Central bank intervention, sterilization and monetary independence: the case of Pakistan

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Central Bank Intervention, Sterilization and Monetary Independence: The Case of Pakistan

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Abstract

This paper analyzes the response of the State bank of Pakistan—the central bank, to foreign exchange inflows for the period of 2001:1 to 2006:8. In this context, we estimated sterilization and offset coefficients using vector autoregression (VAR) model to account for the issue of endogeneity of domestic credit with the foreign exchange interventions. In addition, the paper also analyzes the role of foreign and domestic interest rate differentials in pulling in or pushing out of these foreign exchange flows. We found that the offset coefficient is very small and insignificant (0.16) implying that changes in credit resulted in very minimal offsetting reserve flows. The study found out that for the sample period, SBP only partially sterilized the inflows with magnitude of coefficient at (0.50) confirming the stylized facts. Results also indicate that inflows were neither pulled into the country due to high domestic interest rates due to some domestic policy nor they are pushed into Pakistan owing to low interest rates abroad. This paper also divided the sample in to two periods from 2001:1 to 2004:3 and 2004:4 to 2006:8.

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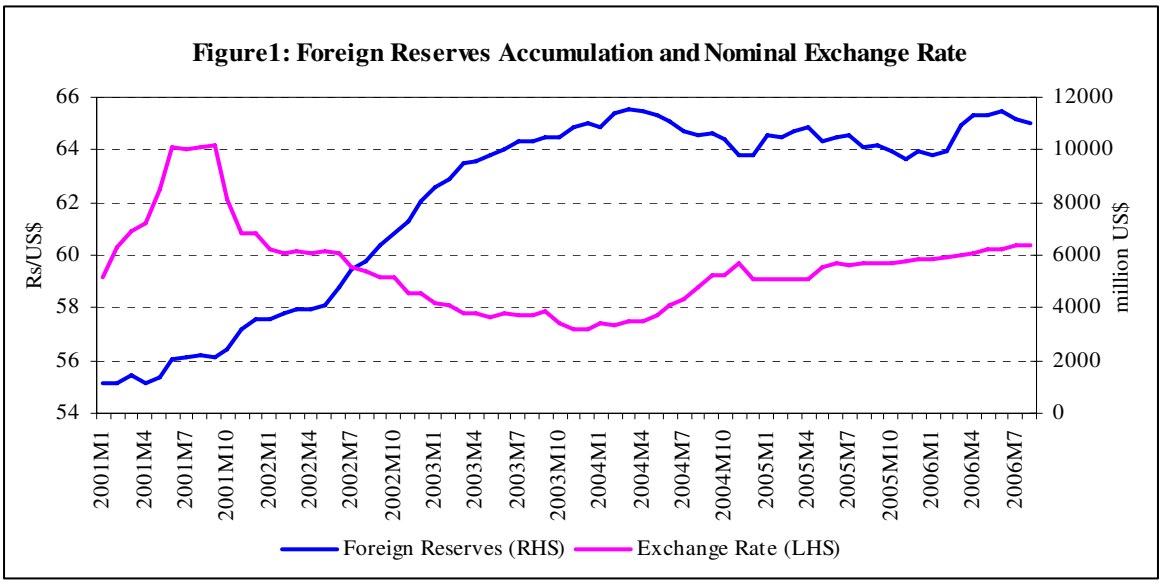
I. Introduction

Since 2000 the emerging economies have experienced a new surge in foreign exchange inflows followed by massive interventions by their central banks to prevent currency appreciation. Pakistan too experienced spurt in these inflows after September 11, 2001. In Pakistan's case, this surge in foreign exchange inflows originated from an increase in aid and investment flows, and more importantly from the growth in workers' remittances. This resulted in reversal of traditional market expectations of devaluation and accordingly rupee started to appreciate (see **Figure 1**). The huge volume of inflows forced the central bank to intervene in the foreign exchange market to keep the parity between Rupee/US$ stable.[1] Consequently, State Bank of Pakistan (SBP) purchased foreign exchange worth US$ 8.22 billion during the period July 2001 to March 2004.

