A re-examination of the exchange rate – interest rate differential relationship in Ghana

Ofori, Isaac Kwesi and Armah, Mark Kojo

University of Cape Coast

11 May 2021

A re-examination of the exchange rate – interest rate differential relationship in Ghana

Isaac Kwesi Ofori[a,*]

School of Economics,
University of Insubria,
Via Monte Generoso, 71, 21100, VA, Varese, Italy.
isaac.ofori1@ucc.edu.gh; ikofori@uninsubria.it;
+393207953101

Mark Kojo Armah[b]

Department of Data Science and Economic Policy
School of Economics,
University of Cape Coast, Cape Coast, Ghana.
marmah@ucc.edu.gh

Abstract

This paper revisits the exchange rate and interest rate differential relationship since Ghana adopted the inflation targeting regime. Using macro-data spanning 2002 to 2019 for Ghana and the United States, we show the nonexistence of the relationship in both the short-run and long-run. Further, we show a positive but slow responsiveness of exchange rate to interest rate differential shocks from the short-run to medium term. The long-run result however shows a case of a strong and significant response of exchange rate to interest rate differential shocks. We recommend that the Bank of Ghana address perennial macroeconomic instability, especially on inflation which we conjecture to fuel investment uncertainty and investment insensitivity to interest rate.

KEY WORDS: *Inflation Targeting, Exchange Rate, Impulse Response Function, Interest Rate Differential, VAR, Ghana.*

1. Introduction

The relationship between exchange rate and interest rate has been of prime importance to policymakers, trade players and academics alike. The significance of these variables stems from the fact that exchange rate is a major driver of investment and trade across borders (Hnatkovska et al;2013). The interest rate parity condition posits that interest rate differentials could trigger substantial flow of capital across borders which in turn can have profound impact on exchange rate movement. Additionally, it has been established that a flexible exchange rate regime has implications for commodity arbitrage, financial innovation, and cross-borders portfolios movements (McDonalds & Hallwood, 2008). The theoretical foundation for the exchange rate and interest rate link stem from the sticky-price and flexible-price models (Dornbusch, 1976). Further theoretical grounds are the arguments put forward by Frankel (1979), and Meese and Rogoff (1988) linking exchange rate and interest rate differentials to the international parity conditions, expectation and rapid adjustment in capital markets. In the developing world, understanding exchange rate and interest rate differentials is crucial because it helps in controlling the formation of expectations, and macroeconomic performance. It is in this regard that emerging economies have, among others, resorted to either inflation targeting, interest rate targeting or exchange rate targeting in a bid to ensuring macroeconomic stability (Holtemöller & Mallick, 2016). This implies that, lack of a clear and comprehensive understanding of the relationship between the two variables poses serious monetary policy concerns for policymakers (Andrieş et al., 2017).

Conspicuously, the link between the two variables have not been revisited since Ghana adopted the Inflation Targeting (IT) framework. In May 2007, Ghana officially became the second country in Sub-Saharan Africa after South Africa to adopt IT framework. The decision by the monetary authorities to adopt the IT regime centred on the notion that: (a) IT minimizes the problem of 'inflation bias' that arises thrives under uncertainty; (b) IT by providing a nominal anchor for monetary policy reduces variability, enhances inflation forecasting by reducing the level of expected inflation and/or increasing its predictability (Miskin, 2007). It is therefore expected that in IT regime, interest rate is bid down which in effect, can reduce frequent exchange rate variability. However, since Ghana adopted the IT regime, policymakers are still unaware of the relationship. The debate on the two since the adoption of IT is only gleaned from public discourse without empirical evidence. This study therefore makes useful contributions to knowledge on three counts. First, the study provides evidence on the existence or otherwise of the exchange rate and interest rate differential relationship. Second, we provide evidence on the short-run and long-run link between exchange rate and interest rate differential. Third, we provide evidence on the responsiveness of exchange rate to a shock in interest rate differential.

Ghosh et al. (2016) argue that in emerging economies, while exchange rate plays a crucial role on economic fundamentals, the short-run interest rate is the typical policy instrument policymakers use to affect currency values. Analyses of the co-movement between these two variables is therefore crucial in policy sense. Further, exchange rate and interest rate differential in the short-run is expected to deviate substantially from

long-run due to the cyclical macroeconomic instability or weak fundamentals. This suggests the need to consider cointegration and autoregressive techniques in the analyses of the Ghanaian context. The rest of the paper is organised as follows. Section 2 presents a brief literature review. Theoretical models underlying the econometric analysis are provided in section 3. The empirical analysis is presented in section 4, whilst section 5 concludes the study.

