# CAPITAL MOVEMENTS AND STERILIZATION POLICIES IN PAKISTAN

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**ABSTRACT**

*This paper focuses on finding out about what extent the Central Bank sterilizes the effect of changes in net foreign assets on domestic monetary base and if such sterilization results equal and opposite changes in net foreign assets using monthly data from 1982M1 to 2013M2. We find that the Central Bank partially sterilizes its foreign exchange operation. However, the Central Bank's foreign exchange interventions results equal and opposite changes in net foreign assets which is consistent with perfect substitutability between domestic and foreign assets. This implies that monetary authorities in Pakistan are not independent in formulating an independent monetary policy. The Central Bank's efforts to maintain domestic monetary base unchanged by changing net domestic assets result equal and opposite changes in its net foreign assets.*

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**Keywords**: Sterilization, Foreign Exchange Intervention, Unit Root JEL Classification Codes: E31, E51, E52, E58

## INTRODUCTION

Since the adoption of managed float on 8th January 1982, Pakistan's foreign exchange reserves have continuously risen though with marked fluctuations. Pakistan received US $ 968.5 million in 1982. During the decade of 1980s, Pakistan's foreign exchange reserves averaged US $ 863.75 million and rose to US $ 1181.41 million at the end of 1999. However, the situation entirely changed in wake of the US terrorist attack on September 11th, 2001. Pakistan aligned itself with western countries in their war against terrorism. This resulted massive capital inflows in the country. Pakistan's foreign exchange reserves, which stood at US $ 1513.35 million at the end of 2000 rose to US $ 8078.29 million by the end of 2002. However, foreign exchange reserves indicated reversing and dropped from US $ 14,044 million in 2007 to US $ 7192.24 million in 2008. Such a volatile behaviour of foreign exchange reserves of the country is attributed to political uncertainty[1], structural adjustments, climatic conditions, lifting of sanctions, and cessation of foreign aid to Pakistan after the collapse of Union of Soviet

[1] From 1988 to 1999, people of Pakistan saw seven governments one after the other.

Socialist Republic (USSR) and country's alignment with western countries in their war against terrorism.

Foreign exchange reserve accumulation has both pros and cons for the country. **C**apital inflows provide additional finance and enhance investment opportunities in the recipient country (Altınkemer, 1998) meet the recipient country's precautionary needs, avoid terms of trade shocks on its real exchange rate, guard its export competitiveness and reduce its reliance on IMF and World Bank (Aizenman & Glick, 2009). Furthermore, foreign exchange reserves have potential to contribute to higher investment and economic growth, ease external financing burden, maintain exchange rate stability, help honour external debt obligation, cushion the economy against future exigencies, and pay for overseas expenditures (Khan 1996; Lee 1996; Khan & Ahmed 2005; Zhang 2010; and Rizvi *et.al.* 2011).

Foreign exchange reserve accumulation also has negative effect for the economy. Foreign exchange reserve changes influence country's nominal exchange rate. Capital inflow/ outflows represent an increase/decrease in demand for a country's assets—thus, in the absence of policy intervention, the recipient country currency appreciates/depreciates in foreign exchange market (Hagiwara, 2004). Exchange rate changes have important implications for key macroeconomic variables that include domestic output, unemployment, inflation, and balance of payments. Exchange rate depreciation cause domestic prices to rise if purchasing power parity holds. Even if purchasing power parity is violated, we do expect the effect of nominal exchange rate changes on domestic economy through real exchange rate.[2] Real exchange rate influences country's competitiveness in international market. Overvaluation of real exchange rate reduces competitiveness of a country in international market and cause current account of the country to worsen (Gilal, 2011).

