The Mystery behind Foreign Reserve Sterilization: Empirical Evidence from The Gambia

Joof, Foday and Tursoy, Turgut

Central Bank of The Gambia, Near East University

28 April 2020

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Foday Joof

Risk Management Officer, Risk Management Department, Central Bank of The Gambia, 1-2 Ecowas Avenue Banjul, The Gambia, email: fjoof@cbg.gm

Turgut Tursoy

Head, Department of Banking and Finance, Near East University, North Cyprus, Mersin 10 Turkey, email: turgut.tursoy@neu.edu.tr

This paper investigates the impact of the foreign reserve on the domestic money supply and the level of sterilization by employing the Auto Regressive Distributed Lag for short-run estimation, the Fully Modified OLS for long run estimation and Granger Causality on a monthly data from 2002 to 2019. The short-run and long-run results revealed that foreign reserve has a positive statistically significant impact on money supply; this suggests a total lack of sterilization on the part of Central Bank of The Gambia. The Granger causality confirms a feedback association between the foreign reserve and broad money supply.

Keywords: Foreign reserve, Money supply, Sterilization, Central Bank of The Gambia

INTRODUCTION

Reserves are the foreign component of the money supply, which serve as a buffer for imbalances between the demand and supply of foreign exchange. Thus Central banks normally purchase foreign currency from the FX markets to boost their reserve holdings; this practice does increase the money supply in circulation thereby putting an inflationary pleasure on the domestic currency because according to Tursoy and Mar'i (2020), money supply and inflations have a bidirectional causal relationship. However, to prevent depreciation of the local currency, central banks engage in open market operations (OMO) by issuing treasury bills, this process is term as sterilization. Earlier studies propounded two critical channels through which sterilization intervention impacts on the exchange rate: "the portfolio balance channel and signalling channel". Sarno and Taylor (2001) hypothesized that the structure of agents' portfolio is impacted by the central banks' interference in the FX market, even subsequent to buying or selling domestic currency to sterilize their operations. Thus, agents endeavour to rebalance their portfolios

purchasing or selling foreign currency; this impacts on the spot exchange rate when the foreign currency and local currency are not a perfect substitute. Mussa (1981) propounded on the signalling channel by arguing that if the foreign asset and domestic asset are local substitutes, the sterilization can be useful. The signalling channel is built on the assumption that there is asymmetric information because central banks are more informed as compared to other players in the FX market, who access this information only through interventions (foreign exchange intervention). Therefore, the central bank can impact on the exchange rate by sharing information on imminent monetary policy to change peoples 'anticipations. These two (portfolio and the signalling channel) techniques are used as customary exchange rate determination simulations grounded on macroeconomic rudiments with the assumptions of homogeneity amid agents in FX markets. A third theory called the coordination channel was proposed by Taylor (1994, 2004, and 2005) and Sarno and Taylor (2001), this theory is centred on foreign exchange microstructure, misalignment and heterogeneity between agents and that the authorities are not better informed than other participants in the FX market because the information from both public and nonpublic is vital to the exchange rate. Further, stated that inventions could impact on exchange rate via market expectations, irrespective of the base of those expectations (either fundamental or non-fundamentals).

Conversely, Dubas (2009) claims that the degree of misalignment could be subject to a country's exchange rate regime; thus the best exchange rate regime for mitigating misalignment of the exchange rate is the one between the hard peg and pure float, but floating exchange rate system performance the poorest. According to IMF (2016), The Gambia operates a floating exchange rate regime[1], because it is adjustably peg to the US dollar, which permits certain skinny manoeuvring in the foreign exchange market and limit the inflationary pressures that could arise from the accumulation of foreign reserve (Azar, 2014). High foreign reserves enable the Central Bank of The Gambia to maintain the stable foreign exchange rate, due to the sufficient resources to finance imports, tackle an obstinate current account imbalance to withstand shocks, particularly political uncertainties (post-presidential election in 2016 when Jammeh refuses to step-down). The Net Foreign Assets of CBG had risen from GMD 3.8 billion in August 2017 to GMD 8.5 billion in December 2019; this indicates 69% increment with 1year 3months. This may be costly because a spontaneous, accommodative and passive money creation instrument has the autonomous implications of triggering inflation and the extent of lack of sterilization will determine the magnitude of the inflation, which may result to the devaluation of the Gambian dalasi (GMD) against the USD. It is in the light; we wrote this paper to determine the impact of the foreign reserve on the domestic money supply and to assess the level of sterilization. A monthly macro data time series covering from 2002:1 to 2019:12 is employed on the Auto Regressive Distributed Lag-Error Correction Model to analysis the short-run relationship and the Fully Modified Ordinary Least Square for