2. Brief Literature Review

Earlier researches which model exchange rate movement as a function of interest rate differential and other macroeconomic variables in advanced countries is evident in the literature[1]. For example, Wu (1999) provides empirical evidence from Johansen cointegration approach to show a long-run relationship between exchange rate and interest rate differential in the case of Germany and Japan. However, using the generalized method of moment technique, Meese and Rogoff (1988) found no such evidence either in the short-run or long-run in USA, Germany, Japan, and the United Kingdom. Moreover, Hacker et al. (2012) explored the relationship between exchange rate and interest rate differentials at different timescales, and provided evidence to conclude that, over a year, the link between the two is negative at shorter time horizons and positive in the longer horizons. The difference in these results is plausibly due the use of different empirical techniques, the degree capital mobility, the type of monetary framework, and economic structure. Providing other alternative, Nakagawa (2002) argues that the failure of the sticky price model prediction in recent times is due to the failure to recognize the nonlinearity in the exchange rate adjustment[2]. Using the wavelet analysis, Andrieș et al. (2017) revisited the subject matter in Romania. They provided convincing evidence to show that the association between interest rate and exchange rate behaves differently in the short-run and long-run. In a related work, Li and Wong (2011) use the bivariate structural vector autoregressive (SVAR) approach in examining the possibility of a contemporaneous relationship between interest rate differential and change in real exchange rate in twelve countries[3]. The results show that out of the twelve countries, nine shows the expected negative relationship of which there is empirical evidence for just three. Likewise, only three countries showed evidence from the impulse response analyses that a positive real interest rate differential shock can generate a negative initial effect to the real exchange rate.

3.The Theoretical Model

Following Hooper and Morton (1982), we present the exchange rate variability as chiefly influenced by interest rate differential, current account differential, and foreign price level.

$$q_t = \propto + \delta^* rd_t + \omega^* cd_t + \lambda p *_t + \varepsilon \quad (1)$$

[1] See Hooper and Merton (1982), Frankel (1979), Isard (1987) among others

[2] Nakagawa's result tends to support most studies, for example, Chortareas and Driver (2001).

[3] United Kingdom, Germany, Iceland, Canada, Chile, Japan, Korea, Singapore, Thailand, China, India

Where q_t is the bilateral exchange rate; rd_t which is interest rate differential; and cd_t is the current accounts differential. In addition, the increase in the domestic current account relative to that of the foreign country, results in the appreciation of the local currency.

3.2 Estimation Strategy

First, we specify two models with (2) as a bivariate model per the thrust of the paper while in (3), we incorporate current account differential to determine its effect on the exchange rate.

$$s_t = \alpha_0 + \alpha_2 ii_t + \mu_t \qquad (2)$$

$$s_t = \alpha_0 + \alpha_1 s_{t-1} + \alpha_2 ii_t + \alpha_3 caca_t + \alpha_4 p*_t + \mu_t \qquad (3)$$

Where s_t is the cedi-dollar exchange rate in IT regime; ii_t is the interest rate differential between Ghana and the USA in IT regime; $caca_t$ is the current account differential between Ghana and the USA in IT regime; and $p*_t$ is the USA price level.

Second, coming from the background of the theorized short-run and long-run movements of the cedi-dollar exchange rate, the study applied the autoregressive distributed lag technique to equation 4 (see, Pesaran, Shin & Smith, 2001).

$$\Delta s_t = \delta_0 + \emptyset s_{t-1} + \alpha_1 ii_{t-1} + \alpha_2 caca_{t-1} + \alpha_3 lnp*_{t-i} + \sum_{i=1}^{\rho} \beta_1 \Delta s_{t-i} + \sum_{i=1}^{\rho} \beta_2 \Delta ii_{t-i} + \sum_{i=1}^{\rho} \beta_3 \Delta caca_{t-i} + \sum_{i=1}^{\rho} \beta_4 \Delta p*_{t-i} + \varepsilon_t \qquad (4)$$

Where, $\emptyset \; and \; \alpha_i$ represent the long-run elasticities while β_i are the short-run elasticities. Per intuition, the study expects an indirect relationship between exchange rate and interest rate differential in both the long-run and short-run. The same is expected of the link between the exchange and current account differential.

