AIUB Journal of Business and Economics [AJBE]

Volume 19, Issue 2, December 2022 Pages 38-51

Research Article

ISSN: 1683-8742 (PRINT) 2706-7076 (ONLINE) Homepage: https://ajbe.aiub.edu

An Empirical Investigation into the Demand for International Reserve using Precautionary and Mercantilist Approach

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Abstract

Purpose of the study: The study aims at analyzing the determinants to the continuous accumulation of foreign reserves in Bangladesh, like other emerging and developing countries.

Methodology: The paper investigates the mercantilist and precautionary motive for hoarding reserves, taking monthly data from 2010:06 to 2019:12. To establish the long-run relationship between foreign reserves and their determinants, the ARDL model has been used.

Findings: The result shows precautionary variables mainly contribute to accumulating the volume of reserves. The sterilization index results show no sterilization of the central bank to devaluate the exchange rate, and the deviation of the real effective exchange rate, which captures the mercantilist motive, remains insignificant in the long-run.

Implications: (Practical / Social /Theoretical) The precautionary motive is the primary determinant of hoarding reserves, while the export-led mercantilist motive is not the contributory factor.

Limitations and Future direction: However, our paper does not measure the optimal level of reserve holding or efficient level of reserves, and inference on efficiency requires more data on the cost of keeping reserves and the probability of exogenous shock.

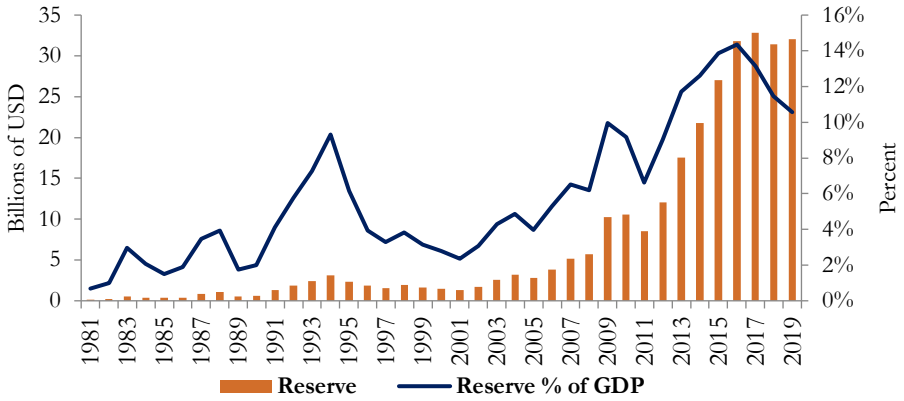
Article History:
Received: 25 August 2022
Accepted:18 November 2022
Online: 5 December 2022

Keywords:
International reserve, Precautionary motive, Mercantilist motive, Real effective exchange rate, ARDL.

1. Introduction

The East Asian Crisis caused the initiation of the accumulated foreign currency reserves in emerging market economies, especially in many Asian countries. The after-event of the crisis shows hints of a sharply changed attitude towards international reserves. The Tequila crisis in 1994 also substantiated the notion of holding reserves to offset the peril associated with hot money. Aizenman and Lee (2007), in their study, showed that countries hold reserves mainly to protect an economy from a negative impact and financial turbulence arising from the sudden stop of reserves or capital flight, termed as self-insurance or precautionary motive. Moreover, from a mercantilist motive, this infers a weakened exchange rate to gain competitiveness in exports. Folkerts-Landau, Dooley, and Garber (2003) support this

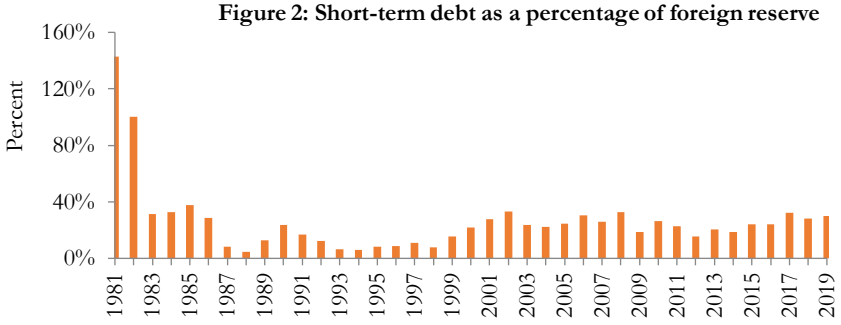
Figure 1: Reserve holdings trends in Bangladesh



Source: International Financial Statistics

mercantilist approach, and they view reserve accumulation as a tool to facilitate exports by slowing down or resisting appreciation of the domestic currency. At the beginning of 2000, Bangladesh also saw an exponential increase in foreign international reserves, and the reserve-to- GDP ratio increased to the highest 15% in 2015 (figure 1). Nevertheless, a country has to keep a definite level of reserves to meet the obligations of import bills, and short-term debt payment.Typically, the standard level of reserves is the amount with which a country can meet 3 months of import payment. However, the excessive amount of reserve accumulation can incur significant costs with an adverse impact on the macroeconomic internal balance. The short-term debt and import payment obligations are the key drivers of acquiring reserves in emerging countries and are termed as the precautionary motive. The short-term debt has continued to rise in Bangladesh due to ongoing various development projects financed by foreign investment, yet the ratio of short-term debt and reserves remained relatively stable for the last twenty years because of the higher growth rate accretion of reserves with the help of hefty remittances inflows throughout the period (figure 2).