[1] An exchange rate arrangement is classified as floating if the exchange rate is mainly market-determined.

long run estimation. To checking the robustness of the results, the Dynamic OLS and Canonical Cointegrating Regression are employed. The Eagle Granger Causality is used to assess the causal associations between the variables. The rest of the paper is organized as follows: This paper is structured as follows. Section 2 provides a literature review and foreign reserves, money supply and interest rate trend. Section 3 elucidates on the methodology employed. Section 4 the data description and discussion. Section 5 conclusion and recommendation.

2. RESERVE COMPOSITION AND TREND

2.1 Reserve Composition of The Gambia

International reserves are external assets that are readily available to and controlled by a country's monetary authority (central bank). Foreign reserves commonly include foreign currencies, other assets denominated in foreign currencies, Special Drawing Rights (SDRs)[2], Gold[3] and IMF reserve position (IMF, 2019). These assets usually encompass T-bills, bonds, banknotes etc., and are mostly denominated in various currencies like U.S dollars, Euro, Pound Sterling and Swiss Franc. The Gambia's reserve composition is highly exposed to global financial risk since 100% are kept the foreign currencies, and about 70% is held in US dollars. This implies that a negative shock on the US dollar will deteriorate the value of Gambia's foreign reserves.

2.3 The Gambia's Foreign Reserve, Money Supply and Interest Rate Trend.

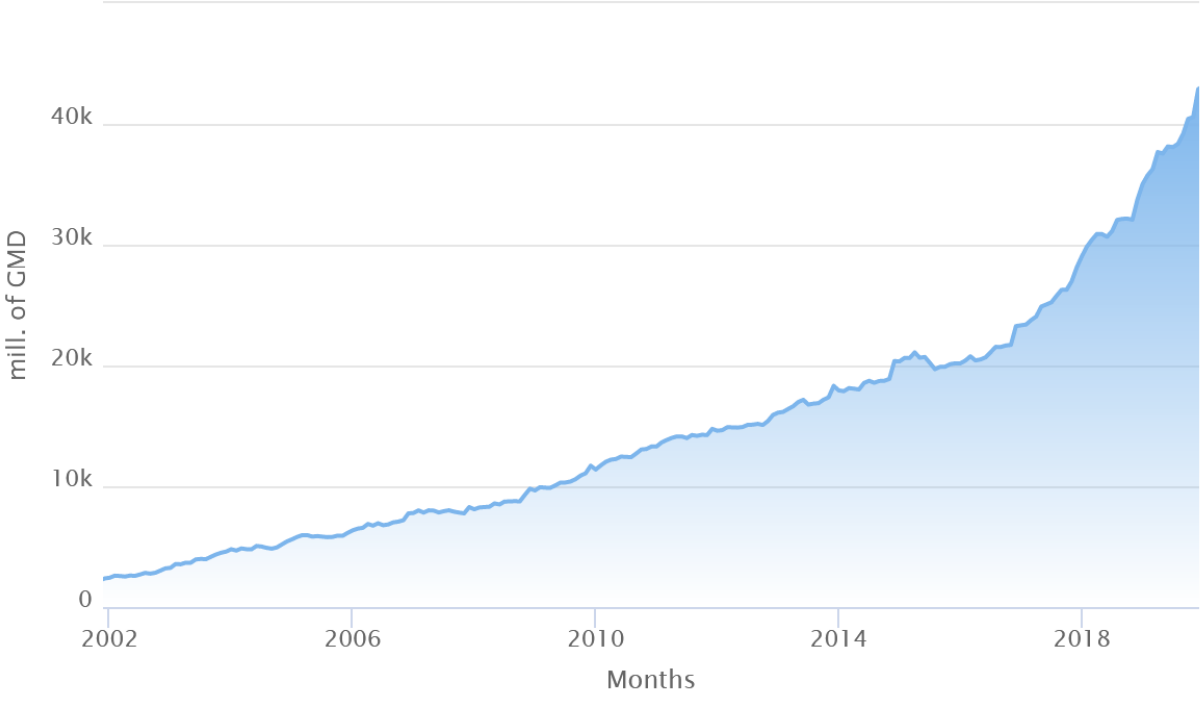
The net foreign assets (NFA) of Central Bank of The Gambia in figure 1 showed a steady upward and downward movement during the period 2002-2019. However, it experienced the worst period in February 2016 with GMD 1.07 billion declines. The NFA has then risen from GMD 3.8 billion in August 2017 to GMD 8.5 billion in December 2019, "reflecting, a large significant amount of budget and balance of payments support from development partners and the intermittent intervention in the foreign exchange market" (CBG, 2019).

