

Asymmetric Causality between Exchange rate and Interest rate differentials: A test of International Capital Mobility

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ABSTRACT

The study employs asymmetric causality to re-investigate the causal relationship between exchange rate and interest rate differentials in emerging economies. We simulate critical values based on the leverage bootstrapping and asymmetric causality test. The result of the asymmetric causality reveals that positive shocks (decrease) in the exchange rate causes positive shocks (increase) in the interest rate in the Malaysian economy. The associated increase in the domestic interest rate leads to increase capital inflow into Malaysia. The result further indicates that increase in the exchange rate will cause decrease in the domestic interest rate in Malaysia, Nigeria and South Africa. Meaning that increase in their exchange rate during bad period will lower their capital inflow due to low rate of return to the foreign investors. Furthermore, a decrease in the domestic interest rate in Nigeria influences increase in the exchange rate during the bad time. This causes fall in the demand for the domestic currency from foreigners. The policy implication is that Malaysian policymakers can control capital outflow and encourage inflow during both good and bad times through manipulating the domestic exchange rate. However, the monetary authority in Nigeria can only control the nation's capital mobility during bad times whereas, in South Africa the monetary policy can only influence capital mobility through a close watch on the domestic interest rate by manipulating the exchange rate in the bad time.

Keywords: Asymmetric causality, leverage bootstrap, Toda-Yamamoto, Exchange rate, interest rate differential.

JEL Classification: C15, C18, F21

1. Introduction

The causal linkage between exchange rate and interest rate has been conflicting for the past three decades (Hnatkowska, Lahiri & Vegh, 2013). This affects policy formulation especially on the nation's capital mobility. The negative relationship between the variables is justified in some previous studies based on portfolio reallocations in the interest rate and expected asset returns in the uncovered interest rate parity condition while the positive relationship is accounted by the flexibility of

the perfect prices based on Fisher hypothesis. This is closely related to the long run condition when money market is seen as a source of fluctuations in the exchange rate.

However, the previous literatures on the exchange rate and interest rate causal relationship used a restrictive assumption of equal response to both positive and negative shocks when testing causality despite, the asymmetric information hypothesis where the response to negative and positive shocks are expected to vary across the two regimes. Moreover, the previous studies examine the properties of the time series variables without considering the effect of the structural breaks especially in the emerging countries where the data generating process is characterized by structural changes.

In the light of the above, this paper differs from the earlier studies in the following ways: unlike the recent study by Hacker, Karlsson and Mansson (2014) who employ a wavelets analysis and Vector Autoregressive (VAR) impulse response causality test in the context of Sweden, Choi and Park (2008) who study causality between interest rate and exchange rate in four Asian countries using VAR and Dąbrowski, Papież & Śmiech (2015) who used country specific bootstrap critical values and Wald test on panel Granger causality based on Seemingly Unrelated Regression (SUR) to study the causal relationship between nominal exchange rates and monetary fundamentals in Central and Eastern European countries, the present study applies the asymmetric leverage causality method to distinguish between the existence of causality in good and bad times. The employed procedures work better when normality assumption is violated and in the presence of ARCH effect. The methods also solve the problem of nuisance parameter estimates and size distortion under small sample size (Guru-Gharana, 2012 and Hacker & Hatemi-J, 2006). To the best of our knowledge, this study is among the first to be conducted on the emerging economies of Malaysia, Nigeria and South Africa using the leverage bootstrap asymmetric causality in addition to the potent Toda-Yamamoto (1995) causality approach. Moreover, the study estimates four variables vector to avoid estimation bias associated with previous studies that mostly employed bivariate models.

The remaining part of the paper is structured as follows: the next section offers the review of literature and theoretical framework; Section 3 describes data and methodology; Section 4 deals with the empirical findings and Section 5 presents the conclusion and policy implication of the study.