Figure 2: Short-term debt as a percentage of foreign reserve



Source: WDI, the World Bank

A country's reserves comprises gold, special drawing rights (SDR), foreign currencies, and the reserve position with the International Monetary Fund (IMF) but in our study, we have defined total reserves as readily available by the external stock of assets minus gold and the control of monetary authorities (IMF, 2000). Bangladesh officially moved to a flexible exchange rate in 2003, but the monetary authority of Bangladesh managed its exchange rate. Thus it is not entirely flexible, and many researchers explain the unprecedented rise in the reserves as an instrument to keep the exchange rate undervalued to gain more competitiveness over rival countries. The empirical inquiry on the relevance of the precautionary motive and mercantilist motive for Bangladesh is limited, so this present study seeks to find the relevance of the mercantilist and precautionary motive for accumulating reserves for Bangladesh. The paper takes specific variables like import payment and short-term debt variables as a precautionary motive, while the devaluated taka against the dollar, regarded as the difference of the real effective exchange rate from its trend is taken as a mercantilist motive.

In section 2, the paper has reviewed the literature on the foreign reserves demand for emerging economies. The used model and the data of this paper are discussed in section 3. Section 4 presents an empirical model to capture the objective of the paper. In section 5, we explain the results and findings of the models. Section 6 offers some conclusions.

2. Literature Review:

Numerous studies are available on the causes of foreign exchange reserves in emerging and developing countries. Cabezas & Gregorio (2019) examined the reason emerging, and developing countries hoard excessive reserves by taking 52 emerging and developing market economies every year from 2000 through 2013. The result shows that earlier than the global financial crisis, mercantilist and precautionary motives were the key factors of massive reserve accumulation. The mercantilist motive remains significant for commodity-exporting-oriented countries. Explaining three East Asian Countries, Korea, China, and Japan, Aizenman & Lee (2008) conducted the objectives of hoarding international reserves. The study found that Japan and Korea might have depended on the mercantilist push for years of accelerated growth, where mercantilist push refers to an under-valued exchange rate to gain export competitiveness. Moreover, to identify the justification of mercantilist and precautionary motives, Aizenman & Lee (2005) outlined a model to explain hoarding international reserves for developing countries. They found that the trade openness and risk to financial instability variables associated with precautionary motives are statistically significant in explaining reserves, while mercantilist motives are also statistically significant although they failed to explain economically the patterns of hoarding reserves, which is held even for China. Moreover, they also analyzed the contribution of both grounds in explaining the accumulation of reserves for emerging countries. The paper has taken data from 1980-2000 and empirical results showed that precautionary motive variable like trade openness is statistically significant. Theoretically, a sizeable precautionary demand acts like self-insurance by protecting the volatile condition of an economy when it faces a sudden stop reserve. However, the mercantilist motive variables are not statistically insignificant while stay insignificant economically in explaining reserves. On the other hand, Cruz (2015) studied the mercantilist motive in Latin American economies from 1996 to 2011 due to the unprecedented rise in hoarding foreign reserves in these countries. The paper investigates mercantilist motives, which implies an active industrial policy that allows the monetary authority to sustain a stable and depreciated real exchange rate by supporting economic growth using raising export competitiveness. However, the empirical results show the mercantilist motive is not statistically significant in hoarding reserves.

An impact on Import demand due to foreign exchange reserves in five Asian countries; Arize & Malindretos (2012) explore Japan, India, Korea, Thailand, and Singapore by examining relative import prices, the long-run and short-run influence on home earnings, and foreign exchange reserves on actual imports using quarterly data over 1973:2-2005:4. The empirical results show that the long-run and short-run, foreign exchange reserves have an impact on the demand of import. However, the economic impact on import demand remains insubstantial. Explaining the precautionary approach, Prabheesh et al. (2007) used the vector error correction model to scrutinize the foreign exchange reserve demand of India using quarterly data from 1983-2005 and found a precautionary measure that acts as the self-insurance motive against sudden capital-flight

holds for hoarding international reserve. However, they found exchange rate movements and the opportunity cost of keeping reserves seem less sensitive to reserve holding.

The abrupt change in the pattern of holding reserve may be caused by the East –Asian Crisis that can act as a structural change, explored by Aizenman et al. (2007) in the case of Korea. The probability of output collapse due to hot money, including short-term debt and foreigners' shareholding, validated the precautionary demand for reserves shown in the study's findings. Meanwhile, the paper did not investigate the differential impact of precautionary versus mercantilist motives where the concerns of export competitiveness can trigger the latter motive. In another paper, Aizenman & Marion (2002) conclude that political upheaval or political graft can play roles in changing the optimality of hoarding reserves taking data from 125 developing countries throughout 1980-1996 for holding reserves using a model incorporating adjustment costs and precautionary saving. The study also reveals demand for precautionary reserves can also be brought by country risk and financing fiscal liabilities with increased tax rates. In the consequences of the 1997 financial crisis, the international reserve demand increased, fearing another shock.