The conventional wisdom asserts that central banks can intervene in foreign exchange markets to resist currency appreciation for some time because there is no simple, clear ceiling to the volume of domestic currency they can sell in forex markets. Just as conservative is the view that extended, significant intervention must eventually weaken domestic macroeconomic performance presenting the central banks with a policy impasse. The main reason for policy dilemma is that intervention in the foreign exchange market has direct consequences for the stance of monetary policy. In general, the central bank would want both to resist currency appreciation and to control the inflationary pressures. If so, injection of liquidity due to foreign exchange intervention would be in direct conflict with monetary policy of the country. To accomplish both its monetary and exchange rate targets, the central banks usually resort to sterilized intervention in the foreign exchange market.[2] Regardless of exchange rate regime, sterilized intervention may be viewed as an attempt to attain independent external and internal targets in short

[1] Since there was large inflows from US and Europe from expat Pakistanis, it was feared that these are one off transfers and as soon as the situation get better in US and Europe, these inflows would shrink substantially. Therefore to shield the external sector from this perceived volatility in exchange rate, SBP intervened in the market.

[2] Sterilized intervention is a combination of two transactions. First the central bank conducts a non-sterilized intervention by buying foreign currency with home currency. This results in the increase in monetary base. Then the central bank sterilizes the effect on monetary base by selling a corresponding quantity of home currency denominated bonds to soak up the initial increase in the monetary base. [Obstfeld and Rogoff (1996) chapter8]



run. For this to be possible, domestic and foreign assets must be imperfect substitutes in private portfolio [Obstfeld (1982a).

In the case of Pakistan, the monetary authority too, was confronted with conflicting goals as foreign exchange inflows continuously poured into the country. According to State Bank of Pakistan (SBP) annual report FY01, page 3 " on the one hand there was an urgent need to shift government borrowings from SBP to banks and to insulate the Rupee from excessive volatility—this placed upward pressure on T-bill rates. On the other hand, efforts to increase private sector investment, ease the government's debt burden, and contain the impact of our commitment to link export finance rates to T-bill rates pushed in the opposite direction." This clearly entailed for SBP to decide on the extent of sterilization.

Thus, the challenge the monetary authority faces is to coordinate intervention with monetary policy. Therefore, in this paper we investigate empirically the questions of the need for and the success of sterilization efforts of State Bank of Pakistan by estimating sterilization coefficient. We also gauged the offset coefficient which measures the extent, to which capital flows offset policy induced changes in monetary base. More specifically it provides a useful summary measure of the scope for a domestically oriented monetary policy. Furthermore, we will analyze the role of foreign and domestic interest rate differentials in pulling in or pushing out of these foreign exchange flows.

This paper is organized as follows. Following section gives us some backdrop of the issue. Section III consists of literature review. Section IV describes the theoretical framework we will be using while section V explains empirical results. Paper is concluded in section VI.

II. Backdrop

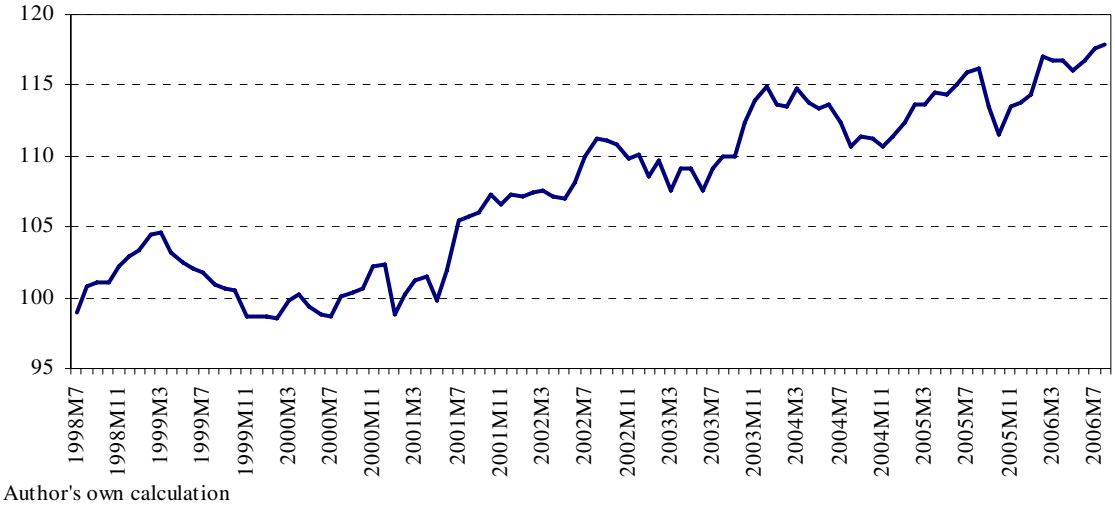
Nineties was a difficult decade for Pakistan economy. Economic growth slowed down due to various factors namely: political uncertainties, weather calamities and structural constraints. This situation further deteriorated in late nineties when Pakistan went nuclear and attracted economic sanctions from the international community. However, it was the external sector of the economy that suffered the most. The significant foreign exchange inflows of 1980s dried down after the end of Afghan war against USSR. That put the economic system of the country under severe strain. In the mean time, rising current account deficit that resulted from increase in domestic absorption and loss of competitiveness due to overvalued rupee caused fall in international reserves. Consequently, the central bank was forced to frequently devalue domestic currency during nineties in order to correct current account imbalances (see **Table A** for selected economic indicators at the end of paper). [3]