[2] The Special Drawing Right is an artificial asset unit created by the International Monetary Fund in 1970 to substitute for gold as a main reserve asset and to improve international liquidity, which was becoming tighter (Tew (1988), p. 136). However, this fund can be deployed by the bank in the event of financial distress.
[3] Private holdings of gold are term as commodities, not means of payments.

Figure 1. Net Foreign Assets

Source: CBG

Figure 2. Broad Money Supply (M2)



Source: CBG

From figure 2 above, we observe that the broad money supply has been increasing from the onset and has attained its highest point with GMD 42.9 billion in 2019. The M2 year-on-year growth rate in 2019 stood at 27.057%, higher than 20.039% growth in 2018. This significant increase can be attributed to an increase in the net external inflows to the banking sector (CBG, 2019). Narrow money (M1) rose to GMD 24.2 billion at the end of 2019, compared to GMD 17.9 billion the year before. The strong growth in narrow money was reflected in the growth in both currencies outside banks and demand deposits. Currency outside banks rose to GMD 7.8 billion in 2019, while demand deposits grew up to 15.9 billion as compared to GMD 11.3 billion in 2018.

Figure 3. Three Months Treasury Bills Rate, Monthly Average

Source: CBG

In figure 3, the interest rate on 91-day treasury bills have been volatile throughout the period, and has declined to 2.24% in the year 2019, which is its lowest point since 2002. Furthermore, the interest rate (91-day treasury bills rate) has decreased from an annual growth rate of 0.596% in 2018 to -55.73% in 2019. This decline can be attributed to a decline in domestic government borrowing, which can stimulate economic growth by facilitating and improving credit condition in the market.

3. METHODOLOGY

3.1. Data

To analysis, the association and co-movements between foreign reserves (LFR), interest rate (LTB), foreign direct investment (LFDI) and broad money supply (LM2), a monthly time series data retrieved from the Central Bank of The Gambia (CBG) Data Warehouse is used from the period 2002-2019. However, the foreign direct investment (FDI) data was obtained from World Bank Development Indicators. The broad money supply (M2) is used as the dependent indicator, whereas foreign reserve, the interest rate on three months treasury bills and foreign direct investment are used as explanatory variables. All the variables were transformed in log form. This can be written as:

$$LM2=f(LFR, LTB \text{ and } LFDI) \quad (1)$$

The model in Equation 1 can be presented as follows:

$$LM2_t= \beta0+ \beta1LFR + \beta2LTB +\beta3LFDI+ \varepsilon it; \quad (2)$$

Where LMS is the logarithm of broad money supply, LFR is the logarithm of the foreign reserve, LTB is the logarithm of interest rate on 3months treasury bills, LFDI is the logarithm of foreign direct investment and εit is the error term.

Table-2. Explanation of the variables.

Variables	Formula	Unit	Source
Money Supply (LM2)	M1 (Coins and currency in circulation +demand deposits +traveler's check) +saving deposits+ money market funds+ certificates of deposits+ other time deposits	GMD	Central Bank of The Gambia (2019)
Foreign Reserve (LFR)	Amount of international reserves	GMD	Central Bank of The Gambia (2019)
Interest Rate (LTB)	3 Months Treasury Bill Interest Rate	Percentage	Central Bank of The Gambia (2019)
Foreign Direct Investment (LFDI)	Net Inflow (% GDP)	Percentage	World Bank (2017)

Source: Created by authors from the available data.