In light of the context of Bangladesh, few papers explain the demand for foreign exchange reserves. Chowdhury et al. (2014) assessed factors of foreign reserves of Bangladesh using annual data between 1972 and 2011, taking 10 variables. The paper used Engle Garner's cointegration technique to find the long-run association. It confirmed an existence of a substantial association among exchange rate, domestic interest rate, M2, remittance, the unit price of import and export, foreign exchange reserves, and per capita GDP. However, this paper needed to establish foreign aid as a factor contributing to foreign exchange reserves. In comparison, Afrin et al. (2014) analyzed the motive of stockpiling international foreign reserves in the context of the recent development of Bangladesh. It used quarterly data from 1997-2012, applying the Johansen cointegration technique as well as error correction model to figure out the optimality of hoarding reserve using some benchmark ratios. The study's finding indicates that variables like average import propensity and exchange rate volatility regarded as precautionary motives are statistically significant. The paper's empirical results conclude that the current account's vulnerability leads to the central bank hoarding foreign exchange reserves.

There are many research papers to explain mercantilist and precautionary motives for accumulating reserves in developing countries. However, in Bangladesh, the empirical researches are scanty, which allows us to explore whether precautionary and mercantilist motives hold in our country. This study wants to fill the void and create new knowledge on amassing foreign exchange reserves.

3. Model Formulation and Data

3.1 Data

The collected data is mainly from "Monthly Economic Trend," a monthly series published by Bangladesh Bank and Bangladesh Treasury Bill rate is collected from International Financial Statistics, and the data for (real)effective exchange rate and short-term external debt are collected from the Monetary Policy Department and the Statistics Department of Bangladesh Bank. While the frequency of all series data is monthly, except for short-term debt is a quarterly data set, the data frequency has been converted to monthly data series using the quadratic match-sum using EViews software, and the sample space is from July 2010 to December 2019.

3.2 Model Formulation

To determine the factors mainly precautionary and mercantilist motive variables to accumulate Foreign Exchange Reserve (FER) in Bangladesh have been taken into account, we construct a reserve demand function estimated approach by incorporating a real effective exchange rate termed as a mercantilist motive, while the volume of import and short-term debt is defined as precautionary motives beside other explanatory variables of the reserve.

$$Fer_t=\alpha_0+\beta_1 Im_t+\beta_2 Cmr_t+\beta_3 Rem_t+\beta_4 Td\_reer_t+\beta_5 Str_t+\varepsilon_t \quad (1)$$

$$Fer_t=\alpha_0+\beta_1 Im_t+\beta_2 Tbr_t+\beta_3 Rem_t+\beta_4 Td\_reer_t+\beta_5 Str_t+\varepsilon_t \quad (2)$$

In the model (1) Fer_t refers to the value of reserves at a time 't', Im is the value of import, Cmr is the call money rate as a proxy to calculate the opportunity cost of holding reserve, Rem is defined as the value of remittance inflow in a month, Td_reer is the difference between real effective exchange rate from its trend, Str denotes the amount of the monthly short-term debt to be repaid within one year. In model (2), the basic difference is the use of the Treasury bill rate as the opportunity cost of holding reserve. Here, $\beta_1, \beta_2, \beta_3, \beta_4,$ and β_5 are the estimated parameters, α_0 denotes the intercept, and ε_t is the disturbance term. Variables are estimated in logarithmic form except for the Td_reer variable, which has some negative value in the series.

The impact of the volume of imports on foreign reserves is still a question in the literature. Heller (1966) argued the volume of imports could be used to measure trade openness while the adjustment cost is the inverse of the import volume so that greater openness could lead to lower reserve holding. In contrast, Frenkel and Jovanovic (1980) argue greater openness increases the probability of facing external shocks. Thus, it can positively affect foreign reserves. The variables Cmr or Tbr have an inverse direction with fer since the higher opportunity cost of reserve holding will induce reduced reserves. With the gradual increase of remittance inflow (Re), foreign exchange reserves have coupled up; they will have a positive association. Economists who support the mercantilist view regard the positive influence of td_reer (depreciation) on fer holding. An undervalued exchange rate will give an extra advantage over other rival countries, which will robust the export demand for the host country. In contrast, developing countries with higher dependency on imported inputs can also be hurt. However, we assume to get a positive relationship between the variables.

Short-term debt has become a concern for countries after the East Asian crisis and fear of a sudden stop of capital inflow can destabilize macroeconomic balance and the overall output of a country. As a precautionary concern, the short-term debt and reserves are expected to have a positive association.

