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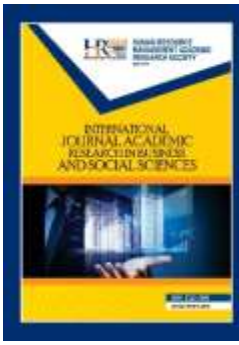
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Ghana's Reserves and Currency Volatility: A Comparison with Empirical Theories

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Abstract
This paper uses a VEC model to assess the relationships between macroeconomic variables and how they conform to empirical theories of an open economy in literature. We assess the reserve policy of Ghana, and the effect of exchange rates on exports. We also examined the effects of foreign direct investments on the volatility of the exchange rates, and the ability of the central bank to roll on bail outs in times of financial turmoil.
We found an increase in exports during episodes of currency appreciation in both time periods, and also, the increase in FDIs led to depreciation of the currency. We again found that, Ghana's reserves policy is not a planned intervention, and mostly depends on occasional large inflows. This is consistent with the findings of the IMF staff as stipulated in the article iv consultation report (2017). We also found positive correlation between reserves and the financial sector. This is in conformity with the empirical works of Lane and Burke (2001) and also Obstfeld et al., (2010). However, we could not confirm the findings in Greenspan (1999) and Bussiere et al., (2015) of short term debts been the most important metric for international reserves neither did we find evidence that reserves accumulation is associated with depreciating currencies in developing economies.
Keywords: Reserves, Exchange Rates, Broad Money (M2), Foreign Direct Investments, Exports.

Introduction

The central bank of Ghana is an inflation targeting bank, though it has persistently failed to meet the inflation target band width of 8 ± 2 (Article iv consultative report, 2017). According to the IMF consultation report, 2017, Ghana's inflation targeting framework has had a mixed performance. This was partly due to fiscal dominance and foreign exchange intervention constantly undermining the transmission of monetary policy (Article iv consultative report, 2017). Assessing how the central bank therefore can achieve fiscal and monetary independence in the wake of great macroeconomic instability could be the way forward for the central bank.
Discussing the ways through which a central bank can loss its independence, huge capital flights into a country and the integration of an economy into the global financial system can rob a central bank's independence on monetary and fiscal policies (Frenkel, 1976). One monetary policy tool

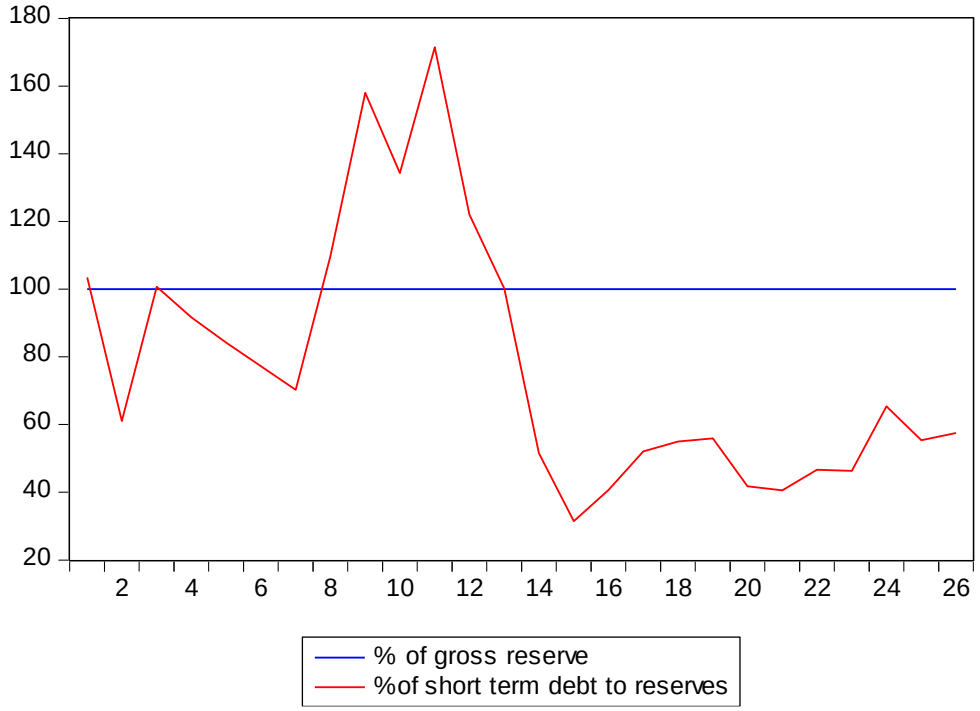
that could avert the negative effects of these factors is the holding of adequate reserves (Obstfeld et al., 2005, Popper et al., 2011 and Aizenman et al., 2010 and 2011).