2. Literature Review and Economic Theory

Despite the presence of literature on the causality between interest and exchange rates, yet the inconclusive findings prompted Ko (2010) to still seek for more clear and direct nature of causality in the model of exchange rate fundamentals. The relationship between interest and exchange rates has not been clear for the past thirty years (Hnatkowska et al., 2013). The nature of this relationship is cherished especially in the measurement of nation's capital mobility. Some studies report bidirectional causality between interest and exchange rates. Such studies include Awe (2012); Dash (2004); Hacker et al., (2014); Paramati and Gupta (2013) and Srinivasan, Kalaivani & Devakumar (2014).

Awe (2012) uses a pairwise causality test on seven macroeconomic variables. The result confirms the existence of two ways causation between interest rate and

exchange rate in Nigeria. Dash (2004) and Paramati and Gupta (2013) explore the causality between interest and exchange rates relationships. The findings show the existence of feedback causality between interest rate and exchange rate in the two sample periods. Hacker et al. (2014) reveal a feedback causation among interest rate differentials and exchange rate in the long run without any causality in the short run. Kayhan, Bayat & Uğur (2013) examine dynamics in the real exchange and interest rates. The test shows a two-way causation between interest rate and exchange rate in Turkey using non-linear Granger causality approach whereas, using frequency domain methodology the relationship tend to disappear in Turkey. Furthermore, unidirectional causation exists in China under both the techniques while, the relationship exist only in the non-linear approach in India. However, bidirectional relation is found in Brazil and India under the frequency domain approach.

Another strand of the debate in the literature is the argument on the unidirectional causality between interest and exchange rates. The vast majority of the literature report an initial causality running from interest rate to exchange rate. This is evident in the studies of Adrangi and Allender (1995); Choi and Park (2008); Hatemi-J and Irandoust (2000); Kisaka, Kithitu and Kamuti (2014); Ko (2010); Olatunji, Sunday and Omolara (2012) and Pi-anguita (1998).

Adrangi and Allender (1995) examine causality between interest rate and exchange rate in the United States. The result shows a unidirectional causality running from interest rate differential to exchange rate without any feedback. A similar finding is obtained by Kisaka et al. (2014) and Pi-Anguita (2014) in Kenya and France respectively. The direction of the causality changes in France immediately after capital control lifting. Choi and Park (2008) investigate exchange rate stability and monetary policy appropriateness in four Asian countries. The result shows that except for Malaysia there exist no causal relationship in the other countries. However, using full sample data, the result shows unidirectional causality in all the countries except for Malaysia. Hatemi-J and Irandoust (2000) re-examine the hypothesis of international capital mobility in Sweden. The finding reveals a unidirectional causation running from interest rate to exchange rate without reverse effect on the interest rate. Ko (2010) finds unidirectional causation under full sample period running from the interest rate to exchange rate in France and Japan. Similar result prevails in the United Kingdom, France, and Japan in the early sample period.

Interest rate like other macroeconomic fundamentals also shows absence of causation from any direction with exchange rate in some studies. This is reported in Alimi and Ofenyelu (2013); Ashfan and Batul (2014); Gupta, Chevalier and Sayekt (2000); Hamrita and Trifi (2011) and Mok (1993). According to Ashfan and Batul (2014) the test of Granger causality between interest rate and exchange rate using autoregressive distributed lags model yield no causal relationship from any of the variables. Alimi and Ofenyelu (2013) revisited the Fisher hypothesis using Toda-Yamamoto methodology. The result could not reject the null that there exist no causality among interest rate and exchange rate and vice versa. Gupta et al. (2000) and Mok (1993) explore the nature of causality among interest rate, exchange rate, and stock prices. The findings unanimously indicate that interest rate does not cause exchange rate and the other way round. In a panel of twelve countries, Hamrita and Trifi (2011) also discover the absence of causality between the interest rate and exchange rate.

