and regime change: a Visegrad comparison. *Journal of Comparative Economics*, 2006, 34(4), pp. 727–753.

LEVY-YEYATI, E. AND STURZENEGGER, F. Classifying exchange rate regimes: deeds vs words. *European Economic Review*, 2005, 49(6), pp. 1603–1635.

PHIRI, A. Nonlinear Relationship between Exchange Rate Volatility and Economic Growth. *Journal of Economics and Econometrics*, 2018, 61(3), pp. 15–38.

REY, S. Effective Exchange rate Volatility and MENA countries' exports to E.U. *Journal of Economic Development*, 2006, 31(2), pp. 23–54.

ROSE, A. K. Explaining exchange rate volatility: an empirical analysis of "the holy trinity" of monetary independence, fixed exchange rates, and capital mobility. *Journal of International Money and Finance*, 1996, 15(6), pp. 9254–945.

SCHNABL, G. Exchange rate volatility and growth in small open economies at the EMU periphery. *Economic Systems*, 2008, 32(1), pp. 70–91.

SELMIA, R., BOUOIYOUR, J., AYACHI, F. Another look at the interaction between oil price uncertainty and exchange rate volatility: the case of small open economies. *Procedia Economics and Finance*, 2012, 1, pp. 346–355.