A surge in capital inflows causes money supply and exchange rate to rise (Calvo, 1994). Such inflows also have inflationary effects on domestic economy. Lee (1996) relates heightened speculative activity and disruption of financial markets in wake of reversal of capital inflows. In addition, these inflows typically burden monetary authorities with difficult choices over conflicting policy objectives and an equally challenging task of maintaining monetary control in a new and liberalized environment (Lee, 1996; Ljubaj *et.al.,* 2010; Zhang, 2010; Hashmi, *et.al.,* 2011; Altınkemer, 1998 & Jan, *et.al.,* 2005). Exchange rate appreciation, export competitiveness, rise in domestic monetary base and associated rise in price level are some of the key effects of capital movements.

[2]Real exchange rate is simply nominal exchange rate adjusted for domestic to foreign price ratio.

Monetary authorities generally intervene in foreign exchange market to minimize undesirable effects of foreign exchange reserve changes on domestic macroeconomic indicators. Official foreign exchange intervention occurs when the authorities buy or sell foreign exchange. These foreign exchange interventions could be either sterilized or unsterilized. It is widely agreed that sustained unsterilized intervention results undesirable effects on domestic economy such as rise in inflationary pressures, create conflict between exchange rate and domestic monetary policy objectives, asset-price bubble and increase the exposure of public sector to foreign exchange. To deal with these undesirable effects on domestic macroeconomic conditions, authorities may resort to sterilized operations, which can be defined in general as any set of policies designed to mitigate the impact of reserve accumulation on domestic inflation and interest rates (Lavigne, 2008). To offset the expansionary effect of increasing foreign exchange reserves, the central bank may sterilize foreign assets by taking opposite actions with domestic assets, or implement other contractionary monetary policies (Zhang, 2010). The first intervention is referred in the empirical literature as unsterilized intervention[3] whereas the latter refers to sterilized intervention.[4] Under sterilized intervention monetary base of the country remains unaffected due to Central Bank's foreign exchange market operation (Sarno & Taylor, 2001; and Waheed, 2010).

However, in order to conduct sterilized operation, Central Bank has to offer higher interest rate to attract foreign investors to hold domestic bonds. The rise in interest rate may reduce demand for domestic money but it attracts further capital inflows. The surge in capital inflows due to increased interest rate may foil the Central Bank's attempt to neutralize the effect of capital inflows on domestic monetary base. Such phenomenon occurs when domestic and foreign assets are perfect substitutes. Hence, for sterilization policy to be successful, it is important that domestic and foreign assets must be imperfect substitute.

Given this context, we evaluate whether the Central Bank sterilizes the effects of changes in net foreign assets on domestic monetary base or not? We also estimate the magnitude by which efforts of the Central Bank to neutralize the impact of foreign exchange operations on domestic monetary base are offset by fresh capital inflows/outflows. Contrary to earlier studies such as: Qayyum & Khan (2003); Jan, *et.al.*, (2005); Waheed (2007 & 2010); Hashmi *et.al.*, (2011); and Hassan (2011), we simultaneously estimates

[3] Unsterilized intervention increase / decrease the monetary base of a country by the amount of purchase / sale of foreign exchange reserves.

[4] Under sterilized interventions, Central Bank neutralizes the effects of foreign exchange intervention on monetary base by selling and purchasing Government securities in open market (Sarno & Taylor, 2001 and Sahadeven, 2002).

sterilization and offset coefficient from 1982 to 2013. Furthermore, we divide the entire sample period into two sub periods from 1982 to 2000 and 2001 to 2013 on the basis of capital flow pattern and structural changes in the economy. Also none of these studies have estimated the sterilization coefficient for Pakistan for recently adopted free floating exchange rate on 17th July, 2000. This study bridges that gap and estimates the sterilization and offset coefficient for free float as well.

Rest of the paper proceeds as, Section-2 discusses the model followed by Section-3 which deals with data. In Section-4, we discuss time series properties of the data and in Section-5 empirical method and estimation results are given. Section-6 concludes.