The economic theory employed to explain the phenomenon is the monetary theory of exchange rate determination. The theory originates from the “purchasing power parity (PPP)” without which exchange rate equilibrium cannot be determined (Cassel, 1916). However, the PPP theory could not explain the phenomenon of money market and balances of foreign payment in the determination of exchange rate (Kanamori & Zhao, 2006). The monetary approach to exchange rate determination explains the significance of money and other variables (assets) in defining the factors responsible for determining exchange rate under flexible regime and balance of payment under pegged regime (Frenkel, 1976 in Frenkel & Johnson, 2013). Frenkel (1976) argues that high domestic interest rate attracts new capital in form of savings and investment from abroad which leads to increase in aggregate demand for domestic currency. This causes appreciation of exchange rate relative to its steady state level. Furthermore, Eun and Resnick (2007) argue that exchange rate is caused by relative interest rate between two countries. They state that under the interest rate parity framework, a higher domestic interest rate will cause exchange rate appreciation in the domestic economy. This is similarly reported in the Mundell-Fleming model of exchange rate. Nonetheless, Dornbusch (1976) argues that increase in interest rate leads to a decrease in the demand for real balances which causes a rise in exchange rate levels.

3. Data and Methodology

3.1 Data

The study employs annual time series data from 1970 to 2013 for Malaysia, Nigeria and South Africa. The data on exchange rate, interest rate, inflation rate and income (real gross domestic products) were collected from the World Development Indicators (WDIs). The U.S. counterpart of the series are considered as the foreign variables in the model. The other variables apart from exchange rate and interest rate are seen as controlled variables in the estimation process.

3.2 Unit Root

The methodology of Toda-Yamamoto (1995) is applicable regardless of the integration properties of the variables (Hacker & Hatemi-J, 2006 and Toda & Yamamoto, 1995). However, in an attempt to determine the maximum order of integration as pre-requisite for estimating Toda-Yamamoto causality, the study employs the Lee and Strazicich (2013) minimum Lagrange Multiplier (LM) with one structural break to determine the maximum order of the integration. According to Lee & Strazicich (2013), the present unit root test differ from the traditional test in that the test is break point nuisance invariant under null and alternative hypothesis, unaffected by neither size nor location distortion. Furthermore, the test is free from spurious rejection and unaffected by the size and incorrect estimation whether the break exist or not.

3.3 Toda-Yamamoto Causality

The study uses Toda-Yamamoto (1995) methodology based on the augmented VAR ($p+d_{max}$) model to determine the causality between exchange rate and interest rate in Malaysia, Nigeria and South Africa. The model performs better; if there is no omitted important variable bias, the appropriate lag lengths are employed and a reasonable sample size is utilized (Zapata & Rambaldi, 1997). Therefore, following Toda and Yamamoto (1995); Shan and Sun (1998) and Zapata and Rambaldi (1997) methodology, the VAR system outlined below is estimated:

$$\begin{bmatrix} EXC_t \\ r - r_t^* \\ \pi - \pi_t^* \\ y - y_t^* \end{bmatrix} = \begin{bmatrix} a_0^{EXC} \\ a_0^{r-r^*} \\ a_0^{\pi-\pi^*} \\ a_0^{y-y^*} \end{bmatrix} + \begin{bmatrix} a_{11}a_{12}a_{13}a_{14} \\ a_{21}a_{22}a_{23}a_{24} \\ a_{31}a_{32}a_{33}a_{34} \\ a_{41}a_{42}a_{43}a_{44} \end{bmatrix} \begin{bmatrix} EXC_{t-1} \\ r - r_{t-1}^* \\ \pi - \pi_{t-1}^* \\ y - y_{t-1}^* \end{bmatrix} + \begin{bmatrix} a_{11}a_{12}a_{13}a_{14} \\ a_{21}a_{22}a_{23}a_{24} \\ a_{31}a_{32}a_{33}a_{34} \\ a_{41}a_{42}a_{43}a_{44} \end{bmatrix} \begin{bmatrix} EXC_{t-2} \\ r - r_{t-2}^* \\ \pi - \pi_{t-2}^* \\ y - y_{t-2}^* \end{bmatrix} + \begin{bmatrix} \mathcal{E}_{EXC_t} \\ \mathcal{E}_{r-r_t^*} \\ \mathcal{E}_{\pi-\pi_t^*} \\ \mathcal{E}_{y-y_t^*} \end{bmatrix} \quad (1)$$