4. Econometrical Methodology

4.1 HP filter Technique:

The standard technique in macroeconomics is the Hodrick-Prescott (HP) filter, often used to flat out the estimates of a series' long-term trend (Hodrick & Prescott, 1997). The HP filter incorporates a time-varying method to reveal the long-term movement of a series by removing the short-run fluctuations and permits the trend to go along with a stochastic process, in contrast to the orthodox method where a trend series does not follow a stochastic path (Prabheesh, et al., 2009). In this paper, the HP calculates the smoothed series of real effective exchange rate $reer_t$ by minimizing the variance of reer around $reer_t^T$ subject to a price that constraints the second difference of $reer_t^T$. The technique selects $reer_t^T$ to minimize

$$\sum_{i=t}^{n}(reer_t - reer_t^T)^2 + \lambda \sum_{i=t}^{n-1}(\Delta reer_{t+1}^T - \Delta reer_t^T)^2$$

Where λ is the flattening parameter and the size of sample is n. A value of 126,400 for the monthly series (Harvey & Jaeger, 1993) is taken for λ. One of the variables of mercantilist motive is Td_reer which is obtained by taking the subtraction between the $reer_t$ (actual series) and the $reer_t^T$ (smoothed series) so that Td_reer is the divergence of the reer from its trend.

4.2 Unit Root Test

The mean-reverting property of a time series variable ensures the stationarity of the series. Suppose a time series variable does not hold the stationarity property. In that case, a series' mean and standard deviation exhibits deviation over time; hence, the covariance between two-time periods depends on the actual time. As a result, a shock to a non-stationary time series process would permanently affect the values of the series, and the long-run equilibrium could not be achieved. The time-series data can be stationary at the level form I (0) or after the first differencing I (I). For this purpose, the ADF test procedure has been used to test the stationarity property. ADF test has three specifications:

$$\Delta M_t = \alpha_1 M_{t-1} + \sum_{j=1}^{p} \gamma_j \Delta M_{t-j} + \varepsilon_t \quad (3)$$

$$\Delta M_t = \alpha_0 + \alpha_1 M_{t-1} + \sum_{j=1}^{p} \gamma_j \Delta M_{t-j} + \varepsilon_t \quad (4)$$

$$\Delta M_t = \alpha_0 + \alpha_1 M_{t-1} + \alpha_2 t + \sum_{j=1}^{p} \gamma_j \Delta M_{t-j} + \varepsilon_t \quad (5)$$

ε_t is a white noise error term. To ensure there is no correlation among errors, additional lagged terms are counted in the model. The propositions for the ADF test are:

H_0: y_t is non-stationary; and H1: y_t is stationary

We make a decision by comparing the ADF test statistics with the critical value from Fuller's table. We reject the null hypothesis of non-stationary and vice-versa if the result of test statistic is not smaller than the critical value. We can have enough evidence that the underlying variable is I (0). If the variable is proved not to be I (0), then the ADF test is performed after first differencing. If a series becomes stationary after first differencing, we refer to the variable as I (1).

4.3 ARDL MODEL:

The Johansen Cointegration technique commonly incorporates establishing an association between a and a set of regressors and a dependent variable. The variables of interest have to be integrated of order one in the Johansen technique. If the variables of interest are of mixed order of integration, the test is not directly applicable. This requirement of order one requires some pre-testings and creates ambiguity in analyzing of the level of associations (Cavanagh, et al., 1995). Pesaran, Shin & Smith proposed a model based on standard F-test and T-statistics known as an autoregressive distributed lag (ARDL) by testing the significance of the lagged levels of the variables in a univariate equilibrium correction mechanism, regardless of whether the regressors are purely I(0) or mutually cointegrated or I(1). The model has some advantages in case of estimation.

While the Johansen test involves a system of equations, the model takes just a single reduced form of the equation to examine the cointegration of the variables, and the model exhibits robustness for a small sample (Pesaran, et al., 2001). Moreover, to choose the optimal lag length, the ARDL model allows different lag lengths for interest variables, which improves the model's fitness. On the contrary, if any one of the interested variable's order is I(2), we cannot apply the ARDL technique.

The following ARDL models are estimated to verify the long-run associations.

$$\Delta Fer_t = \alpha_0 + \beta_1 Fer_{t-1} + \beta_2 Im_{t-1} + \beta_3 Rem_{t-1} + \beta_4 Td\_reer_{t-1} + \beta_5 Str_{t-1} + \beta_6 Tbr_{t-1} + \sum_{i=1}^{p} \gamma_i \Delta Fer_{t-i} + \sum_{i=1}^{p} \delta_i \Delta Im_{t-i} + \sum_{i=1}^{p} \theta_i \Delta Rem_{t-i} + \sum_{i=1}^{p} \vartheta_i \Delta Td\_reer_{t-i} + \sum_{i=1}^{p} \rho_i \Delta Str_{t-i} + \sum_{i=1}^{p} \tau_i \Delta Tbr_{t-i} + \varepsilon_t \dots\dots (6)$$

$$\Delta Fer_t = \alpha_0 + \beta_1 Fer_{t-1} + \beta_2 Im_{t-1} + \beta_3 Rem_{t-1} + \beta_4 Td\_reer_{t-1} + \beta_5 Str_{t-1} + \beta_6 Cmr_{t-1} + \sum_{i=1}^{p} \gamma_i \Delta Fer_{t-i} + \sum_{i=1}^{p} \delta_i \Delta Im_{t-i} + \sum_{i=1}^{p} \theta_i \Delta Rem_{t-i} + \sum_{i=1}^{p} \vartheta_i \Delta Td\_reer_{t-i} + \sum_{i=1}^{p} \rho_i \Delta Str_{t-i} + \sum_{i=1}^{p} \tau_i \Delta Cmr_{t-i} + \varepsilon_t \dots\dots (7)$$