After enduring a painful decade of low growth and contractionary demand management policies, Pakistan's economic performance since 2000 could be characterized as satisfactory. Fiscal deficit was contained within limit, inflation was low, and foreign exchange accumulation was satisfactory. In short, macroeconomic fundamentals were back on track. As part of stabilization program, Pakistan's central bank allowed a free float for its currency and dismantled the Rupee band that had been in place during FY00. As a result rupee depreciated by 23.8 percent during the year. Consequently trade deficit fell. In order to augment its reserves, the SBP purchased US$ 2157 million from kerb market. Instead of direct intervention and moving the Rupee/Dollar band, monetary policy was the main tool to quell episodes of speculation in foreign exchange market and to smooth out the volatility caused by lumpy payments.

[3] See Janjua (2004), History of The State Bank of Pakistan 1988-2003 Chapter 7 for more details.

Post September 11, 2001; Pakistan experienced large inflows of foreign exchange and a resulting build up of foreign reserves and appreciation of the real exchange rate (see **Figure 2**). It would seem that external factors played a crucial role in brining home these foreign exchange inflows. Most noteworthy was the big upsurge in workers' remittances through official channels that resulted from the global crack down on illegal channels of money transfer. This led to the collapse of *Hundi* system and demise of kerb market premium over official rate. Another contributing factor was the reverse capital flight as the balances of Pakistani's came under scrutiny abroad. In addition, debt rescheduling and new large aid inflows to Pakistan for siding with US and its allies in the war against Al Qaeda augmented the net inflows (see **Table 1** of non-debt creating inflows).

Figure 2: Index of Real Exchange Rate (WPI based)



Author's own calculation

The tremendous improvement in Pakistan's external sector post September 2001, either directly or indirectly, contributed to positive developments for many macroeconomic indicators.[4] For instance, workers' remittances almost doubled during FY02 in comparison with previous year to reach at US$ 2.39 billion. Together with increased official transfers, these inflows allowed SBP to augment its foreign exchange reserves and therefore perhaps a need to sterilize its impact on base money. Moreover, the current account recorded a surplus and underpinned the 6.2 percent appreciation of Pakistan

[4] This was attributed to a reversal of capital flight, as Pakistani balances held outside came under increased scrutiny from host countries and then increasingly waning attraction of foreign exchange holdings due to appreciating rupee.

Rupee. Indeed the purchases allowed the SBP to stabilize the Exchange rate. The rationale for SBP intervention in foreign exchange market for slowing down of rupee appreciation was the fear that this upsurge in inflows might be temporary. In short, while FY01 SBP foreign exchange net purchases were to support Rupee, the FY02 buying was essentially to prevent it from strengthening too sharply.[5]

Table 1: Non-debt creating inflows

	FY00	FY01	FY02	FY03	FY04	FY05	FY06
Non-debt creating	13,794	14,534	16,693	19,581	20,772	24,212	28,851
As a percentage of total inflows	0.82	0.73	0.75	0.78	0.81	0.74	0.71

Source: State Bank of Pakistan

Furthermore the rupee liquidity injected through the foreign exchange purchases enabled SBP to ease its monetary policy which was contrary to FY01 when monetary policy was kept tight to support Rupee. Interestingly however, SBP reserve money growth was contained to only 9.6 percent, as injections through SBP foreign exchange purchases were sterilized by a net retirement of SBP's government securities holdings. The process of SBP-NDA reduction was particularly very intriguing, as the increased market liquidity (against SBP intervention) was neutralized without actually pursuing any explicit instrument for sterilization. Specifically, while most of the increased market liquidity was being channeled to the government securities, the government was retiring SBP debt using borrowings from commercial banks. This resulted into a reduction of SBP-NDA. Hence, what seems to be a shift in domestic debt structure of the government actually helped the SBP's efforts to restrict monetary base expansion.[6]