where EXC denotes exchange rate, r represents domestic interest rate, π denotes inflation rate, and y represents income whereas, the variables with asterisk represent the foreign counterpart. To test the null hypothesis of whether interest rate causes exchange rate or not, the following restriction is specified $H_0 a_{12} = 0$ where a_{12} is the coefficient of the restricted lag value of interest rate variable in the model. Similarly, the second hypothesis that exchange rate does not causes interest rate is tested by imposing the following restrictions: $H_0 a_{11} = 0$ where a_{11} is the coefficient of the lag value of the exchange rate. The significance of the MWALD statistics on the lagged values of the explanatory variables in the two hypotheses respectively indicate the rejection of the null hypotheses of no Granger causality from interest rate differential to exchange rate and vice versa.

The appropriate lag length is chosen through testing the significance of the lags in Equation 1 for $p > k$ condition (Toda & Yamamoto, 1995) and minimizing the Hatemi-J (2003) information criterion described below.

$$HJC = \ln\left(\left|\widehat{\Gamma}_z\right|\right) + z \times v^2 \left(\frac{\ln N + 2\ln(\ln N)}{2N}\right) \quad z = 0, \dots, p. \quad (2)$$

where HJC is the Hatemi-J information criterion, \ln is the natural logarithm, $\left|\widehat{\Gamma}_z\right|$ represent the lag order z determinant of the estimated white noise variance-covariance matrix in the VAR framework, v and N denote the number of variables and observations used in the VAR model respectively. Furthermore, Equation 2 has been tested to work better especially if integration exist among the variables (Hatemi-J, 2003).

However, when normality assumption is not fulfilled, and the effect of autoregressive conditional heteroscedasticity exist, the usual asymptotic distribution theory does not work well (Hatemi-J & Irandoust, 2006 and Hatemi-J, 2012). Therefore, the more reliable leverage distribution theory and asymmetric causality are employed in this kind of finite sample to avoid size distortion and spurious inferences.

3.4 Test for Asymmetric Causality

We checked asymmetric causality following Hatemi-J (2012). The above process will be replicated, assuming $y^+ = (y_{1t}^+, y_{2t}^+)$ and $y^- = (y_{1t}^-, y_{2t}^-)$. The following VAR(p) order is applied as shown in Equations 3 and 4.

$$y_t^+ = \mathcal{G} + A_1 y_{t-1}^+ + \dots + A_p y_{t-1}^+ + e_t^+ \quad (3)$$

$$y_t^- = \mathcal{G} + A_1 y_{t-1}^- + \dots + A_p y_{t-1}^- + e_t^- \quad (4)$$

here y_t^+ and y_t^- represent vector of positive and negative variables. These include: exchange rate, interest rate differential, inflation differential and income differential

for both positive and negative aspects. ϑ is a vector of constant parameters. The symbol A is a vector of parameters to be estimated and e_t^+ and e_t^- denote the vector of both positive and negative error components for the cumulative sum of positive and negative shocks respectively in the integrated variables analysis and positive and negative changes in the stationary variables. The information criteria in Equation 2 is also adjusted to include the square of the number of observation in the equations N^2 in the VAR model (Hatemi-J, 2012). The remaining process is as presented in the previous and subsequent sections while taking into account asymmetric condition of positive and negative shocks in the model.

3.5 Bootstrap Procedure

The asymmetric causality and leverage bootstrap critical values are generated using GAUSS based on the program procedure developed in Hatemi-J (2012) and Hacker and Hatemi-J (2010) respectively. The critical values are generated using the underlying empirical data through bootstrap simulation. The iteration is conducted 10,000 times and *MWALD* t -statistics are estimated after every iteration to determine the upper $(\alpha)^{th}$ quantile of the bootstrapped distribution of the *MWALD* t -statistics in order to generate 1%, 5% and 10% bootstrapped critical values. Finally, the raw data rather than the bootstrapped one is utilized to calculate the *MWALD* statistics. The hypothesis of no Granger causality is rejected if the *MWALD* statistics calculated using the original data is greater than the bootstrapped critical values (C_α^*).