Steiner (2013) observed that it is impossible to achieve monetary independence in an open economy with a floating exchange regime either de facto or de jure. Having adequate reserves gives a leeway for an independent monetary and financial policy despite the theory of classic trilemma (Steiner, 2013, Aizenman et al., 2010 and 2011). Also, accumulating adequate reserves could be a substitute for capital control mechanisms, and can be used to absorb the net effect of capital flight, and also preserve the monetary and fiscal independence of the central bank from vulnerabilities associated to shocks in external factors. Steiner (2013) summarizes the purpose for keeping reserve as reducing the interdependence of an open economy from developments in the rest of the world.

A casual analysis of the data using three empirical benchmarks in literature seems to point at Ghana's preference of targeting domestic shocks rather than external shocks. Ghana's reserve levels for the past two decades are well above the Greenspan rule and the twenty percent M2 bench marks, which mostly reflects resistance to shocks in the domestic financial system. Figure 1, 2 and 3 show the performance of Ghana's reserve levels to different empirical benchmarks.

Ghana since gaining access to the international capital market in 2007, and the discovery of oil in commercial quantities in 2009, has attracted huge capital inflows into the country (Article IV, Consultion Report, 2017). Foreign direct investments (FDI) have increased largely as well and this has been a growing trend in developing countries compare to developed economies (Antwi et al., 2013). FDIs and external debts have contributed to a large increase in external liabilities from 26% of GDP in 2006 to 70% of GDP in 2015 (Article IV Consultation Repot, 2017). Ghana's vulnerability and dependence on external economies is getting worse day by day. These threaten the monetary and fiscal independence of the Central bank.

Figure 1. Ghana's reserves in line with the Greenspan rule:



The literature on foreign exchange reserves and the purpose for holding them is grouped into two orderly classes. The traditional literature on foreign exchange reserves argue that reserves are for the purpose of correcting imbalances in the balance of payment account in economies with fixed exchange rates (Krugman, 1979, Flood and Garber, 1984, and Broner, 2008). In these Papers, the level of reserves determines the duration of an unsustainable exchange rate peg (Pina, 2015). Recent literature views the holding of reserves as an insurance or a precautionary savings against financial crisis (Alfaro and KancZuk, 2009, Durdu et al., 2009, Jeanne and Ranciere, 2011, Bianchi et al., 2014). This group of researchers sees the stock of reserves as a buffer to be used to smooth aggregate consumption and avoid volatility in the economy. Lane and Burke (2001), Obstfeld et al. (2010) and Pina (2015) see the level of reserves to have a positive correlation on the size of the financial system in the economy. Greenspan (1999) argue that the level of reserves should be exactly equal to the level of short term debts, and therefore the ratio of reserves to short term debts should be equal to one(1). This is latter known as the Greenspan rule.