The equations 6 & 7, the RHS with parameter β_i s denotes long-run relationship and the parameters $\gamma_i, \delta_i, \theta_i, \vartheta_i, \rho_i,$ and τ_i characterizes the model's short-run dynamics. An F-test for the joint significance of the coefficients of the lagged levels of the variables to establish the long run associations is required.

$$H_0; \beta_i = 0 \text{ and } H1; \beta_i \neq 0 \quad \text{while } i = 1 \dots 6$$

The rejection of the null hypothesis requires the existence of a long-run relationship or cointegration is established. However, to test the hypothesis, Pesaran, Shin, & Smith (2001) suggests lower and upper values for the F-statistic while the upper critical value takes the regressors are I(1) and the lower critical value takes

the regressors are I(0). If the calculated F-statistics is higher than an upper critical value, we can reject the null hypothesis irrespective of the order of integration of the variables. The result is unsettled if the test statistic remains between the lower and upper critical values. If the cointegration is verified, the conditional ARDL long-run model for Foreign Exchange Reserve can be derived as the following:

$$\Delta Fer_t = \alpha_0 + \sum_{i=1}^{p} \gamma_i \Delta Fer_{t-i} + \sum_{i=1}^{p} \delta_i \Delta Im_{t-i} + \sum_{i=1}^{p} \theta_i \Delta Rem_{t-i} + \sum_{i=1}^{p} \vartheta_i \Delta Td_{reer_{t-i}} + \sum_{i=1}^{p} \rho_i \Delta Str_{t-i} + \sum_{i=1}^{p} \tau_i \Delta Tbr_{t-i} + \varepsilon_t \quad (8)$$

$$\Delta Fer_t = \alpha_0 + \sum_{i=1}^{p} \gamma_i \Delta Fer_{t-i} + \sum_{i=1}^{p} \delta_i \Delta Im_{t-i} + \sum_{i=1}^{p} \theta_i \Delta Rem_{t-i} + \sum_{i=1}^{p} \vartheta_i \Delta Td_{reer_{t-i}} + \sum_{i=1}^{p} \rho_i \Delta Str_{t-i} + \sum_{i=1}^{p} \tau_i \Delta Cmr_{t-i} + \varepsilon_t \dots\dots (9)$$

Then we choose these models' appropriate lag lengths based on Schwarz's Bayesian information criterion (SBC). The error correction model estimates short-run dynamics (Prabheesh, et al., 2009).

$$\Delta Fer_t = \alpha_0 + \sum_{i=1}^{p} \gamma_i \Delta Fer_{t-i} + \sum_{i=1}^{p} \delta_i \Delta Im_{t-i} + \sum_{i=1}^{p} \theta_i \Delta Rem_{t-i} + \sum_{i=1}^{p} \vartheta_i \Delta Td\_reer_{t-i} + \sum_{i=1}^{p} \rho_i \Delta Str_{t-i} + \sum_{i=1}^{p} \tau_i \Delta Tbr_{t-i} + \varphi ECM_{t-1} + \varepsilon_t \dots\dots (10)$$

$$\Delta Fer_t = \alpha_0 + \sum_{i=1}^{p} \gamma_i \Delta Fer_{t-i} + \sum_{i=1}^{p} \delta_i \Delta Im_{t-i} + \sum_{i=1}^{p} \theta_i \Delta Rem_{t-i} + \sum_{i=1}^{p} \vartheta_i \Delta Td\_reer_{t-i} + \sum_{i=1}^{p} \rho_i \Delta Str_{t-i} + \sum_{i=1}^{p} \tau_i \Delta Cmr_{t-i} + \varphi ECM_{t-1} + \varepsilon_t \dots\dots (11)$$

5. Empirical Analysis

5.1 The Sterilization Index[1] for Bangladesh

Using 12 months observation, a coefficient β based index of sterilization is constructed by the following annual ordinary least squares regression:

$$\Delta NDA_{i,T,k} = \alpha_{i,T} + (-1)\beta_{i,T}\, \Delta NFA_{i,T,k} + \mu_{i,T,k} \quad (12)$$

Here, $\Delta NDA_{i,T,k}$ is the country i's monetary authority's net domestic assets monthly change, and $\alpha_{i,t}$ is a constant and $\Delta NFA_{i,t,m}$ are the changes in the net foreign asset of country i at month m of year t and $\mu_{i,t,m}$ is the error term (WEO, 2007). Full monetary sterilization indicates the value of β equal to –1 or lower, while a value of 0 represents no sterilization. This index estimates the degree of the central bank's sterilization effort, while the purchase of foreign exchange is offset by changing the composition of the net domestic asset. The slope coefficient β is multiplied by -1 for simplicity and now an estimated value of β equals 1 means full sterilization while no sterilization means a value of 0.

$$\Delta NDA = 552.65 + (-1)0.46^{*}\, \Delta NFA + \mu$$

(76.31) (0.21) adj R squared= 0.030

Here, the estimated following equation with OLS using monthly data from 2010:M1:2019:M12 for Bangladesh. The parameters are statistically significant at a 5%. The β' coefficient value is (-.46) which is lower than 0 implies there is no sterilization in Bangladesh.