3.2. Model Specification

The Auto-Regressive Distributed Lag is employed to test the co-movement between foreign reserves (LFR), interest rate (LTB), foreign direct investment (LFDI) and broad money supply (LM2). The existence of cointegration between the indictors was primarily analysed using the bound test through the ARDL technique initiated by Pesaran *et al.* (2001). The main advantage of this method is that it allows variables to have a different order of integration (level and first difference). The decision that cointegration exists can be made when the F-statistics of the bound test is more than the corresponding critical values. Similarly, if the value of F-statistics is between the upper and lower bounds, an inconclusive result of cointegration is evidence. Below is the ARDL equation for LM2, LFR, LTB and LFDI:

$$\Delta LM2_t = y_o + \sum_{i=1}^{n} y_1 \Delta LM2_{t-j+} \sum_{i=1}^{n} y_2 \Delta LFR_{t-j} + \sum_{i=1}^{n} y_3 \Delta LFR_{t-j} + \sigma 1 InLM2_{t-1} + \sigma 2 LTB_{t-1} + \sigma 3 LTB_{t-1} + \sigma 4 LFDI_{t-1} + \sigma 5 LFDI_{t-1} + \varepsilon_{1t} \quad (3)$$

Where Δ depicts the different form of the variables, whereas n is the optimal lag number and ε_{1t} error condition.

3.3. Bound Cointegration

The Bound cointegration technique is employed to determine the cointegration between the variables. The bound cointegration has the following inertia: $H_o = \sigma_1 = \sigma_2 = 0$ and $H_1 \neq \sigma_1 \neq \sigma_1 \neq 0$. The existence of cointegration is established when the F-statistics (Fspp) is greater than the critical values. After establishing the presence of cointegration amid the variable, the error correction model is employed based on the equation below:

$$\Delta M2_{t=} \beta o + \sum_{i=1}^{n} \beta_1 \Delta LM2_{t-j} + \sum_{i=1}^{n} \beta_2 \Delta LFR_{t-j} + \sum_{i=1}^{n} \beta_3 \Delta LTB_{t-j} + \sum_{i=1}^{n} \beta_4 \Delta LFDI_{t-j} + ECT_{t-1} + u_t \quad (6)$$

Where Δ illustrates the change in the variables, while ECT_{t-1} shows one period lagged error correction condition of the long run estimation, and it is anticipated to be negatively significant (Gujarati, 2003).

3.4. Long-Run Estimation

The long-run co-movement among the cointegrating indicators is analysed using Fully Modified OLS (FMOLS) propounded by Phillips and Bruce (1990). Thus, this technique has the advantage of attaining asymptotic performance; due to its ability to solve the problems of serial correlation and remove the endogeneity problem between the variables. Furthermore, the Dynamic Ordinary Least Square (DOLS) and the Canonical Cointegrating Regression proposed by Stock and Mark (1993) are used to check the robustness of the results. These techniques have the qualities to avoid probable endogeneity issues that might arise among the regressors. At this stage, the model can be written as follows:

$$LM2_t = a_{it} + \beta_{1i}LFR + \beta_{2i}LTB + \beta_{3i}LFDI + e_{it}; \quad (7)$$

Where a_{it} are the country-specific effects, LM2 is the natural log of broad money supply, LFR is the natural log of the foreign reserve, LBT is the natural log of interest rate, LFDI is the natural log of foreign direct investment and ε is the error term.

DATA PRESENTATION

4.1 Descriptive Statistics

The outcome of the descriptive statistics in Table 1 revealed that money supply, foreign reserve, foreign direct investment and the interest rate has a monthly average growth rate of 9.29%, 8.16%,1.19% and 2.42% respectively, with a monthly fluctuation rate varying from 7.79% to 10.66% (LM2), 6.77% to 9.54% (LFR), -1.02% to 2.01%(LFDI) and 0.63% to3.44% (LTB).