The final value we provide in this study is informing policymakers of the short-run to long-run response of exchange rate to a standard deviation shock to interest rate differential. To do this, we present three vector autoregression (VAR) models obtained from the general VAR(ρ) as seen in equations 5.

$$y_t = \rho Y_{t-1} + \omega_0 x_t + \mu_t \qquad (5)$$

y_t is the $K \times 1$ vector of endogenous variables; ρ is the $K \times Kp$ matrix of coefficients; ω_0 is the $K \times M$ matrix of coefficients; x_t is the $M \times 1$ matrix of coefficients; μ_t is the $K \times 1$ vector of white noise innovations, and Y_t is the $Kp \times 1$ matrix of outcome variables. Given a strong responsiveness of exchange rate to interest rate differential, a significant short-run to long-run impulse response is expected for a shock to interest rate differential.

3.1 Data and variable description

The study uses macro-data spanning 2002 to 2019. Data on nominal exchange rates, nominal interest rates, the current accounts, and consumer price indices of the two

countries were sourced from the International Monetary Fund's International Financial Statistics. The nominal exchange rate is captured as the bilateral cedi-dollar rate; annual inflation rate is proxied by the consumer price indices for Ghana and United States of America; the currents account is defined as the ratio of current account to GDP while the treasury bill rates proxied the nominal interest rates.

4.0 Results and Discussion

4.1 Summary statistics

Summary statistics was presented to show the location, variability and the distribution of the data. The summary statistics shows that but for the current account differential, all the variables have positive average (Table 1). For instance, the average interest rate differential between Ghana and United States of America was 19 percent while the average nominal exchange rate of the cedi to the dollar was 2.2. The standard deviations showed minimal variability in the series used.

Table 1: Summary Statistics

Variable	Obs	Mean	Std.Dev.	Min	Max
ca	18	-5.838	3.730	-12.492	1.332
ca*	18	-2.553	1.533	-5.817	0.150
i	18	23.289	9.270	10.500	45.000
i*	18	2.277	3.140	0.390	5.020
s	18	2.219	1.655	0.720	6.032
ii	18	19.113	9.428	2.000	39.750
caca	18	-3.285	3.733	-10.077	5.839
p*	18	2.282	2.465	-0.356	5.490

***Note**: Std Dev. represents Standard Deviation while Obs stands for Observation; s is nominal exchange rate; ii is interest rate differential; caca is current account differential; p* is foreign inflation rate; i is domestic interest rate; i* is foreign interest rate; ca is domestic current account balance; and ca* is the foreign current account balance.*

4.2 Unit root tests

To clear any doubt of spurious regression, we use Augmented Dickey and Fuller (1979), and Phillips and Perron (1988) to test the statistical properties of the variables. The results for these tests with intercept are provided in Tables 2 and 3 respectively. The rejection of the null hypothesis of non-stationarity is based on the MacKinnon (1996) critical values. From the results, all the variables are integrated at order one permitting the application of autoregressive techniques.

Table 2: Results of Unit Root Test with Trend and constant: ADF Test

Level		First Difference	
Variables	**ADF-Statistics**	**Variables**	**ADF-Statistics**
s	5.143[1.000]	s	-3.238[0.0179]**
caca	-3.621[0.0054]***	Δcaca	-8.601[0.0000]***
ii	-2.142 [0.2279]	Δii	-6.296 [0.0000]***
p*	-4.681[0.0001]***	Δp*	-14.11[0.0000]***

*** p<0.01, ** p<0.05, * p<0.1*; Δ denotes the first difference; P-values in parenthesis*

Table 3: Results of Unit Root Test with constant and trend: PP Test.