Again we can construct a broader index of sterilization using 12-month observations:

$$\Delta M2_{i,T,k} = \alpha_{i,T} + \beta_{i,t}\, \Delta NFA_{i,T,k} + \mu_{i,T,k} \quad (13)$$

[1] World Economic Outlook, April (2007)

Here $\Delta M2_{i,t,m}$ is country i's money supply's monthly change, and $\alpha_{i,t}$ is a constant and $\Delta NFA_{i,t,m}$ are the changes in the net foreign asset of country i at month m of year t and $\mu_{i,t,m}$ is the error term. Therefore, a zero value of β suggests full monetary sterilization, whereas no sterilization means the value of 1.

$$\Delta M2 = 552.66 + 1.456^{*} \Delta NFA + \mu$$

(76.31) (0.21) adj R squared= 0.038

The estimated following equation with OLS is using monthly data from 2010:M1:2019:M12 for Bangladesh. The parameters show a 1% level of significance. The β' value is (1.46) which is higher than 1, implying there is no sterilization in Bangladesh.

5.2 Estimation of Real Effective Exchange Rate using HP Filter

Figure 3: Deviation of reer from its trend

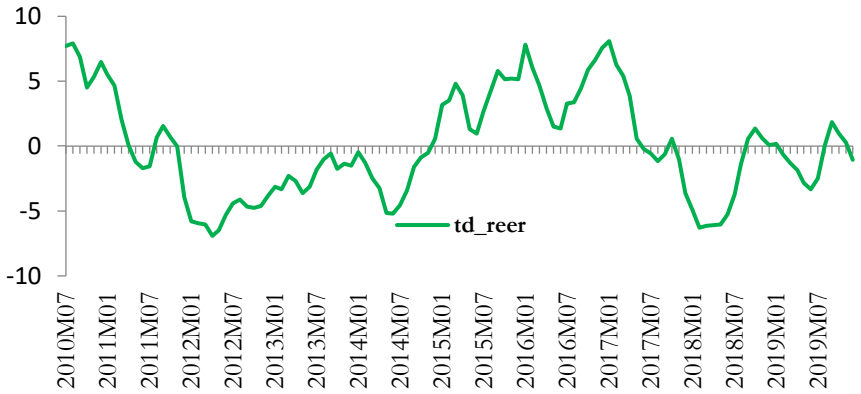


Figure 3 shows an approximately equal number of periods of positive and negative value, while the no negative values indicate an appreciated (real) exchange rate of the US dollar in opposition to the taka.

5.3 The Test of Stationary

The Augmented Dickey-Fuller (ADF) test' outline for stationary intended for each variable in the model is shown in Table 1.

Table 1: The Result of ADF Test

Variable	Level (intercept)		First Difference		Order
	T-statistics	P-Value	T-statistics	P-Value	
Fer	-1.208276	0.669	-2.889747**	0.0498	I(1)
Im	-1.738639	0.4091	-9.949895*	0.0000	I(1)
Tbr	-1.84684	0.3563	-10.3018*	0.0000	I(1)
Rem	-0.21748	0.9317	-5.74197*	0.0000	I(1)
Ex	-0.68877	0.844	-5.32234*	0.0000	I(1)
Td_reer	-3.35761**	0.0146			I(0)
Cmr	-2.4209	0.1384	-15.5236*	0.0000	I(1)
Std	-1.1071	0.7111	-6.624453*	0.0000	I(1)

Note: ***, **, * indicates 10% ,5%, 1% significance levels respectively.

Firstly, the variables are examined at their level form, if they are not statistically significant in their probability value; they are tested at their first difference, the ADF test suggests that except Td_reer, all other variables are non-stationary at level data and Td_reer becomes stationary at level data as expected because Td_reer is the difference of the reer from its trend. As we have a mixture of I (0), I (1), and no I (2) variables, we can use the ARDL model to find short-run and long-run relationships among the variables.

5.4 ARDL Model Estimation

Estimation of the reserve equation (1) & (2) process is needed to perform a bound test, which indicates the variables' long-run relationship. Table 2 exhibits the results of the F-test-based bound test of cointegration.

Table 2: Bound Test Result of Cointegration

Model 1			Model 2		
Level of Significance	SBC		Level of Significance	SBC	
	F -statistics= 6.626622			F-statistics= 6.6621	
	I(0)	I(1)		I(0)	I(1)
10%	2.26	3.35	10%	2.26	3.35
5%	2.62	3.79	5%	2.62	3.79
2.5%	2.96	4.18	2.5%	2.96	4.18
1%	3.41	4.68	1%	3.41	4.68

Note. ***, **, * indicates 10% ,5%, 1% significance levels respectively.

In Model 1, to select the appropriate lag length, we have chosen Schwarz's Bayesian information criterion (SBC), and the estimated value of F-statistics value is 6.62 higher than the upper critical value, while the significance level is 1%. The estimate results imply the rejection of the no cointegration (null hypothesis).