Figure 2. Ghana's reserves against the M2 benchmark:

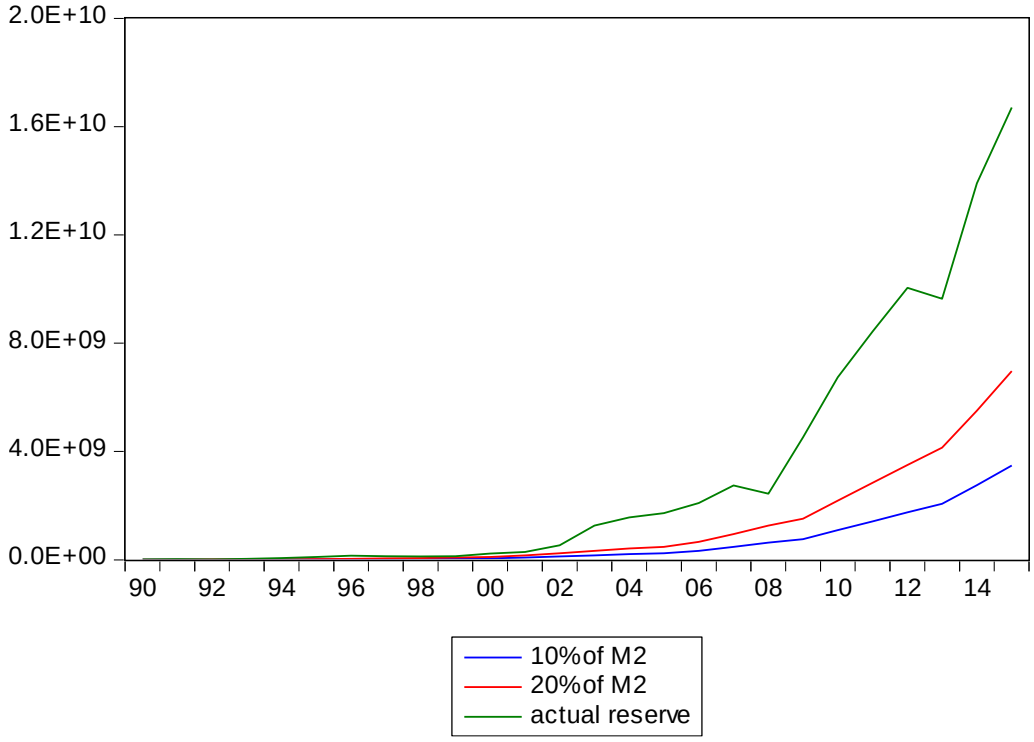
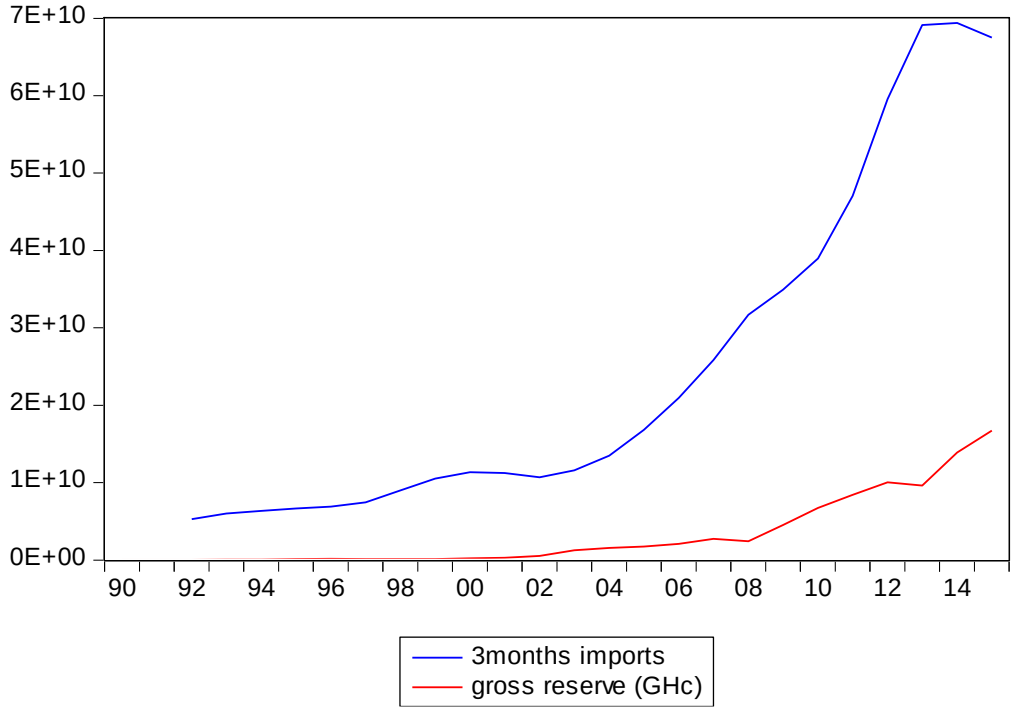