**MODEL**

There are two approaches to evaluate empirically the effects of foreign exchange intervention on country's monetary base. The first empirical approach is developed by Cumby and Obstfeld (1981) and estimates sterilization coefficient from Central Bank's reaction function. In other words, this approach empirically estimates Central Bank's response to changes in domestic monetary base brought about by changes in net foreign assets of the country. It does not take into account the counter effect of sterilized intervention that attract further capital flows which offset the initial effect of sterilized intervention.

The second approach developed by Kouri & Porter (1974) is based on a net capital-flow equation. It examines how changes in net domestic assets influence capital inflows from abroad. This approach uses net foreign assets and net domestic assets as interdependent variables and can be used for estimating both sterilization and offset coefficient by inverting the equation of interest. Kouri & Porter (1974) net capital flow equation is given as:

$$\Delta NFA_t = \beta_0 + \beta_1 \Delta NDA_t + \beta_2 \Delta X_{1t} + u_{1t} \quad (1)$$

Here $NFA_t$ and $NDA_t$ refers to net foreign assets and net domestic assets respectively. $X_t$ is a vector of other exogenous variables that influence net domestic assets. $u_t$ and $\Delta$ refer to stochastic disturbance term and first difference operator respectively. Since, net domestic assets and net foreign assets are simultaneously determined therefore, we can use eq.1 for estimating sterilization and offset coefficients. Based on Kouri & Porter (1974) approach, we estimate the following empirical equations to evaluate sterilization and offset coefficient for Pakistan:

$$\Delta nda_t = \alpha_0 \Delta nfa_t + \alpha_1 \Delta mpi_t + \alpha_2 \Delta id_t + \alpha_3 \Delta q_t + u_t \quad (2)$$

The vector of exogenous variables now includes seasonally adjusted manufacturing production index ($mpi_t$), interest rate differential ($id_t$) and real exchange rate ($q_t$). Equation (2) is monetary authority's reaction function and is used to evaluate the Central Bank's response to changes in net foreign assets.[5] $\alpha_0$ in eq. (2) represents sterilization coefficient. Its values range between $0 \le \alpha_0 \le -1$. $\alpha_0$ = -1 implies that Central Bank fully sterilizes the effects of changes in net foreign assets on domestic monetary base. $\alpha_0$ = 0 imply no sterilization and $\alpha_0$ < -1 indicates partial sterilization. $\alpha_1 > 0$ since industrial production ($mpi_t$) represents real economic activity (Ljubaj, 2010) and stronger economic activity increase demand for real money balances to finance increased number of transactions. Thus an increase in production or real income causes domestic credit to increase. $\alpha_1$ could be either greater or less than zero. $\alpha_1$ > 0 when foreign interest rate ($i_t^*$) is greater than domestic interest rate ($i_t$).[6] $\alpha_3$ > 0 because monetary authorities tend to increase domestic credit to depreciate domestic currency in order to maintain competitiveness of domestic good in international market (Cumby & Obstfeld, 1981).

In order to estimate offset coefficient, equation (2) is inverted in terms of net foreign assets and is given as:

$$\Delta nfa_t = \beta_0 \Delta nda_t + \beta_1 \Delta mpi_t + \beta_2 \Delta id_t + \beta_3 \Delta q_t + v_t \quad (3)$$

$$-1 \le \beta_0 \le 0,\ \beta_1 > 0,\ \beta_3 > 0.$$

$\beta_0$ is an offset coefficient and it ranges between zero and minus one.[7] $\beta_0$ = -1 implies full capital mobility that is each increase / decrease in $nda_t$ is compensated by an equal increase/decrease in $nfa_t$. Under such circumstances, sterilization is unsuccessful because each increase / decrease in net domestic assets is replaced by increase / decrease in fresh foreign flows by the same amount. $\beta_0$ = 0 suggest imperfect substitutability between

[5] We instrument changes in net foreign assets in monetary policy reaction function with its own one period lagged change.