In a sense, the sterilization pursued by SBP is not very different from open market operations: while this process shifts the SBP holdings of government securities to commercial banks *indirectly*, the open market operation achieves similar results *directly*. Looking at sterilization during FY02, the retirement of Rs 287 billion worth of government securities with SBP more than offset the impact of SBP intervention in the

[5] In FY01, the SBP foreign exchange purchases were being injected into the interbank market to lower volatility and meet lumpy payments. The SBP was net seller in interbank market during FY01.

[6] The practice of sterilization had cost for SBP in terms of foregone interest earning on government securities etc. In addition, this could have increased quasi fiscal cost for government. However, low private sector credit demand left ample liquidity with the banks resulting in switch of government debt from SBP to banks without putting much pressure on interest. However we ignore this discussion here because it is not in the scope of this paper.

foreign exchange market. Consequently, as mentioned above, the reserve money growth was held down to 9.6 percent despite sizeable foreign exchange purchases by SBP.[7]

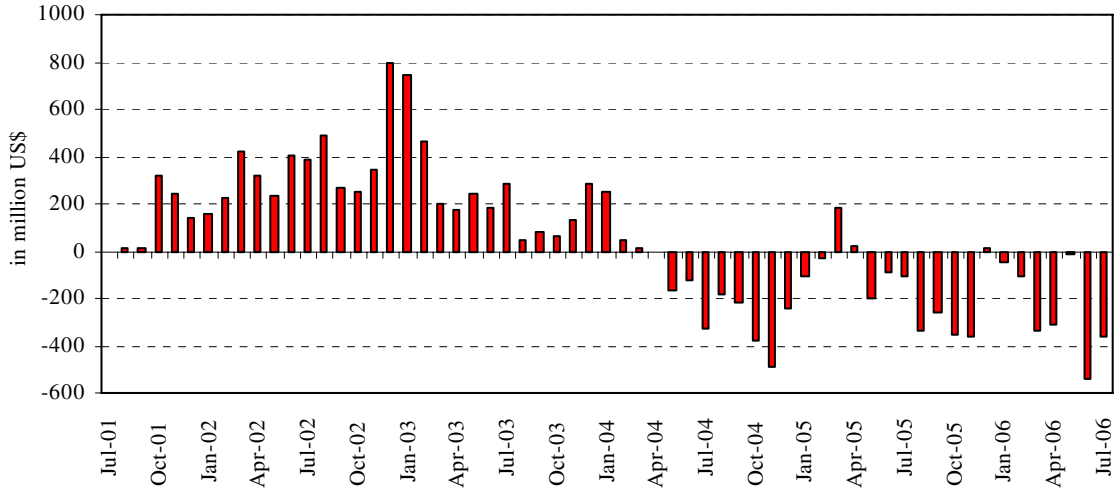
The FY03 too witnessed current account surplus owing to reduction in trade deficit and phenomenal increase in worker remittances to US$ 4237 million. SBP intervened heavily to stabilize the Rupee/Dollar parity by not letting it to appreciate too quickly. Indeed we can characterize this policy to be a pseudo free float, as SBP never allowed the Rupee to move freely. The SBP in its Annual report for FY03 page 7 conceded that exchange rate practically acted as a nominal anchor for the monetary policy, which was discount rate during previous year. In contrast to FY02 position, when SBP essentially mopped up rupee liquidity resulting from its forex market interventions, FY03 saw a very deliberate reduction in these sterilization operations, despite a sharper rise in forex purchases (See SBP Annual Report FY03, page 3). This resulting liquidity flooding the banking system raised competitive pressures and led directly to fall in interest rates. As a result of low sterilization effort, reserve money grew by 14.5 percent without resulting in inflationary pressures, which can be attributed to lags in inflation dynamics.