Figure 3. Ghana's reserves in line with Imports benchmarks:



On the causes of the growing trend in reserves accumulation in developing economies, Pina (2015) found out that reserves accumulation is associated with a depreciating currency, and Steiner (2015) saw a 'fear of capital mobility' suffered by central banks as a cause of reserves accumulation. This research determines the foreign exchange reserve policy and strategy of the

Bank of Ghana in line with the traditional and modern theories discussed above, and also assesses the impact of the reserve levels on exchange rate movements in Ghana. It also examines how the reserve stock responds to the growing inflows of FDIs into Ghana.

Theoretical Background and Econometric Framework

Clarida and Gali (1994) develop their conceptual framework based on the pioneering work of Mundell-Fleming-Dornbusch (the M-F-D model). Clarida and Gali (1994), hence forth known as C-G, developed a three variable structural VAR to test the sources of exchange rate fluctuations, and how important nominal shocks contribute to these fluctuations. The variables in their model were, relative output, relative prices and real exchange rates.

Also, Wang (2005) hence forth known as W, worked on the same variables. He developed a structural VAR on relative output, real exchange rate and relative prices. He also identified supply shocks, demand shocks and nominal shocks as the three major structural shocks in the model. Relative output was measured as the log of real GDP in China minus the log of a trade weighted measure of real GDP in trading partners. He adopted the same method with Clarida and Gali, to measure relative prices, and uses grain prices index as a way of transforming the CPI series. This was to remove the effect of constant price controls and episodes of liberalizations in the early part of the sample.

Restrictions Imposed by C-G

They imposed three restrictions on their structural identification to be able to isolate the effect of the structural shocks on the endogenous variables mentioned above.

(a) They assume that relative output is only explained by supply shocks in the long run. (b) Imperfect substitution of foreign and domestic goods and,

(c) Sticky adjustments of prices and output.

Supply shocks were defined to mean relative changes in domestic production over foreign production. Demand shocks were the relative changes in government spending and market access for domestic goods compared to foreign goods, whereas nominal shocks referred to the monetary policy shocks.

Findings of C-G

Their findings revealed that, a positive supply shock only affects relative output in the short run, and leads to an increase in relative output. However, the long run effect of a positive supply shock was found to increase relative output, and decrease both relative prices and real exchange rate. On the demand shocks, a positive demand shock was found not to have any effect on the long-run output, but affects all other variables positively in both the short-run and long-run analysis. Positive nominal shocks, lowers domestic interest rate, decreases real and nominal exchange rate, and increases both relative prices and output in the short-run.

Contradiction between C-G and M-F-D

The findings on nominal shocks contradict the prediction in the M-F-D model which finds a negative correlation between interest rate and nominal exchange rate. Also nominal shocks were found not to have a long-run effect on both output and real exchange rate. The relationship

established by Clarida and Gali (1994) by both supply shock and demand shocks on relative prices and real exchange rate also creates a Purchasing Power Parity Puzzle.

Set-Up and Estimation of the Empirical Model

A. Set-up of the model

A VEC model with six variables is set up below:

$\Delta X_t = \alpha\beta_1 X_{t-1} + \sum_{i=1}^{p-1} \Gamma_i \Delta X_{t-i} + U_t$

Where

X_t is a vector of endogenous variables.

$\beta 1$ Is a vector of parameters for the error correction term.

α is a vector of long run adjustments.

Γ_i the number of cointegrating equations

U_t vector of error tems

X_t, that is the endogenous variables in the model, are six variables; gross reserves, foreign direct investments, exports, exchange rates, broad money (M2), and short-term debts.