[6] Interest rate differential ($id_t$) is constructed by taking the difference between domestic ($i_t^*$) and foreign interest rate ($i_t$)

[7] We instrument changes in net domestic assets in eq. 3 with its one period lagged change.

domestic and foreign assets. $-1 \leq \beta_1 \leq 0$ represents partial effect of changes in net domestic assets on net foreign assets. Such a case warrants partial sterilization. $\beta_1$ is expected to be positive. $\beta_2$ could be greater than or less than zero. When, $i_t > i_t^*$ it attracts foreign capital inflows hence $\beta_2 > 0$. $i_t < i_t^*$ results capital outflows as investors withdraw their capital in pursuit of earning a higher foreign interest rate. In such a case, we expect $\beta_2 < 0$. Which effect is more dominant is an empirical issue.

**DATA**

This study uses monthly data from 1982M1 to 2013M12. All data is taken from International Monetary Fund International Financial Statistic CD Rom and is used in log form for estimating equations of interest. The choice of sample period is based on exchange rate regime shift in Pakistan. Pakistan adopted managed float on January 8th, 1982. Further, we divided the entire sample in two sub-samples i.e. 1982M1 to 2001M09 and 2001M10 to 2013M12 in order to see if the sterilization stance of the monetary authorities changed in the wake of surge in capital flows after September 11, 2001.When Pakistan allied itself with US and its strategic partners in their war against terror and in return received huge capital inflows.

**UNIT ROOT TESTS**

Empirical work based on time series data assumes that underlying stochastic process is stationary..…its mean, variance and covariance remain time invariant no matter at what point they are calculated (Gilal, 2011). Violation of these assumptions results non-stationary stochastic process.[8] Augmented Dicky Fuller test has been widely used in empirical time series literature for testing nonstationarity of the data. It is based on the following equation:

$$\Delta y_t = \beta_1 + \beta_2 t + \delta y_{t-1} + \sum_{i=1}^{m} \alpha_1 \Delta y_{t-1} + \varepsilon_t \quad (4)$$

Where $Y_t$ and $\varepsilon_t$ refers to stochastic time series process and white noise error term respectively. The test in equation 4 follows a random walk with drift ($\beta_1$) and a deterministic trend ($t$). Table 1 shows ADF test results in log level and log first difference with constant and constant and trend. Results indicate that null of unit root cannot be rejected for all variables in levels in both specifications. First difference result, on the other hand show

[8] The use of non-stationary data in empirical estimation results spurious regression.

that null of unit root can be rejected for all variables except net foreign assets ($nfa_t$). We also applied Phillips and Perron unit root test to test the nonstationarity of the data. Results indicated that null of unit root is rejected for all including net foreign assets at first difference in both specification.[9] Hence we conclude that all variables are *I*(1) in levels and *I*(0) at first difference.

**ECONOMETRIC METHOD AND EMPIRICAL RESULTS**

This paper uses instrumental variable estimation method for estimating monetary authorities' reaction function given by eq. (2) and capital flow equation given by eq. (3). Our main focus is to estimate $\alpha_0$ (sterilization coefficient) in eq. (2) and $\beta_0$ (offset coefficient) in eq. (3). This approach is adopted because changes in net domestic assets $(\Delta nda_t)$ and changes in net foreign assets $(\Delta nda_t)$ are simultaneously determined which results simultaneity problem.[10] In such situation, least square approach is biased which we overcome by using instruments for:

**TABLE-1**
**ADF TEST IN LOG LEVELS AND LOG FIRST DIFFERENCE**

| | Log Levels | | First Difference | |
|---|---|---|---|---|
| **Variable** | **Constant** | **Constant +Trend** | **Constant** | **Constant +Trend** |
| $id_t$ | 0.392 | -1.73 | -5.390 | -5.643 |
| $f_t$ | -0.849 | -2.894 | -6.018 | -6.009 |
| $mpi_t$ | -1.439 | -1.984 | -5.982 | -6.087 |
| $nda_t$ | 0.803 | -1.568 | -3.323 | -3.395 |
| $nfa_t$ | -0.749 | 2.736 | -0.749 | 2.854 |
| $q_t$ | -2.300 | -1.119 | -4.915 | -5.209 |
| 5% critical values | -2.869 | -3.422 | -2.869 | -3.422 |