Table 1: Descriptive Statistics

Variable	LM2	LFR	LFDI	LTB
Mean	9.292414	8.161196	1.188254	2.417562
Median	9.353614	8.058475	1.213638	2.363209
Maximum	10.66604	9.538757	2.053969	3.435921
Minimum	7.795420	6.772598	-1.016534	0.631272
Std. Dev.	0.728602	0.694407	0.720073	0.555301
Skewnes	-0.090088	0.276455	-1.560321	-0.245976
Kurtosis	2.233144	2.537898	5.905290	3.495897
Observations	216	216	216	216

4.2 Multicollinearity

The Multicollinearity test in Table 2 showed that there is no multicollinearity problem with the explanatory variables in the model. Thus multicollinearity issues arise if the co-movement between two or more variables is 0.8 (rule of thumb)

Table 2: Multicollinearity Matrix

Variables	LFR	LFDI	LTB
LFR	1.00000		
LFDI	0.652171	1.00000	
LTB	0.764584	0.400016	1.00000

4.3 Bound Cointegration Test

The bound outcome of cointegration in Table 4 suggested the presence of long-run cointegration between LM2, LFR, LFDI and LTB. Thus, the null inertia of no cointegration is rejected if the Fpss value is higher the "bound critical value" at 5% significance.

Table 4: Bound test of cointegration.

Dependent Variable	**F-statistics (Fpss)**	**Bound critical value****		**Cointegration**
		I(0)	I(1)	
LM2=f(LFR,LTB, LFDI)	21.76*	3.37	3.2	Yes

Note:*indicates the null hypothesis of no cointegration at 5%. ** The critical bounds values are taken from Pesaran, Shin, and Smith (2001) with unrestricted intercept and no trend.

4.4. Auto-Regressive Distributed Lag

The short-run ARDL-ECM in Table 5 revealed that foreign reserve has a positive statistical significant impact on money supply both at first and second lag period. This suggests that a percentage increment in foreign reserves of The Gambia, the domestic money supply (dalasi) will increase by 0.25% and 0.06% at lag 1 and 2 respectively. Our result supports total deserialization on the part of Central Banks of The Gambia. This confirms the study of Azar (2014) in the case of Lebanon. Similarly, foreign direct investment has a significant positive association on domestic money supply, and that a 1% increase in LFDI leads to a 0.03% increase in LM2. However, the 3month treasury bills rate has no significant implications on money supply in the short run at lag 1, 2, 3 and 4 respectively.

Table-5. Short-run coefficient of the ARDL technique.

Variables	Coefficient	t-statistics	P values
ΔLFS(-1)	0.252477	8.719900	0.0000***
ΔLFS (-2)	0.085138	2.994308	0.0031***
ΔLFDI (-1)	0.018643	2.193855	0.0295***
ΔLTB(-1)	0.003294	0.210899	0.8332
ΔLBT(-2)	0.007338	0.432001	0.6663
ΔLTB (-3)	-0.013951	-0815043	0.4161
ΔLTB (-4)	0.016177	0.915449	0.3612
$\boldsymbol{ECT_{t-1}}$	**-0.030616**	-2.753813	0.0065***
C	0.009871	6.722595	0.0000
R^2	0.342295		
DW	2.411531		
Normality	4.322577		
LM Serial correlation	0.7671		
Heteroskedasticity	6.6210		

Note: ***'**' * indicates the level of significance at 1% 5% and 10%. ECT_{t-1}represents the estimated error correction coefficient in the model and Durbin Watson.