For Model 2, we have used Schwarz's Bayesian information criterion (SBC). The estimated value of the F-statistics value is 6.66 greater than the upper critical value at a 1% significance level. Thus, the rejection of null hypothesis of no cointegration can be established for Model 2. Thus, the bound test establishes a long-run relationship between foreign exchange reserves and its determinants for Model 1 and Model 2.

5.5 Long-run Estimation

In Model 1 and Model 2, the long-run coefficients are calculated by the ARDL model in EViews and the technique assumes that residuals are serially uncorrelated. As the frequency of data is monthly, the chosen maximum lag length is eight for Model 1 and Model 2. The long-run coefficients of ARDL for Model 1 and 2 using SBC criteria are exhibit in table 3.

Table 3. Result of Long-run coefficients

	Model 1	Model 2
Regressors	SBC	SBC
Im	-1.103 [0.05]**	-1.529 [0.04]**
Cmr	-0.261 [0.04]**	
Tbr		-0.154 [0.07]**
Rem	0.322 [0.28]	0.511 [0.19]
Td_reer	0.013 [0.18]	0.013 [0.29]
Std	0.349 [0.00]*	0.439 [0.00]**

Note: ***, **, * indicates 10% ,5%, 1% significance levels respectively.

The coefficients are not statistically significant at even 10%. The variable Td_reer, the deviation of reer from its trend, shows a positive result that implies the depreciation. Table 3 shows that we have estimated the long-run relationship for two equations while the difference between the two equations is for only one variable. In

Model 1, we have taken Call money rate as the measure of opportunity cost and, in Model 2, Treasury bill rate is taken as a substitute variable to measure the opportunity cost of holding reserve. The call money rate and the rate of treasury bill have shown theoretically expected sign, which is negative, and both are statistically significant.

All long-run coefficients for reserve demand functions show theoretically expected signs while import shows a negative relationship. The coefficient of import elasticity is more stable in Model 2.

The coefficient of Remittance is positive, which is theoretically expected, but the exchange rate increased the amount of reserve while the coefficient is not significant even at 10% level in both models. The test result of this variable substantiates the results of the sterilization index in the paper where we have seen the monetary authority has never sterilized the money market to devaluate the exchange rate to increase export competitiveness, which is defined as the mercantilist approach to accumulate reserves.

The coefficient of short-term debt has a positive impact on foreign exchange demand and is statistically significant at a significance level of 1%. After the East-Asian Crisis, the monetary authority of developing countries started to give attention to the volume of short-term debt, which poses a greater risk on the verge of the crisis. The estimated coefficients of short-term debt are consistent, (0.35) and (0.44), in both models, that infer 1% increase in short-term debt raises reserve demand by 0.35% in Model 1 and by 0.44% in Model 2.

5.6 Short-run Estimation

The error correction term's outcome is exhibited in Table 4 and the value of the short-run coefficient of the error-correcting parameter is statistically significant. The error-correction term's coefficient is negative that implies the speed variables converge to the equilibrium if there is short run disequilibrium.

Theoretically, the error-correction term's value should be -1 to 0, if there is no disequilibrium. In table 4, based on SBC, the value of ECM for Model 1 is -0.05 and, the value of ECM for Model 2 is slightly different which is -0.04.

The short-run estimate for Model 1 based on the SBC lag length criteria using ARDL specification determines the lag length respectively for and ARDL (SBC) (7, 0, 4, 0, 0, 0).

Table 4: Results of Error Correction Term

		Ecm_{t-1}	P-value
Model 1	SBC	-0.048*	0.00
Model 2	SBC	-0.039*	0.00

Note: ***, **, * indicates 10% ,5%, 1% significance levels respectively.

The short-run estimation of Model 1 for SBC is highly similar to what we have seen in the long-run estimation. The own lag of foreign reserves has an ambivalent impact on the current foreign exchange reserves, while one month remains statistically significant other lags are not statistically significant.

Table 5: Result from Short-run Estimation for Model 1 and 2

Variables	Model 1		Model 2	
	SBC(7,0,4,0,0,0)		SBC(7,0,4,0,0,0)	
	Coefficient	P-value	Coefficient	P-value
C	0.702*	0.00	0.614*	0.00
ΔFer_{t-1}	-0.176**	0.02	-0.170**	0.02
ΔFer_{t-2}	0.081	0.30	0.099	0.20

ΔFer $_{t-3}$	-0.021	0.78	-0.001	0.99
ΔFer $_{t-4}$	0.141***	0.06	0.152**	0.04
ΔFer $_{t-5}$	-0.062	0.35	-0.048	0.46
ΔFer $_{t-6}$	0.418*	0.00	0.421**	0.00
ΔIm $_{t}$	-0.052*	0.00	-0.059**	0.00
ΔRem $_{t}$	0.057*	0.00	0.061**	0.00
ΔRem $_{t-1}$	0.000	0.98	-0.001	0.95
ΔRem $_{t-2}$	0.006	0.63	0.007	0.60
ΔRem $_{t-3}$	0.045*	0.00	0.046**	0.00
ΔCmr $_{t}$	-0.012	0.12	-0.006	0.09
ΔStd $_{t}$	0.017*	0.00	0.017**	0.00
ΔTd_reer $_{t}$	0.001	0.25	0.000	0.36
Adj R-square	.9995		.9993	

Note: ***, **, * indicates 10% ,5%, 1% significance levels respectively.