B. The data

The data for the research is an annual time series data taken Central Bank of Ghana database, and others from World Bank database from 1990 to 2016. The variables on which data was taken are; gross reserves, foreign direct investments, exports, exchange rates, broad money (M2), and short-term debts.

C. Unit root test

Before beginning our analysis with the six variables under study, that is, gross reserves, foreign direct investments, exports, exchange rates, broad money (M2), and short-term debts, it is important to study the characteristics of the series. It is important to see whether the series is stationary I(0) or nonstationary I(d).

The general regression form below is used for the standard Unit root test:

$\Delta X_t = \alpha + (\beta - 1)X_{t-1} + \sum_{i=1}^{p-1} \Gamma i \Delta X t - i + Ut$ _____equation(3)

DECISION RULE:

H_0: $\beta = 1$; There is a Unit Root

H_A: $\beta < 1$; There is no Unit Root

Table 1. Unit root test

Dependent Variable	$\hat{\alpha}$		$\hat{\beta}$		$@TREND$		Augmented Dickey Fuller TEST		
	t-statistic	Prob.	t- statistic	Prob.	t-statistic	Prob	t-statistic	5% Critical Value	Prob.
Export	-1.24189	0.228	-5.78482	0	2.176528	0.0411	-5.78482	-3.6032	0.0004
Exrate	-0.37757	0.7092	1.074534	0.2937	0.621147	0.5406	1.074534	-3.59503	0.9998
Fdi	-1.17008	0.2551	-3.58961	0.0017	1.819372	0.0831	-3.58961	-3.6032	0.0514
gross reserve	-1.10706	0.2797	-2.78665	0.0105	1.934779	0.0654	-2.78665	-3.59503	0.214
M2	-0.51355	0.6125	12.18413	0	1.086628	0.2885	12.18413	-3.59503	1
Stdebts	-1.01647	0.32	-2.80884	0.01	1.870991	0.0741	-2.80884	-3.59503	0.2067

Table 2. Unit root decision on Variables

Dependent Variable	Result from Unit Root table	Decision
Export	$t_s > t_T$	There is no Unit Root
Exrate	$t_s < t_T$	**There is a Unit Root**
Fdi	$t_s > t_T$	**There is a Unit Root**
gross reserves	$t_s < t_T$	**There is a Unit Root**
M2	$t_s > t_T$	**There is a Unit Root**
Stdebts	$t_s < t_T$	**There is a Unit Root**

At the critical value of 5%, the ADF- test has found the exchange rate, foreign direct investment, gross reserves, broad money (M2), and short-term debts to have unit root.

No variable in the model was found to have a significant constant. However, exports have a significant trend, but all the variables that are nonstationary I(1) do not have a significant trend. The fact that some of the series are I(1) can lead to a spurious regression when a nonstationary I(1) series is regress on another nonstationary I(1) time series. This will create a serious problem, and produce misleading estimates and impulses when the traditional testing techniques are used as estimators. To satisfy our selves that this is not the case, the residuals from the linear combination of the five variables have been tested and they are I(0).

D. Johansen Cointegration test

We run a cointegration test with the five variables that are I(1). The general regression equation to test cointegration for VAR models is:

$\Delta X_t = \sum_{i=1}^{p} \pi_i X_{t-1} + U_t$, where u_t ? IN[0,Ω]. _____equation (4)

Where
X_t is a (5x1) vector of I(0) variables.
When the series of the regression X_t is I(1), the model is reformulated to include an error correction term (Engle and Granger, 1987; Johansen, 1988).
$\Delta X_t = \alpha\beta X_{t-1} + \sum_{i=1}^{p-1} \Gamma_i \Delta X_{t-i} + U_t$ _____equation (5)
As we have already mentioned, for the system in equation (3) to be correctly specified, the residuals from the linear combination of the I(1) variables ($\alpha\beta X_{t-1}$) must be I(0).
We have run the cointegration test in this paper using both Trace test and the Maximum Eigenvalue test from Johansen test methodology. They all showed similar results. Both of these tests have shown one cointegrating equation at a 5% critical value.