Level		First Difference	
Variables	**ADF-Statistics**	**Variables**	**ADF-Statistics**
s	6.247[1.000]	s	-3.267[0.0164]**
caca	-3.741[0.0036]***	Δcaca	-8.565[0.0000]***
ii	-2.161[0.2208]	Δii	-6.296 [0.0000]***
p*	-4.731[0.0001]***	Δp*	-16.71[0.0000]***

*** p<0.01, ** p<0.05, * p<0.1*; Δ denotes the first difference; P-values in parenthesis*

4.3 Evidence of cointegration on exchange rate and interest rate differential

From Table 4, the F-statistics that the joint null hypothesis of lagged level variables is zero was rejected at 5 percent level of significance. Since the calculated F-statistics of approximately 3.958 exceeded the upper bound's critical value of 3.69, there is an evidence of cointegration among the variables.

Table 4: Bounds test results for cointegration

Critical Value Bound of the F-statistic						
K	90% Level		95% Level		99% Level	
	I(0)	I(1)	I(0)	I(1)	I(0)	I(1)
7	2.72	3.77	3.23	3.69	4.29	5.61
F-Statistics: $F_{(s)}(S\mid$ ii, caca, p $*)$= 3.958 **						

Source: Authors' Computation (2020)

4.4 Finding and discussion

The presentation of our findings starts with the evidence from the ordinary least squares and autoregressive distributed lag techniques in Table 5.

Table 5: Least Squares and Autoregressive Distributed Lag Estimates on Exchange Rate and Interest Rate Differential

VARIABLES	(1) OLS	(2) OLS	(3) ARDL(a)	(4) ARDL(b)	(5) ARDL(c)	(6) ARDL(d)	(7) ARDL(e)
Exchange rate (lag1)			0.126***	0.110***		-0.765***	
			(0.024)	(0.025)		(0.193)	
Interest rate differential	0.001	0.002	0.024		0.010		0.0021
	(0.029)	(0.028)	(0.031)		(0.034)		(0.004)
Interest rate differential (1)				0.010			
				(0.006)			
Current account differential		-0.123*			0.180		0.009
		(0.072)			(0.123)		(0.012)
Current account differential (1)				-0.022**			
				(0.010)			
Foreign price							0.020***
							(0.002)
Foreign price (1)						0.044***	
						(0.015)	
Constant	1.183*	0.871	-0.034	-0.048		-0.056	
	(0.622)	(0.633)	(0.088)	(0.088)		(0.091)	
Observations	18	18	17	17	17	16	16
R-squared	0.000	0.077	0.441	0.543	0.543	0.702	0.702

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

It is evident from our ordinary least squares estimate in Table 5 that interest rate differential is not statistically potent enough to induce appreciation of the cedi though the sign of the coefficient suggests so. This finding concurs that of Li and Wong (2011) who provided evidence to show that the link is largely non-existent in 9 out of 12 countries examined. This also implies that even in IT regime, the BoG is highly unlikely to affect real variables through its policy rate. However, at 90 per cent confidence interval, we show that a 1 percent increase in current account differential leads to an approximate 0.002 per cent appreciation of the cedi. This suggests a more productive Ghanaian economy with growing exports and falling levels of consumption of foreign goods. The second contribution of the paper is in the utilization of autoregressive techniques on the subject matter [see models (3) & (4)]. From model (3), we show that the relationship between the two variables is both unconventional and insignificant in IT regime. Interestingly, the link is even non-existent in the long-run. The result is in contrast with the finding of Andrieș et al. (2017) who found a negative link between the two variables in the BRICS countries. This result is interesting, at least from the short-run results as it suggests loss of investor confident in interest bearing assets in Ghana relative to the USA though the former commands higher interest rates. The result, therefore, does not lend itself to the sticky price argument that an increase in the nominal interest rate of Ghana relative to that of US results in appreciation of the Ghanaian cedi. Additionally, there is empirical evidence that in IT regime, previous year's depreciation of the cedi fuels current's depreciation by 0.1 percent. In model (4), we introduce a term for economic performance, current account differential. Like we observe in the least squares, the contemporaneous effect is significant and suggests a 0.02 appreciation of the cedi relative to the dollar if current account balance of Ghana exceeds that of the USA by 1 percent. This result is similar to the result obtained by Hooper and Morton (1982) which made it clear that exchange rate movement is related to the current account both through the formation expectations about long-run equilibrium real exchange rate and through changes in the risk premium. In models (6) and (7), we acknowledge the impact of commodity arbitrage on exchange rate movements by introducing the general price level of the USA as a proxy for foreign price. We show that there is both short-run and long-run effects that a rise in foreign price leads to a depreciation of cedi relative to the dollar. The contemporaneous effect of a percentage rise in foreign price is 0.04 in the short-run as compared to 0.02 in the long-run. This plausibly underscores the slow rate of economic performance as a chunk of the Ghanaian imports is about consumables. In economies like this, commodity arbitrage can increase even as foreign price rises resulting in marginal depreciation of the local currency. This results in a slump in demand for the Ghanaian cedi causing the depreciation. The reliability of our estimates lies in the series of diagnostics tests which the model passes. The test results are presented in Table 6 and Figure 1.