Figure 4. CUSUM for representing the stability of the Model

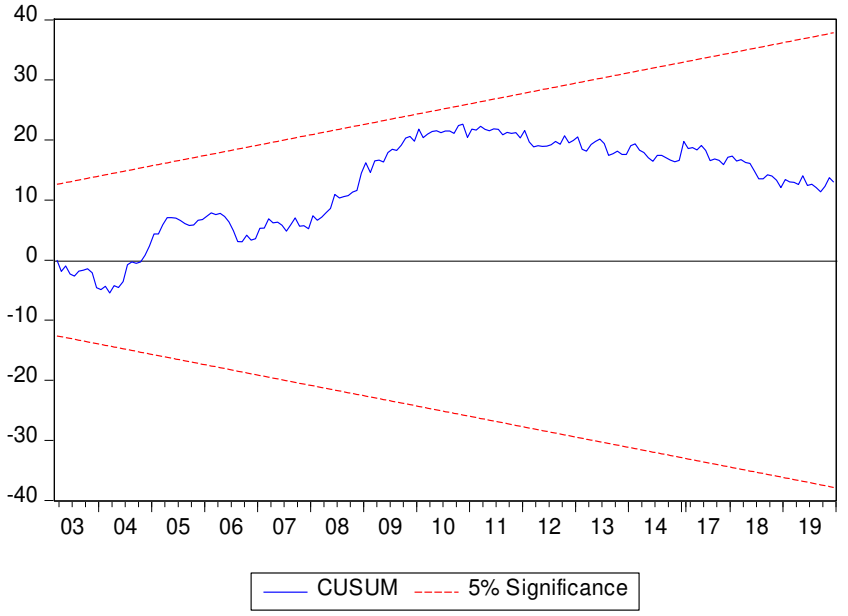


Figure 5. CUSUM of Squares for representing the stability of the Model

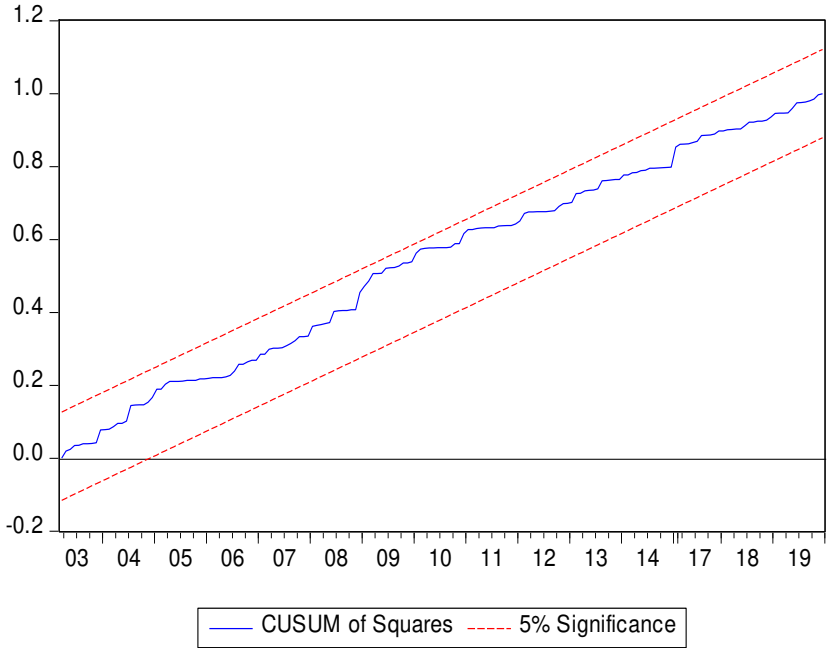


Table 5 represents the short-run estimation and diagnostic tests for the ARDL-ECM framework. The outcome revealed the absence of autocorrelation and heteroskedasticity. Furthermore, the CUSUM and CUSUMsq revealed in Figure 4 and 5, respectively, as proposed by Brown *et al.* (1975) were computed to access the robustness of stability in the model. Both figures illustrate that the model is stable; hence the plots of CUSUM and CUSUMsq are 5% significant; hence the blue lines are within the red lines.

4.5 FMOLS, DOLS and CCR

Table 6 represents the long run estimations, the results from the FMOLS, DOLS and CCR highlighted a positive association between the foreign reserve and domestic money supply at a significant level of 1%; implying that 1% increment in foreign reserve of CBG increases domestic money supply (dalasi) by 0.95%, 0.94% and 0.96% respectively. Contrarily, a negative association between the 3month treasury bills rate and money supply is found. Highlighting that 1% increase in LTB leads to 0.11%, 0.13% and 0.12% in the respective models. Finally, foreign direct investment has an insignificant co-movement with the money supply.

Table 6: Long-run coefficients of FMOLS, DOLS and CCR models.

Variables	FMOLS	DOLS	CRR
LFR	0.956934***	0.940510***	0.956470***
	(0.0000)	(0.0000)	(0.0000)
LFDI	-0.041483	-0.049247	-0.040166
	(0.2580)	(0.2121)	(0.2672)
LTB	-0.114243**	-0.130631**	-0.117180***
	(0.0398)	(0.0281)	(0.0011)
C	1.80626	2.014383	1.836036
R^2	0.96	0.97	0.97
Adj. R2	0.9657	0.9708	0.9655
S.E	0.1339	0.1215	0.1341
Long run	0.0700	0.0662	0.0700

Note: LFR= foreign reserve, LFDI= foreign direct investment and LTB= interest rate. The brackets symbolize the P values while, ***'**'* represent 1%, 5% and 10% significance level respectively.