Table 3. Cointegration test run with five I(1) variables.

Number of cointegrating equations (H_0: Rank p≤	TRACE TEST			MAXIMUM EIGENVALUE TEST		
	Test statistic	0.05 Critical Value	Prob.	Test statistic	0.05 Critical Value	Prob.
0	142.6079	60.06141	0	87.03738	30.43961	0
1	55.57053	40.17493	0.0007	32.26179	24.15921	0.0032
2	23.30875	24.27596	0.0659	12.48491	17.7973	0.2628

COINTEGRATION VECTOR 1				
Exrate	Fdi	gross reserves	M2	Stdebts
1	-7.04E-10	-2.34E-09	2.47E-09	-3.25E-09
	-2.00E-10	-1.30E-10	-2.50E-10	-5.00E-10
COINTEGRATION VECTOR 2				
Exrate	Fdi	gross reserves	M2	Stdebts
1	0	-1.77E-09	9.70E-10	-9.95E-10
		-1.80E-10	-1.70E-10	-5.70E-10
0	1	0.806121	-2.134772	3.205053
		-0.25104	-0.24052	-0.7943

NB: The asymptotic p-values are estimated with no constant and no trend in the cointegrating regression.

Remember that non of our nonstationary variable I(1) has neither a significant alpha (constant) or a significant trend. We therefore did not restrict a variable trend into our cointegration equations.
$\Delta X_t = \alpha\beta_1 X_{t-1} + \sum_{i=1}^{p-1} \Gamma_i \Delta X_{t-i} + U_t$, _____equation (6)

The identified cointegrating equations from the unrestricted long-run relationship of the I(1) variables are:

$CE\ (1)_t$ = exrate -7.04E-10FDI – 2.34E-09gross reserve + 2.47E-09M2 – 3.25E-09Stdebts

$CE\ (2)_t$ = exrate – 1.77E-09gross reserves + 9.70E-10M2 -9.95E-10Stdebts.

Model Estimation

We have conducted a unit root test and also a cointegration test on the series identified to be I(1). We therefore set-up a VEC model using d(gross_reserve__ghc_) d(fdi_ghc) exports__ghc_ d(exrate_ghc_us$) d(m2__ghc_) d(stdebts__ghc_), intercept and a trend in the cointegration equations (CE), and a linear trend in the VAR as the variables in the model. Note that estimation was done by assuming a quadratic trend in our data though we have earlier on mentioned that both the trend and constant in the cointegrating regressions are not significant. Our general model specification therefore does not capture them.

The VEC is estimated using multivariate ordinary least square as in the work of Fomby and Hirsch (1989). One virtue of the VAR models, over structural equation models, is its ability to estimate the parameters of the model using the usual Ordinary Least Square (Gujarati, 2004, p853). Table 5 and 6 in the appendix show the estimation output of the VEC and coordinates respectively.
Estimating individual coefficients are difficult to interpret in VAR models, and therefore we are going to be estimating the impulse response function (IRF) which will trace out the response of the dependent variables in the VAR system. The VAR system was also subjected to residual diagnostic test. All these tests validate the system and hence fit to be used for analyses. Table 4 shows a summary of the residual diagnostic test.

Table 4. Residual Diagnostic Test

Type of Test	LM-statistic	Probabilty
a. Serial correlation LM-Stat Test (Lag 1)	39.99002	0.2974
b. Heteroscedasticity (Joint test) Chi-square	392.0466	0.2985
c. Normality test-Jarque Bera Test (Joint test)	17.45851	0.1331

Impulse response and variance decomposition

A positive shock to gross reserves impacts the reserves only after the eighth period. Gross reserves respond to own shock by increasing for just one period and falling afterwards. The response of reserves to positive shocks in FDIs is similar to the response of reserves to own shocks; only increasing after the eighth period and falling again after just one period. Also, gross reserves again respond to positive shocks in exports after the ninth period. Gross reserves respond to positive shocks in all the variables after the eighth period including M2, exchange rate and short term debts. The exchange rate begins to respond to shocks to gross reserve during the seventh period. The shock to gross reserves first increases the exchange rate for one period and

then a decline afterwards. Also, both reserves and FDIs have a similar effect on the exchange rate movements. The exchange rate do not respond to shocks to itself, but until the seventh period.