Table 6: Diagnostic Tests for ARDL Model

Test	F/Chi Version	P-Value
Serial Correlation	1.075	0.299
Normality	0.916	0.175
Heteroscedasticity	35.05	0.110
CUSUM	–	stable
CUSUMSQ	–	stable

*** p<0.01, ** p<0.05, * p<0.1

The response of exchange rate to interest rate-differential shocks

On the third contribution of the paper, we provide results on the response of cedi-dollar exchange rate to a standard deviation shock in the interest rate differential in the IT regime using the vector autoregression approach. Per the focus of the study, we concentrate on the estimates from models (1), (3) and (6) in Table 7.

Table 6: VAR Results of Exchange Rate and Interest Rate Differential Relationship

VARIABLES	*(1) nominal exchange rate*	*(2) interest rate differential*	*(3) nominal exchange rate*	*(4) interest rate differential*	*(5) current account differential*	*(6) nominal exchange rate*	*(7) interest rate differential*	*(9) current account differential*	*(10) foreign price*
nominal exchange rate									
lag(1)	1.132***	5.342	1.018***	2.502	-0.175	3.827	0.851***	2.135	8.191***
	(0.173)	(4.064)	(0.170)	(4.151)	(2.525)	(5.169)	(0.207)	(2.596)	(2.096)
lag(2)	-0.008	-6.488	0.089	-3.654	-0.184	-4.727	-0.172	5.910**	-1.368
	(0.198)	(4.655)	(0.191)	(4.661)	(2.835)	(5.784)	(0.232)	(2.906)	(2.346)
interest rate differential									
lag(1)	0.0004	0.759***	0.001	0.819***	0.028	0.876***	0.002	-0.035	0.079
	(0.007)	(0.169)	(0.006)	(0.163)	(0.099)	(0.165)	(0.006)	(0.083)	(0.067)
lag(2)	-0.001	0.046	-0.002	-0.021	-0.067	-0.0251	-0.001	-0.086	-0.066
	(0.006)	(0.163)	(0.006)	(0.158)	(0.096)	(0.156)	(0.006)	(0.078)	(0.063)
current account differential									
lag(1)			-0.016	0.233	0.501***	0.360	-0.008	0.242*	-0.090
			(0.010)	(0.246)	(0.150)	(0.268)	(0.010)	(0.135)	(0.109)
lag(2),			-0.013	-0.527**	-0.015	-0.524**	-0.010	-0.076	-0.107
			(0.011)	(0.267)	(0.163)	(0.265)	(0.010)	(0.133)	(0.107)
foreign price									
lag(1)						-0.500	0.0123	0.152	0.968***
						(0.541)	(0.021)	(0.272)	(0.220)
lag(1)						0.565	-0.001	-0.414*	-0.024
						(0.500)	(0.020)	(0.251)	(0.203)
Constant	0.0376	4.336**	-0.0172	3.968*	-0.432	3.280	-0.050	0.779	-0.049
	(0.0889)	(2.090)	(0.0842)	(2.049)	(1.247)	(2.081)	(0.083)	(1.045)	(0.844)
Observations	18	18	18	18	18	18	18	18	18

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Similar to the results from the ordinary least squared and autoregressive distributed lag techniques, we find evidence of no exchange rate and interest rate differential relationship (see model 1). From model (6), the interest rate differential effect on the exchange rate is present. There is a strong empirical evidence that a 1 percent increase in the interest rate differential induces a 0.8 percent depreciation of cedi in the very short term. Also, the effect of current account differential is conventional and suggests that a 1 percent increase leads to a 0.5 percent appreciation of the cedi.