During FY04, although net forex inflows declined relatively, the SBP continued with its loose monetary stance. In fact net credit to private sector grew by Rupee 325 billion, which was more than twice the cumulative net credit expansion in preceding three years. The negative of this expansionary policy was the rise of inflationary expectation. Headline inflation measured with CPI recorded at 4.6 percent. This coupled with the reduction in unilateral inflows of foreign exchange put pressure on Rupee to depreciate.[8] As stated in SBP annual report FY04, page 9; "in fact the depreciation in Rupee would have been even steeper had the central bank not defended the rupee aggressively,…".[9] All of these resulted in the upward pressure on interest rates. With relatively low inflows and deliberate expansionary monetary policy, sterilization effort was on the lower side. As the governor of the SBP stated "Despite some mopping up, the Central Bank has left excess liquidity with the banks which has driven down the cost of credit to historically low levels of 5 percent average. The banks are, therefore, reaching out to new customers

[7] See SBP *Annual Report* for FY02.
[8] Saudi oil facility ended this year.
[9] State Bank of Pakistan was a net seller of foreign exchange since April 2004 (see **Figure 3**)

particularly the middle and lower income groups by providing them agriculture credit, SME loans, mortgage loans and consumer loans. This is the most direct way the reserve accumulation is benefiting the common man…."[10]

Figure 3: Net Foreign exchange purchases



Source: State Bank of Pakistan

However, with inflation peaking at 9.3 percent, SBP had to switch to tightening of monetary stance during FY05. This shift in policy was more pronounced during second half of the FY05, with the benchmark 6-month T-bill yield rising by 416 basis points during this period, as against 166 basis points increase in first half of the same year. However, despite this rise in interest rates monetary growth remained high at 19.3 percent. Current account deficit was recorded at US$ 1.4 billion, which stemmed mainly from trade deficit of US$6.2 billion during the year. However, worker remittances of US$4.0 billion helped finance this deficit. On net basis SBP was a seller of foreign exchange in market. This aggressive selling was to defend the rupee from falling. Throughout the year, SBP remained an active player in forex market.

III. Literature Review

[10] A paper presented at Pakistan Administrative Staff College on March 11, 2004 by Dr. Ishrat Hussain, Governor, State Bank of Pakistan.

Central bank intervention following foreign exchange inflows has direct implications for the stance of monetary policy. Generally, the central bank would want *both* to resist currency appreciation *and* to control inflationary pressures. If so, foreign exchange intervention would be in direct conflict with monetary policy of the country and the monetary authorities will find it harder to prevent appreciation pressure while at the same time raising the interest rate. Thus, a first challenge the monetary authority faces is to coordinate intervention with monetary policy. This is achieved through sterilization. But the close coordination with monetary policy that sterilized intervention assumes may not be easy to achieve in practice. In particular, intervention to resist appreciation might confuse the market when the central bank is raising interest rates to fight inflationary pressure. There is a danger that exchange rate policy might dominate monetary policy. In addition, Truman (2003) raises the concern about distraction risk which means that the authorities might be tempted to postpone fundamental adjustments hoping that intervention will succeed. He shows that during the late 1970s intervention against a weak dollar was primarily used as a substitute for monetary tightening in the United States. But the delay in tightening monetary policy eventually led to a sharp rise in inflation and the need to raise interest rates to a very high level. The tighter monetary policy, in turn, led to one of the worst recessions in US postwar history.

In view of these challenges, many economists have argued that intervention should be restricted to cases where it is consistent with the central bank's inflation forecast. For instance, intervention to resist depreciation should be accompanied by the forecast that inflation would - if depreciation occurred - rise above the target during the targeting horizon. Conversely, the central bank would intervene to resist appreciation only when inflation is forecast to fall below the target. Holub (2004) argues that in the Czech Republic such coordination has been maintained since the introduction of inflation targeting in 1998: most interventions against currency appreciation were carried out when (a) inflation was expected to fall below the target and (b) the output gap was negative.

A second question concerns the ability of monetary authorities to conduct sterilized intervention on a sustained basis. What are the limits to sterilized intervention? At least three major impediments have been discussed in the literature.