In the short-run, variations in gross reserves is basically due to itself. This is probably due to the ordering of the variables. However, FDIs explain close to 22% of the variations in the long-run. Exchange rate and M2 explain 4% of the variations in the long run. Also, reserves is the main factor that explains the variations in FDI in the short-run. Reserves in the long-run even exceeds own shocks in determining the variations in FDI. Exports do not explain upto 1% of the variation in itself in the short-run. Reserves and FDI explain more than 90%of the variation in exports in the long-run. In addition, FDI is the next highest variable in terms of explaining exchange rate movements follow by exports in the short-run. However, the stock of reserves is the most important in the long-run, accounting for more than 70% of the variation. Reserves explain more than 75% of the variations in M2. The combine effect of FDIs and exchange rate explain a little above 20% of the variations in M2 in the short-run. The situation does not change much in the long-run. Furthermore, reserves explain more than 70% of the variation in short term debts in both time periods. The level of FDI becomes increasingly important in the long-term.

Conclusion

Our results show that the reserves of Ghana increases in respond to increase in foreign direct investment in the long-run. This supports the theory that reserves are used as buffers against external vulnerabilities (Ben-Bassat and Gottlieb, 1992, Alfaro and KancZuk, 2009, Jeanne and Ranciere, 2011, and Bianchi et al, 2004) . However, short-run increase in FDI is matched with a decline in reserves. This situation suggests that Ghana's reserve policy regarding inflows is not progressive; in the sense that it is not build over a period of time. It is build and used up and again build and used up. This supports the IMF findings of Ghana's reserves not build-up in a planned intervention strategy and that it rest on occasional large capital inflows (Article iv consultation, 2017).

Also, we found that Reserves increase along with increases in M2 in the long-run and in the short-run. This shows a carefully planned out strategy that evolves over time regarding matching the stock of reserves with the growth in the financial system. The empirical findings in Lane and Burke (2001) and also Obstfeld et al (2010) of M2 having a positive correlation with reserves therefore also applies to Ghana. Whiles the central bank matches the reserves with the growth in the financial system, the reserves do not have any role in determining the level of M2.

Furthermore, Increase in short term debts increases the reserves in the long-run as well as in the short-run. However, from the variance decomposition, FDIs explain much of the variations in reserves than any other variable in the model. We were therefore unable to confirm the findings in Greenspan (1999) and Bussiere et al., (2015) that short term debts are the most important metric for international reserves.

Lastly, the findings in Pina (2015), Aizenman and Sun (2012) and Domnguez et al., (2012) of reserves accumulation associated with depreciating currencies in developing economies could not be verified in this research. Our long-run test for binding restrictions rejected the null of the claim. The claim was also not verified in the short-run, and neither does the central bank uses the reserves to influence exchange rates in the short run.

Ghana's reserve stock is not employed as an alternative to capital control measures as suggested in the work of Steiner (2013). It is rather a buffer aimed at mitigating the negative consequence of domestic economic fluctuation, and not so much targeting the effect of openness of the economy. It is a policy that is aimed at targeting volatilities in the domestic financial system, and also to smoothen aggregate expenditure of Government. Failure of the policy to target openness of the economy has resulted in exposure to external vulnerabilities and has thus lead to the central bank losing its monetary and fiscal independence (Article iv consultation Report, 2017).
On the effects of currency movements on exchange rate, we found an increase in exports in episodes of currency appreciation in both time periods. This findings possibly could be down to the willingness of exporting companies to reduce profit margins in times of appreciation of the currency in other to maintain sales volume. Marston (1990) and Goldberg (1995) found similar results with exchange rates and exports. However, increases in FDIs lead to depreciation of the currency.

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