Supporting this with the impulse response functions, it is evident that from the short-run to the medium-term, the exchange rate does not respond significantly to a standard deviation shock to interest rate differential. However, in the long-run, an inverse response is evident. Additionally, the exchange rate responds positively but slowly to a standard deviation shock in current account differential from the short-run to the medium-term. The response of exchange rate to a standard deviation shock in current account differential in the long-run is also positive and relatively faster. The impulse response functions are presented as Figure 2 of the appendices. Finally, our model passes the diagnostic test of autocorrelation and model stability as presented in Figure 3 and Table 8 of the appendices

Table 8: Lagrange-Multiplier Test for VAR Model

Test	Chi Statistic	P-Value
Serial Correlation	25.6027	0.429
Normality	26.9935	0.356

*** p<0.01, ** p<0.05, * p<0.1

5. Conclusion and policy recommendations

We conclude that the exchange rate and interest rate differential relationship in Ghana since the adoption of the IT framework is non-existent both in the short-run and long-run. There is however strong evidence on the effect of current account differential, and foreign price on the barter price of the local currency. Further, we find slow responsiveness of the exchange rate to interest rate differential and current account differential shocks both in the short-run and medium-term. In the long-run however, we find a clear and strong positive impulse response of the exchange rate to both interest rate differential and current account differential. The finding shows a clear case of unattractive domestic interest rates to foreign investors raising central bank credibility issues even in IT regime. The result also shows the crucial effect of economic performance

and foreign price on the value of the local currency which should be an incentive for policymakers to prioritize pro-growth spending. We recommend for the attention of the Bank of Ghana that insensitivity of exchange rate in IT regime could be as result of perennial macroeconomic instability, especially on inflation could fuel investment risk. Lastly, we recommend prudent monetary policy management geared towards the reduction of interest rate to boost economic activity.

References

Andrieș, A. M., Căpraru, B., Ihnatov, I., & Tiwari, A. K. (2017). The relationship between exchange rates and interest rates in a small open emerging economy: The case of Romania. *Economic Modelling*, *67*, 261-274.

Beng, G. W., & Le Ying, S. (2000). Exchange rate and interest rate differential: the case of the Malaysian Ringgit/US Dollar. *Applied Economics Letters*, *7*(2), 95-97.

Chortareas, G. E., & Driver, R. (2001). PPP and the real exchange-rate interest rate differential puzzle revisited: evidence from non-stationary panel data. *Bank of England.*

Dickey, D. A., & Fuller, W. A. (1979). Distribution of the estimators for autoregressive time series with a unit root. *Journal of the American statistical association*, *74*(366a), 427-431.

Dornbusch, R. (1976). Expectations and exchange rate dynamics. *Journal of political Economy*, *84*(6), 1161-1176.

Frankel, J. A. (1979). On the mark: A theory of floating exchange rates based on real interest differentials. *The American Economic Review*, *69*(4), 610-622.

Ghosh, A.R., Ostry, J.D., Chamon, M., (2016). Two targets, two instruments: monetary and exchange rate policies in emerging market economies. *J. Int. Money Financ*. 60, 172–196

Hacker, R.S., Karlsson, H.K., Månsson, K., (2012. The relationship between exchange rates and interest rate differentials: a wavelet approach. *World Econ*. 35, 1162–1185.

Holtemöller, O., & Mallick, S. (2016). Global food prices and monetary policy in an emerging market economy: The case of India. *Journal of Asian Economics*, *46*, 56-70.

Hnatkovska, V., Lahiri, A., Vegh, C., (2013). Interest Rate and the Exchange Rate: A Nonmonotonic Tale 63. *European Economic Review*, 68–93.

Hoffmann M., & MacDonald R. (2009). Real exchange rates and real interest rate differentials: A present value interpretation. *European Economic Review* 53, 952–970

Hooper, P., & Morton, J. (1982). Fluctuations in the dollar: A model of nominal and real exchange rate determination. *Journal of international money and finance*, *1*, 39-56.

Isard, P. (1987). Lessons from empirical models of exchange rates. *Staff Papers*, *34*(1), 1-28.

Li, K. W., & Wong, D. K. (2011). The Exchange Rate and Interest Rate Differential Relationship: Evidence from Two Financial Crises. *Department of Economics and Finance, City University of Hong Kong, Working Paper*, (2011018)

Mishkin, F. (2007). Money, banking and financial markets. *New Horizons, Paris, France*.