The first is the issue of the impossible trinity which asserts that with no capital controls, the central bank cannot indefinitely control both the nominal exchange rate and the money market rate. This is the classic argument of Mundell (1968). In the case of intervention to prevent depreciation, such a limit will be often set by the reserves and contingency credit lines available to a country. Depleting reserves, at some stage, will make an interest rate increase inevitable. The limit on intervention to prevent appreciation is, however, less clear cut because reserves can keep rising. When the exchange rate is fixed and capital is mobile, the central problem of monetary management is the endogeneity of home money supply. Domestic credit expansion aimed at affecting internal markets cause an incipient weakening of exchange rate. To maintain the official parity, the central bank must intervene in the foreign exchange market by buying high-powered money with foreign reserves. In this manner, attempts to alter the domestic source component of the monetary base are hindered, even in the short run, by offsetting movements in its foreign source component. If the offset to domestic credit expansion is complete, the monetary base is determined independently of the central bank's policies by the saving and portfolio decisions of the public. The central bank can affect the monetary base only when domestic and foreign assets are imperfect substitutes. If there is perfect substitutability, the net foreign assets offset to domestic credit measures is immediate and complete, provided there are no lags in portfolio adjustments [Obstfeld (1982a)]. When the exchange rate is flexible, the level of exchange rate is determined by the supply and demand of currency. In this system, the nominal money supply becomes a policy determined variable and as in the fixed exchange rate, the central bank can attain independent monetary management only if there is imperfect substitutability between domestic and foreign assets.

Calvo, Leiderman and Reinhart (1993) argued, however, that resisting currency appreciation would prevent the domestic money market interest rate from falling, attract more inflows and thus continuously increase the need for sterilization. Eventually, the cost of sterilization would rise to high levels, leading either the interest rate to fall or the exchange rate to appreciate. Therefore according to them, sterilization is difficult and costly. In the long run, therefore, appreciation becomes unavoidable because even in the

case of a fall in interest rate and the resulting increase in inflation will lead to an appreciation of the *real* exchange rate.

In fact, large-scale sterilized intervention had previously led to sharp increases in short-term interest rates - particularly in countries with a history of inflation. Reinhart and Reinhart (1999) document evidences during the early 1990s. In Chile the short-term interest rate (30- to 89-day bank lending rate) rose from about 28% in the period (1988-89) preceding capital inflows to over 46% during the period (January to July 1990) of heavy inflows and sterilization. The rise in interest rates was as dramatic in Colombia, with prime lending rates of banks more than doubling from 22% during the pre-inflow period (1989-90) to over 47% during the peak of sterilization (January to November 1991). Reinhart and Reinhart (1999) conclude that "sterilization policies were either abandoned or scaled back or complemented by capital controls, as it became evident that the high domestic interest rates were attracting more inflows".

Reisen (1993), however, argued that sterilization is easier. He asserts that some Asian countries have been able to achieve the impossible trinity of open financial markets, fixed exchange rates and the monetary independence.

Frankel (1994) examines the issue of foreign exchange inflows and the ability of the monetary authorities to conduct sterilized intervention. He concludes that sterilization is expensive when the cause of the capital inflows is a rise in money demand or an increase in exports. Attempts to sterilize such inflows would raise interest rates, leading to even larger inflows, thereby rendering the sterilization practice as difficult and expensive. On the other hand, when the source of foreign exchange inflows is an external shock, sterilized intervention is not likely to alter the interest rates and hence it can be a viable option in the short run.

Secondly, imperfect substitutability among assets means that changes in the supplies of such assets as a result of sterilization affect relative prices. Classic models e.g. Argy and Murray (1985) typically assume that the central bank sells domestic bonds to sterilize. If domestic bonds (whose yield carries a risk premium) are imperfect substitutes of foreign

bonds, the authorities would have to pay higher interest rates on their sterilization bonds to encourage bondholders to switch out of foreign bonds.

Finally, the high costs of issuing high-yield local currency debt to acquire low-yielding reserves can exacerbate fiscal deficits and so threaten macroeconomic stability. This can be particularly serious in countries that already have large public sector debts. In some circumstances, the combination of high costs and increasing reserves may provide a signal to markets that policy is on an unsustainable path and so accentuate destabilizing capital flows.

Calvo (1991) argued that such effects would eventually weaken central banks' anti-inflation credibility by raising the probability of debt monetization and high inflation. Comparing the high interest rate differentials of Chile and Colombia with Argentina, which followed a policy of non-sterilized intervention during the early 1990s, Calvo et al (1993), cast serious doubts on the desirability of sterilized intervention because it raised debt service costs at a time when countries were attempting to bring domestic debt expansion under control.

In short, various possible consequences of sterilizing prolonged or very large interventions could be that it could undermine monetary objectives; it could compromise financial stability; and it could impose heavy financing costs on the monetary authorities.