**Note**: Superscript * indicates the significance of the variable at 5% critical values. Lag lengths are determined by Akakike Information Criterion (AIC) with maximum number of 11 lags. 5% one sided critical values are been taken from McKinnon (1996). Monthly data for the period 1982M1 to 2013M12 is used.

[9] Phillips and Perron unit root test results can be obtained from the author on request.
[10] We followed Kim (1995) approach and implemented Hausman's Exogenity test to test if net domestic assets and net foreign assets are orthogonal to each other. The results indicate both these variables are simultaneously determined.

endogenous variable in estimating the equations of interest. The instruments used for endogenous variables must be (a) uncorrelated with the error term [$Cov(X_i u_i) = 0$], (b) must be correlated with endogenous variable [$Cov(X_i u_i) \neq 0$] and (c) must not be an independent variable in the equation estimated (Murray, 2006; Ljubaj, 2010 and Gilal & Paul, 2015). Two stages least square is an example of instrumental variable approach. It requires an exact number of instruments and endogenous variables. Equation is exactly identified when the number of instruments equals number of endogenous variables. When the number of instruments is greater than the number of endogenous variables than the system is over identified. However, when the number of instruments is lower than the number of endogenous variables than the equation is under identified (Murray, 2006). There may be the case that the instruments may not be strongly correlated with the endogenous variables. Using such instrument results large standard errors and insignificant estimated parameters (Verbeek, 2008).

Table-2 contains the results of monetary policy reaction function for different sample periods. Net foreign asset coefficient although negatively sloped is significant only from 2001M10 to 2013M12. Real exchange rate estimate is statistically significant for entire period and for both sample period. However, it has negative sign in second sample period. Similarly, real income estimate is significant and correctly signed for the entire sample period and second sample period. Interest rate differential estimate is significant and positively signed only for the entire period. To summarize, results say that the Central Bank sterilized almost 35 percent effect of changes in net foreign assets on domestic monetary base. Positive estimate of real exchange rate indicate that increase in real exchange rate and real income resulted increase in net domestic assets. Similarly, positive estimate of interest rate differential implies that higher foreign interest rate resulted capital outflow. In this case, the Central Bank has to increase net domestic assets in order to neutralize the effect of capital outflow on domestic monetary base.

**TABLE-2**
**MONETARY POLICY REACTION EQUATION**

| **Sample** | **1982M1 to 2013M12** | | **1982M1 to 2001M09** | | **2001M10 to 2013M12** | |
|---|---|---|---|---|---|---|
| **Variable** | **Coefficient** | **T-Statistic** | **Coefficient** | **T-Statistic** | **Coefficient** | **T-Statistic** |
| $c$ | -0.730828 | -0.468695 | **-3.414662** | **-4.042972** | **18.36855*** | **6.218814** |
| $nfa_t$ | -0.180161 | -1.374921 | -0.001615 | -0.036471 | **-0.347588*** | **-3.423477** |
| $q_t$ | **2.614784*** | **2.458827** | **5.118988*** | **6.695401** | **-5.549171*** | **-5.035999** |
| $mpi_t$ | **1.492864*** | **4.601590** | -0.118914 | -0.405422 | **0.554815*** | **2.106331** |
| $id_t$ | **0.334298*** | **6.725553** | -0.035709 | -0.475620 | 0.048532 | 1.121222 |
| $R^2$ | ***0.920031*** | | ***0.987702*** | | ***0.941509*** | |
| ***Adjust*** $R^2$ | ***0.918116*** | | ***0.985360*** | | ***0.939801*** | |
| ***DW Test*** | ***0.181906*** | | ***0.671690*** | | ***0.238884*** | |
| ***F Statistic*** | ***521.9976*** | | ***426.9152*** | | ***585.2064*** | |
| ***Probability*** | ***0.000000*** | | ***0.000000*** | | ***0.000000*** | |

**Note**:* shows the level of significance at 5% critical values. We also used Newey-West heteroscedasticity test to adjust standard errors of the estimated parameters.