MacDonald R. and Hallwood, P. (2008), International Money and Finance, No 2008-02, Working papers, University of Connecticut, Department of Economics

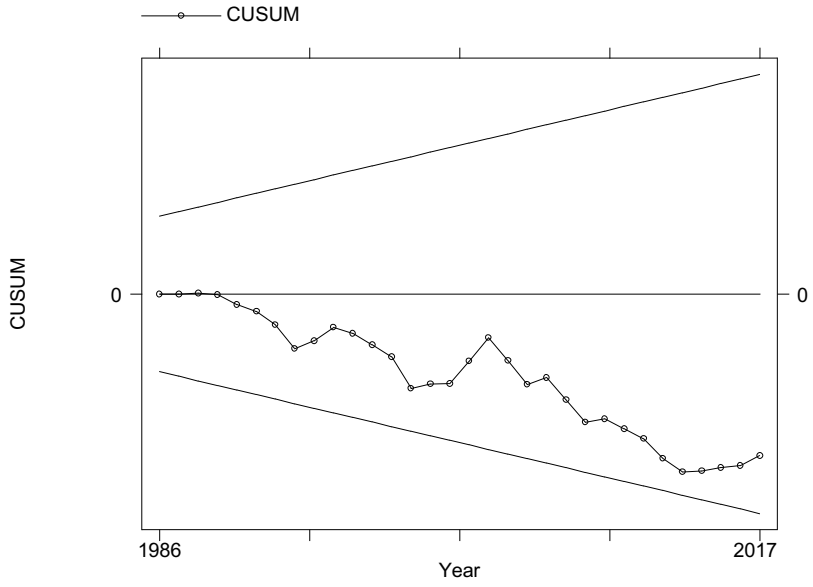
MacKinnon, J. G. (1996). Numerical distribution functions for unit root and cointegration tests. *Journal of applied econometrics*, *11*(6), 601-618.

Meese, R. A., & Rogoff, K. (1988). Was it real? The exchange rate interest rate relation,

1973-1984. *Journal of Finance*, *43*(4), 933-948.
Nakagawa, H. (2002). Real exchange rates and real interest differentials: implications of nonlinear adjustment in real exchange rates. *Journal of Monetary Economics*, *49*(3), 629-649.
Pesaran, M. H., Shin, Y., & Smith, R. J. (2001). Bounds testing approaches to the analysis of level relationships. *Journal of applied econometrics*, *16*(3), 289-326.
Phillips, P. C., & Perron, P. (1988). Testing for a unit root in time series regression. *Biometrika*, *75*(2), 335-346.
Wu, J. L. (1999). A re-examination of the exchange rate–interest differential relationship: evidence from Germany and Japan. *Journal of International Money and Finance*, *18*(2), 319-336.

Figure 1: Stability Test For ARDL Model

A. Plot of CUSUM



B. Plot of CUSUMSQ

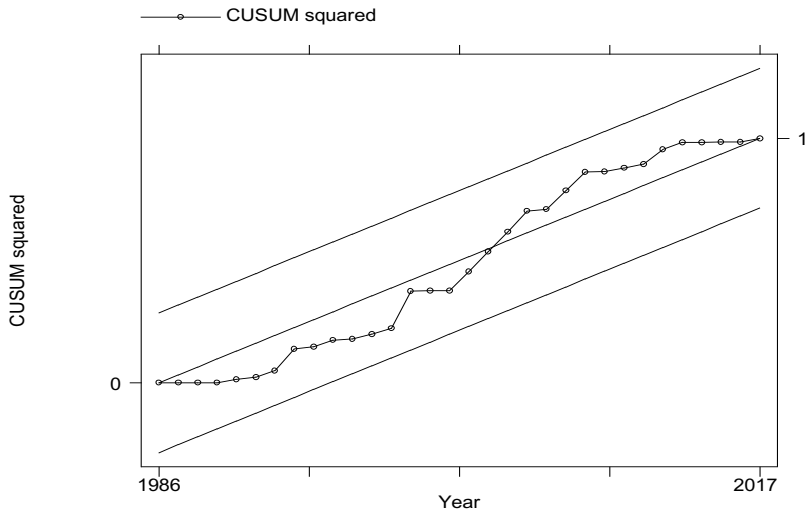

CUSUM squared
CUSUM squared
0
1
1986
2017
Year

Figure 2: Impulse Response Graph of Response of Exchange rate to interest rate shocks