5. Empirical Results

Despite the fact that the methodology of Toda-Yamamoto causality is robust regardless of the stationarity properties of the series, yet the maximum order is required in modeling the augmented VAR ($p+d_{max}$) framework. Therefore, the maximum order of integration of the time series properties of the variables is investigated using LS test (Lee & Strazicich, 2013). The result is presented in Table 1 below:

Table 1
Lee and Strazicich One-Break Minimum Lagrange Multiplier (LM) Unit Root Test

Variables	Model A					Model C				
	\hat{k}	\hat{T}_a	$\hat{t}_{\gamma j}$	<i>Test Statistic</i>	λ	\hat{k}	\hat{T}_a	$\hat{t}_{\gamma j}$	<i>Test Statistic</i>	λ
MALAYSIA										
<i>EXC</i>	1	2009:01	-1.417	-1.652	-.03	1	1999:01	2.610**	-3.649	.06
$r - r_t^*$	1	2005:01	-.318	-2.595 ^b	-.01	1	1998:01	-3.910***	-5.152 ^a	-.09
$\pi - \pi_t^*$	1	1979:01	-.820	-4.197 ^b	-.02	1	1975:01	-2.777***	-5.463 ^a	-.07
$y - y_t^*$	1	1985:01	-3.831***	-2.348	-.09	1	1985:01	.420	-3.098	.01
NIGERIA										
<i>EXC</i>	1	1998:01	11.375***	-1.538	.27	1	1997:01	3.764***	-2.946	.09
$r - r_t^*$	1	1988:01	-1.303	-4.518 ^a	-.03	1	1987:01	-4.715***	-6.060 ^a	-.11
$\pi - \pi_t^*$	1	1982:01	1.455	-4.234 ^b	.03	1	1987:01	-2.129**	-4.521 ^b	-.05
$y - y_t^*$	1	1991:01	-1.137	-1.411	-.04	1	1988:01	3.725***	-3.005	.09

S/AFRICA										
<i>EXC</i>	1	2001:01	3.223***	-3.637 ^b	.08	1	1997:01	2.292**	-3.863	.05
$r - r_t^*$	1	1993:01	1.314	-4.007 ^b	.03	1	1990:01	3.884***	-5.296 ^a	.09
$\pi - \pi_t^*$	1	1980:01	1.481	-2.583	.04	1	1989:01	-2.692***	-4.041	-.06
$y - y_t^*$	1	1980:01	-3.121***	-2.678	-.07	1	1988:01	2.694***	-3.502	.06
Critical values		1%	5%	10%						
Model A		-4.239	-3.566	-3.211						
Model C		-5.110	-4.500	-4.210						

Note: \hat{k} is the optimal number of lagged first-difference terms included in the unit root test to correct for serial correlation. $\hat{\tau}_B$ denotes the estimated break points. $\hat{\tau}_{p,j}$ is the t value of DT_{jt} , for $j=1$. λ is the critical value break point. See Lee and Strazicich

(2013) page 2488, for the critical values. a, b and c indicates significance of the LM test statistics at 99%, 95% and 90% critical level, respectively. While ***, ** and * indicates the two-tailed significance level of the break date at 99%, 95% and 90% respectively.

Source: *Authors' computation*

Table 1 above represents the stationarity analysis of the variables under study. The test is important in determining the highest order of integration of the variables, a necessary requirement to efficiently estimate the Toda-Yamamoto (1995) modified WALD test. Although some variables are found stationary at level in all the countries under both the intercept and trend models, the test establishes that the maximum order of integration of the variables for all countries is found to be $I(1)$ order. It implies that the lag augmentation in estimating Toda-Yamamoto (1995) vector autoregressive model for all the countries is determined as one. This results further allows the opportunity to estimate the cumulative positive and negative shocks of the asymmetric causality analysis.

Table 2

Test for Normality and ARCH effect in the VAR

Country	Normality	ARCH Effect	Optimal Lag Length
Malaysia	.000***	.038**	1
Nigeria	.000***	.013**	1
South Africa	.000***	.013**	1

*** & ** represents significance level at 1% and 5% respectively. The lag length is chosen based on Hatemi-J information criterion.