Table-3 contains the results of capital flow equation. It is evident from the table that estimate of net domestic asset is significant only for the second sample period. Real exchange rate estimate is significant for entire sample period and second sub sample period. However, it has negative sign from 2001M10 to 2013M12. Real income is positive and significant for the entire sample period and second sub sample. Interest rate differential estimate however, is insignificant in all sample periods. To summarize, the results from table 2 indicate that the changes in net domestic assets are fully offset by equal and opposite direction changes in net foreign assets. This implies perfect substitutability of domestic and foreign assets. In such circumstances, the Central Bank monetary policy action will be fully offset by changes in net foreign assets, hence monetary policy is impotent. Positive estimates of real exchange rate and real income show that any increase in them results surge in capital inflows in the country.

**TABLE-3**
**CAPITAL FLOW EQUATION**

| **Sample** | **1982M1 to 2013M12** | | **1982M1 to 2001M09** | | **2001M10 to 2013M12** | |
|---|---|---|---|---|---|---|
| **Variable** | **Coefficient** | **T-Statistic** | **Coefficient** | **T-Statistic** | **Coefficient** | **T-Statistic** |
| $c$ | -1.886907 | -0.858886 | -0.808436 | -0.197077 | 20.31579 | 5.908559 |
| $nda_t$ | -0.632789 | -1.216306 | 2.510406 | 1.241296 | -1.003151* | 2.724621 |
| $q_t$ | 1.682731** | 1.798458 | -3.131441 | -0.469317 | -5.565900* | 4.804584 |
| $mpi_t$ | 4.296519* | 4.039984 | -2.531839 | -0.963609 | 1.559671* | 2.785398 |
| $id_t$ | 0.086183 | 0.734007 | 0.812077 | 1.202931 | -0.019358 | 0.288205 |
| $R^2$ | 0.870314 | | 0.355004 | | 0.666892 | |
| Adjusted $R^2$ | 0.867263 | | 0.242831 | | 0.657166 | |
| DW Test | 0.326917 | | 0.965841 | | 0.201347 | |
| F Statistic | 285.2252 | | 3.176014 | | 68.71975 | |
| Probability | 0.000000 | | 0.032396 | | 0.000000 | |

**Note:** Superscript * and ** indicate the significance of the variables at 5% and 10% critical values respectively.

**CONCLUSION**

Pakistan's foreign exchange reserves have risen though with market fluctuation since the adoption of managed float on 8thJanuary, 1982. Fluctuation in foreign exchange reserves has implication for domestic macroeconomic indicators. Central Banks generally intervene to avoid undesirable effects of foreign exchange reserves on domestic macroeconomic indicators. The Central Bank's foreign exchange interventions could be either sterilized or unsterilized.

In this paper, we focused upon finding out if the Central Bank sterilizes the effects of changes in net foreign assets on domestic monetary base. We also evaluated whether any changes in the country's net domestic assets are neutralized by equal and opposite change in net foreign assets. Results indicate that the Central Bank partially sterilized the effect of changes in net foreign assets on domestic monetary base by changing its net domestic assets. Offset coefficient estimate show that any changes in net domestic assets led equal and opposite changes in net foreign assets which is consistent with perfect asset substitution. This implies that monetary policy is impotent. Any effort by the Central Bank to keep monetary base unchanged by changing net domestic assets is foiled by equal and opposite changes in its net foreign assets.

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