Import has a significant adverse impact on reserve in short-run estimation also. SBC-based model, lags of import are not taken in the specification. The coefficient of Remittances is positive as predicted and statistically significant for concurrent and lag 3. In the AIC case, the Call money rate shows positive and negative relationships with foreign exchange reserve while lag 2 and 4 of the Call money rate remain significant. The short-term debt shows mixed positive and negative coefficient results, and most of the lags are statistically insignificant.

The divergence of the real effective exchange rate theoretically exhibits a positive sign as expected but remains statistically insignificant, as we have seen in the long-run estimation. For call money rate and short-term debt and deviation of reer, the model specification does not take any lags, the two variables' signs are empirically expected, and short-term debt is statistically significant while Cmr remains significant.

The short-run estimate for Model 2 is based on SBC lag length criteria using ARDL specification, which determines the lag length for ARDL (SBC) (7, 0, 4, 0, 0, 0) (See Figure 4.2 in Appendix). In model 2, we have used the Treasury bill rate as a proxy variable of

The opportunity cost, while in model 1, call money has been used, and all other variables are the same in both models. The short-run estimates for the model based on SBC show similar results to model 1. Lags of treasury bill rates in SBC are not statistically significant.

Table 6 represents the diagnostic tests on both models to find the existence of serial correlation and heteroskedasticity. The alternative hypothesis of both tests assumes that the models have serial correlation and heteroskedasticity. The F-statistics and associated P-value in both cases show that the null hypothesis cannot be rejected at a 10% significance level. So, the models used in this study are free of heteroskedasticity and serial correlation.

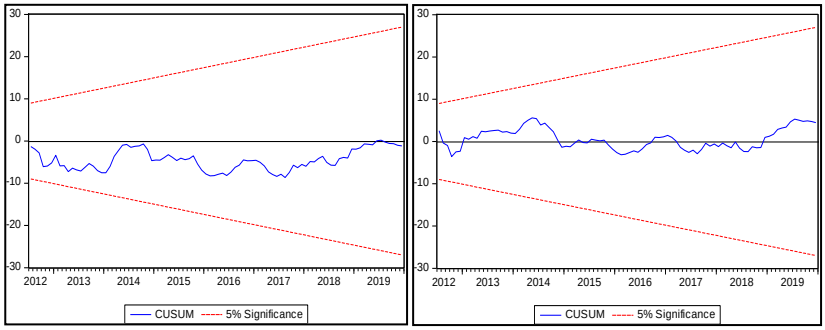
Table 6: Diagnostic Tests

		Test of Serial Correlation		Test of Heteroskedasticity	
		F-statistic	P-value	F-statistic	P-value
Model 1	SBC	1.7161	0.11	1.4677	0.18
Model 2	SBC	1.4567	0.19	1.4336	0.19

Note. *,**,*** indicates 1%, 5%,10% significance level, respectively

Moreover, figures 4 and 5 show the finding of the cumulative sum (CUSUM) test to verify the stability of the long-run parameters across sample periods. The graphs show that the cumulative sum does not go outside of the area between the two critical lines and the models are stable over the sample periods.

Figure 4 & 5 : CUSUM Test for Model 1& 2 based on SBC



6. Conclusion

This paper empirically investigated the raised question of what factors contributed to the stockpiled reserve accumulation in Bangladesh. This paper has also outlined two models for a reserve demand function that aids in isolating contributions derived from precautionary motives and mercantilist motives for reserves. Using monthly data from July 2010-December 2019, the reserve demand functions include explanatory variables such as call money rate and treasury bill rate as a proxy measure for opportunity cost, imports, and short-term debt to capture precautionary intention and the divergence of the reer from its trend to encapsulate the mercantilist motive and the HP filter estimation method has been used to derive the deviation.

The cointegration results based on the ARDL model show a long-run relationship between reserves and their factors, except for the difference in the real effective exchange rate that intends to capture the mercantilist motives. The two models unanimously remained statistically insignificant for the mercantilist motives, and the positive value of the coefficient is staggeringly low. The sterilization index calculated in this study also validated the non-sterilization of foreign exchange reserves to impart a depreciation of the domestic currency to gain export competitiveness. The variables associated with precautionary motives (import and short-term debt) are statistically significant in determining hoarding reserves. Therefore, the balance of payment vulnerability and the self-insurance against the short-term debt repayment influence the holding reserve. The proxy variables for measuring opportunity cost show that reserve holding is sensitive to opportunity cost. However, our paper does not measure the optimal level of reserve holding or efficient level of reserves, and inference on efficiency requires more data on the cost of keeping reserves and the probability of exogenous shock. Our study reveals that the precautionary motive is the primary determinant of hoarding reserves, while the export-led mercantilist motive is not the contributory factor.

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