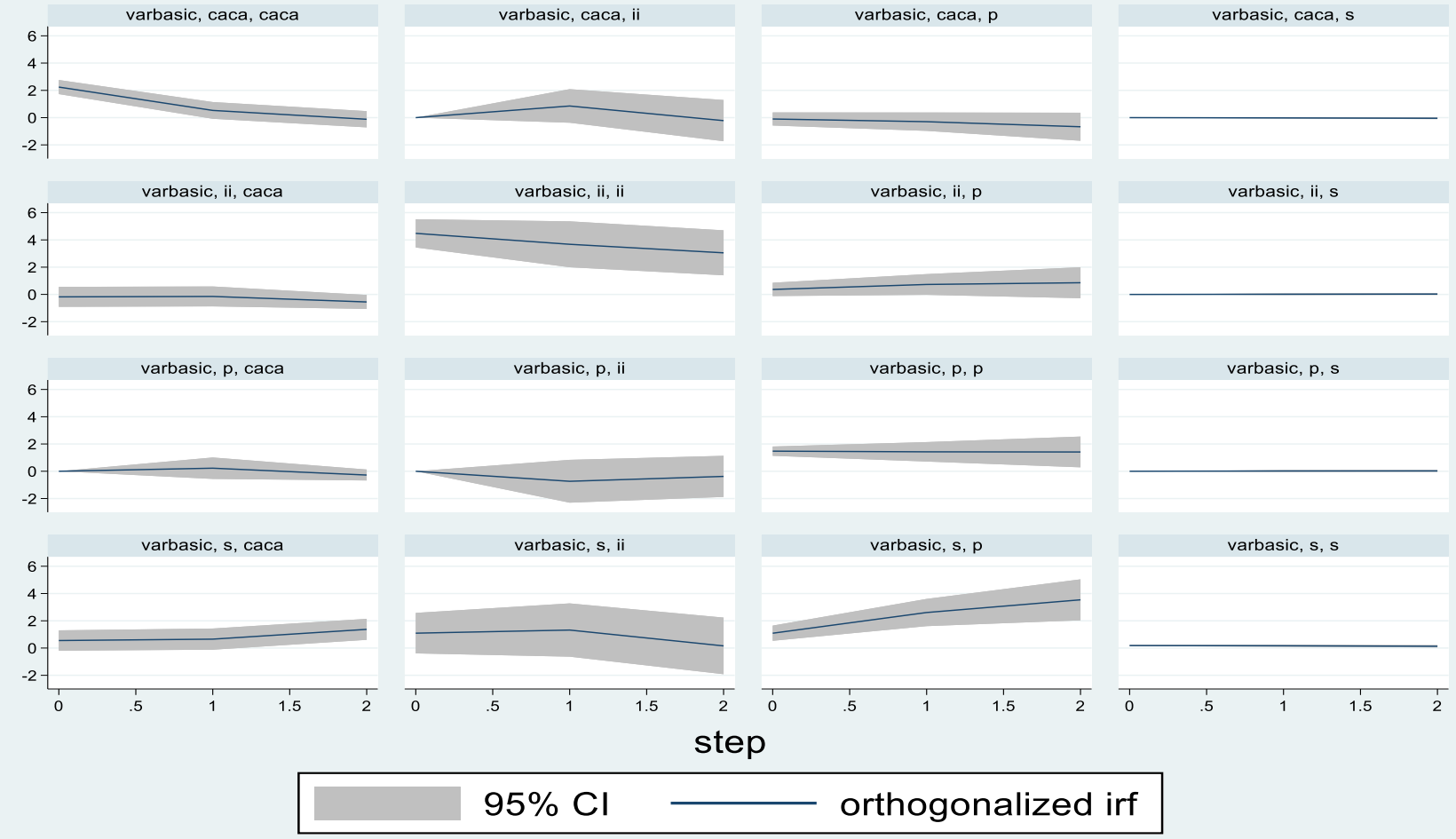


Figure 3: VAR Stability Graph