4.6. Granger Causality

The analysis in Table 8 revealed a feedback causal association between foreign reserve and money supply; this implies a complementary relationship at a significant level of 10%. Furthermore, the EG causality showed a unidirectional moving from money supply to interest rate. However, a neutral association is fund between money supply and foreign direct investment.

Table 7: Granger causality test.

Variables	F-statistics	P values
LFR⇆ LM2	2.29251	0.0608*
	2.14724	0.0763*
LFDI≠LM2	1.14782	0.3357
	0.76761	0.5476
LM2→LTB	2.33749	0.0566*
	1.37739	0.2430

Note: ***'**'* represent 1%, 5% and 10% significance level respectively.

5. Conclusion

The aim of this paper is to assess the impact of foreign reserve on domestic money supply and the degree of sterilization in The Gambia. A monthly macro data time series covering

from 2002:1 to 2019:12 is employed on the Auto Regressive Distributed Lag-Error Correction Model to analysis the short run relationship and the Fully Modified Ordinary Least Square for long run estimation. To checkmate the robustness of the results, the Dynamic OLS and Canonical Cointegrating Regression are employed. The Eagle Granger Causality is used to assess the causal associations between the variables. The short run and long run results revealed that foreign reserve has a positive statistical significance impact on money supply; this suggests total deserialization on the part of Central Bank of The Gambia. This illustrates that reserve accumulation increases the domestic currency supply. Similarly, foreign direct investment has a positive relationship with money supply in the short run but insignificant in the long run. In the contrary, interest rate has a negative impact on money supply in the long run bit insignificant in the short run. The EG-causality confirms a feedback association between foreign reserve and money supply. Conversely, a unidirectional-relationship from money supply to interest rate is found and a neutral relationship between foreign direct investment and money supply

.

6. Policy Implications and Recommendation

Form the analysis above we observed that the Central Bank of The Gambia (CBG) have failed to sterilize the impact of reserve accumulation on the Gambian dalasi (GMD), and as propounded by Tursoy & Mar'i (2020) an increase in money supply leads to a corresponding increase in inflation. Therefore this failure to sterilize may decline the value of the GMD in both the short and long run. Thus, the selling of 91 days treasury bills by the CBG through open market operations (OMO) is not an effective method of sterilizing it operations because of its limitation. Even though CBG have tried to sterilize in the long run due to the significant coefficient of 91 days T-bills rate, however, this coefficient (-0.11%) is insipid to offset the foreign reserve coefficient (0.95%).

The conventional OMOs are normally constrained by the availability and nature of financial instruments, predominantly in developing countries like The Gambia, which lack proper financial infrastructures or markets, as a result foreign investors do not see T-bills or central bank papers as imperfect substitute of financial assets because must investors prefer to hold stocks or bonds. Secondly, allotting a enormous stock of securities in an endeavor to decrease the money supply frequently places a substantial burden of debt-service on the central bank or government, and it has repeatedly cause a decline in the quasi-fiscal balance (IMF, 1997). The other reason why OMOs are not effective method of sterilization is, due to their self-defeating nature, thus successful operations have the tendency of increasing domestic interest rates and kindle even bigger capital inflows. This normally happened when the financial system of a country is not entirely liberalized. In terms of policy recommendations, we have suggested three possible strategies for sterilization:

- *Financial infrastructure:* We recommend the CBG to pay more attention or spend toward financial liberalization and financial infrastructure rather than foreign reserve accumulation.
- *Government Deposits:* Shifting public sector deposit form commercial banks to the central bank can reduce the money supply in The Gambia. This method has been proven to the effective as in the case of Malaysia and Thailand.
- *Variable Deposit Requirements:* To limit excess capital inflows, we recommend the central bank to impose a deposit requirement, whereby a certain portion of foreign currency borrowed by domestic residents is deposited with the central bank as interest-free, non-assignable deposit, denominated and paid in foreign currency for a specified period, however, the holding date can be varied, and could be adjusted recurrently in reply to fluctuating market conditions. Commonly viewed as a method of capital control, it is also be regarded as a sterilization mechanism since it directly sterilizes a portion of capital inflows and this, can offset certain cost of sterilization. Variable deposit requirements do not have direct influence on national interest rates and does not have a direct perpetuating risk on the money supply. The main benefit is that it discourages short-term borrowings, and such borrowings are generally seen as the most destabilizing form of capital inflows.

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