Source: *Author's Computation*

From Table 2 above the normality and autoregressive conditional heteroscedasticity (ARCH) tests in the VAR model show that the null hypotheses of both the normality and ARCH effect are rejected for all countries under study. Therefore, the inability of the models to fulfill the normality assumption and the existence of ARCH effect, render the usual asymptotic distribution theory to be less relevant (Hatemi-J & Irandoust, 2006 and Hatemi-J, 2012). Furthermore, using the asymptotic distribution theory in this scenario would result to size distortion and nuisance parameter estimates in establishing causality (Hacker & Hatemi-J, 2006). Thus, this study employs the more

reliable leverage distribution theory and asymmetric causality test which perform better in the presence of non-normality and ARCH effect.

Table 3
Asymmetric Dynamic Toda-Yamamoto Causality and Bootstrap Simulation

The null hypothesis	Non-Granger causality	MWALD t -statistics	Leverage Bootstrap		
			1% CV	5% CV	10% CV
MALAYSIA					
$r - r_t^* \neq > EXC$	0.846 (.358)	1.215	8.038	4.384	2.982
$r - r_t^{*+} \neq > EXC^+$		2.095	10.242	4.520	2.924
$r - r_t^{*-} \neq > EXC^-$		0.339	9.407	4.487	2.904
$EXC \neq > r - r_t^*$	0.811 (.368)	23.234***	9.968	4.438	2.868
$EXC^+ \neq > r - r_t^{*+}$		48.448***	13.659	4.659	2.806
$EXC^- \neq > r - r_t^{*-}$		3.336*	7.937	4.226	2.898

***, ** & * represent rejection of the null hypothesis at 1%, 5% and 10% significant level respectively, with reference to bootstrap simulated critical values. The symbol $\neq >$ represents Granger non-causality. The figures enclose in parenthesis under column two represent the p values of Granger non-causality.

Source: Authors computations

Table 4
Asymmetric Dynamic Toda-Yamamoto Causality and Bootstrap Simulation

The null hypothesis	Non-Granger causality	MWALD t -statistics	Leverage Bootstrap		
			1% CV	5% CV	10% CV
NIGERIA					
$r - r_t^* \neq > EXC$	1.552 (.213)	3.653*	7.304	4.126	2.878
$r - r_t^{*+} \neq > EXC^+$		2.113	8.709	4.355	2.873
$r - r_t^{*-} \neq > EXC^-$		2.879*	8.736	4.292	2.814
$EXC \neq > r - r_t^*$	0.593 (.441)	12.341***	7.651	4.279	2.949
$EXC^+ \neq > r - r_t^{*+}$		1.865	10.077	4.584	3.059
$EXC^- \neq > r - r_t^{*-}$		4.852**	10.252	4.477	2.862

***, ** & * represent rejection of the null hypothesis at 1%, 5% and 10% significant level respectively, with reference to bootstrap simulated critical values. The symbol $\neq >$ represents Granger non-causality. The figures enclose in parenthesis under column two represent the p values of Granger non-causality.

Source: Authors computations

Table 5

Asymmetric Dynamic Toda-Yamamoto Causality and Bootstrap Simulation

The null hypothesis	Non-Granger causality	MWALD <i>t</i> -statistics	Leverage Bootstrap		
			1% CV	5% CV	10% CV
SOUTH AFRICA					
$r - r_t^* \not\Rightarrow EXC$	0.067 (.793)	4.010*	7.412	4.228	2.941
$r - r_t^{*+} \not\Rightarrow EXC^+$		0.166	11.869	7.216	5.499
$r - r_t^{*-} \not\Rightarrow EXC^-$		0.837	9.101	4.468	2.947
$EXC \not\Rightarrow r - r_t^*$	0.003 (.956)	0.579	7.685	4.281	3.036
$EXC^+ \not\Rightarrow r - r_t^{*+}$		2.311	12.636	7.393	5.568
$EXC^- \not\Rightarrow r - r_t^{*-}$		4.852**	9.521	4.416	2.848

***, ** & * represent rejection of the null hypothesis at 1%, 5% and 10% significant level respectively, with reference to bootstrap simulated critical values. The symbol $\not\Rightarrow$ represents Granger non-causality. The figures enclose in parenthesis under column two represent the *p* values of Granger non-causality.

Source: *Authors computations*

Table 3, 4 and 5 show the results of Granger and Toda-Yamamoto asymmetric causality for Malaysia, Nigeria and South Africa respectively. The estimated order of the VAR ($p+d_{\max}$) model is determined to be two for all the countries. This is made up of the VAR order *p* which is estimated to be one and a constant one lag augmentation, the fact that the maximum order of integration does not exceed one for all series. The Granger non-causality results indicate that none of the tests in all the countries show any evidence of causation from either of the variables. However, the traditional test was conducted based on VAR asymptotic critical values which leads to a spurious inference. Moreover, Sims, Stock & Watson (1990) and Toda & Philips (1993) argue that the null hypothesis of the integrated Granger causality suffer from independence of nuisance parameter estimates whereas, the null hypothesis of level variables suffer from the non-standard asymptotic distribution. In the case of Toda-Yamamoto MWALD statistics the results indicate the existence of unidirectional causality from exchange rate to interest rate differentials in Malaysia, bidirectional causality in Nigeria and a unidirectional causality from interest rate differentials to exchange rate in South Africa. However, Hatemi-J (2012) argues that the response to positive and negative asymmetric shocks may leads to varying causal relationship which has not been explore in the previous studies. In other words, the asymmetric causality test differentiate between the nature of causality during good and bad times.

Nonetheless, the result of the asymmetric causality test reveals that positive shocks (decrease) in the exchange rate causes positive shocks (increase) in the interest rate in the Malaysian economy. The associated increase in the interest rate differentials leads to increase capital inflow into Malaysia. The result further indicates that increase in the exchange rate will cause decrease in the domestic interest rate in Malaysia, Nigeria and South Africa. The result implies that increase in the countries' exchange rate in relation to US dollar during bad period will lower the capital inflow into the economies due to low rate of return to the foreign investors. Furthermore, a decrease in the domestic interest rate in Nigeria influences increase in the exchange rate during the bad times. This causes fall in the demand for the domestic currency from foreigners due to low

interest rate. This result is in line with the concept of interest rate parity, the Frenkel (1976) argument and Mundell-Fleming model of exchange rate.

6. Conclusions

We estimate asymmetric causality in addition to MWALD test based on leverage bootstrapping conducted on Toda-Yamamoto causality approach. The existence of ARCH effect and non-normal distribution lead to spurious inferences when asymptotic critical values are used. This is seen when the traditional Granger causality is estimated where there exist no causal relationship between exchange rate and interest rate differentials in all the countries under study. The major contribution of this study is that we distinguish causality between the positive and negative shocks scenarios using data from emerging economies. The findings based on the asymmetric causality confirm the existence of the Frenkel (1976) flexible version of the monetary theory of exchange rate determination, the Mundel-Fleming model of exchange rate and the interest rate parity in the context of Malaysia, Nigeria and South Africa respectively.

The asymmetric causality results reveal that both positive and negative cumulative shocks in exchange rate causes the respective cumulative positive and negative shocks in interest rate in Malaysia. The later also holds for Nigeria and South Africa with a feedback running from the cumulative negative shock in interest rate differential to exchange rate in Nigeria. The policy implication is that Malaysian policymakers can control capital outflow and encourage inflow during both good and bad times through manipulating the domestic exchange rate. Any policy towards exchange rate appreciation can equally causes increase in the domestic interest rate thereby encouraging capital inflow and controlling capital outflow in Malaysia. However, in the Nigerian scenario, the monetary authority can only have control on the nation's capital mobility during bad times. The findings further show that Nigeria can attain exchange rate appreciation by lowering the domestic interest rate during the bad time. This is in line with Dornbush (1976) who argue that decrease in interest rate leads to increase in demand for real balances which causes exchange rate appreciation. In South Africa the monetary policy can only influence capital mobility through a close watch on the domestic interest rate by manipulating the domestic exchange rate in the bad time.

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