Despite the possibility of these consequences and the concerns about coordination between intervention and monetary policy, monetary authorities do engage in sterilized intervention in the foreign exchange market. Since, failure to sterilize market intervention and the consequent increase in domestic liquidity can result in inflation as well as unwanted movement in exchange rate. In addition, the real exchange rate is also influenced by the ability of central banks to sterilize. Under these circumstances, determining the offset and sterilization coefficients of the central bank could be useful in terms of measuring of the scope and the stance of the monetary policy. Indeed, this issue has discussed in the literature by several authors.[11]

[11] Offset coefficient indicates the fraction of any domestic credit expansion reversed by central bank foreign reserve losses in the same period while sterilization coefficient indicates that the degree of

Kouri and Porter (1974) and Obstfeld (1982a) pointed out that the offset coefficient is subject to a possible sterilization bias.[12] The source of the bias is the possible endogeneity of changes in NDA, when central bank follows a sterilization policy. If capital inflow is systematically sterilized, the change in NDA will be correlated with the disturbance term in the NFA equation (or capital-flow equation), therefore OLS estimates will be inconsistent. To remedy this problem, Argy and Kouri (1972) suggested that the offset and sterilization equations be estimated by two-stage least squares using instrumental variables.[13] They found evidence of partial sterilization on part of Germany and the Netherlands, but inconclusive evidence for Italy.

Kouri and Porter (1974) developed a model of international capital flows and applied it to the data of Germany, The Netherlands, Australia and Italy. The offset coefficient which measures the extent, to which capital flows offset policy induced changes in monetary base, were statistically significant in all cases. The estimates were -0.77 for Germany, -0.59 for Netherlands, -0.47 for Australia, and -0.43 for Italy. All these estimates are statistically different from minus one, which suggested that sterilization was possible in these countries at least in short run.

Miller and Askin (1976) examines the degree to which the balance of payment of two small, relatively open economies influence the ability of their monetary authorities to control the money supply. More specifically, they investigate to what extent variations in the domestic components of monetary base are offset via international payment imbalances, and then to what extent the authorities sterilize the effect of payments imbalances on monetary base. They built a simple model that incorporates the monetary approach to the balance of payments for Brazil and Chile. They used the reduced-form solutions and two stage-least square regressions to tackle the issues of simultaneity between (a) changes in the international and domestic components of the monetary base

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sterilization which is offset in the inflows so as to leave the overall money supply unaffected through open market operations or some other monetary regulations like reserve requirements etc.

[12]The offset coefficient measures the extent to which capital flows offset policy induced changes in monetary base. It explains the changes in foreign exchange reserves (NFA) due to the variations in net domestic assets (NDA).

[13] For detailed discussion on sterilization bias, see Obstfeld (1982)a.

and (b) the level of income and the monetary base. The empirical results concluded that only a relatively small portion of changes in domestic component of monetary base was offset through the balance of payments while authorities completely sterilized the impact of payments imbalance on monetary base. Their results suggest that the monetary authority in these countries had almost complete control over money supply. However, Sheehey (1980) used an alternative specification of Miller and Askin (1976) model and suggested a limited ability of monetary authorities to influence the money supply.

Kamas (1986) used a reduced form equation derived from a general macroeconomic model. Kamas made estimations in the context of three different specifications: the monetarist, the portfolio balance, and Keynesian for the period of 1971:03 to 1981:4 for Mexico and for the period of 1970:4 to 1982:04 for Venezuela. The offset coefficient for varied from 0.04 to 0.09 for Mexico and from -0.65 to -0.82 for Venezuela. The sterilization coefficient came out to be 1.55 and -1.04 respectively for both countries.

Altınkemer (1997) estimates the domestic credit reaction function of Central Bank of Turkey (CBRT) by dividing the estimation period into two sub-periods, February 1990-October 1993 and April 1994-June 1997. Study concludes that, during the pre-financial crisis period, it seems that the CBRT was reacting to changes in net foreign assets (NFA), real exchange rate and not to interest differential. While in the post financial crisis period, it seems that the CBRT reacted more to NFA changes compared to the pre-crisis period and also interest rate differentials gained importance in the monetary policy framework. The sterilization coefficients have been found as 0.82 and 0.91 for the first and second periods respectively by using OLS.

Another study for Turkey on the same subject by Celasun et al, (1999) computed the sterilization coefficients. They estimated Net Domestic Assets (NDA) by using two-stage least squares, for the period February 1990 to June 1996, wherein the reaction function allows net domestic assets to respond to other variables, such as, net foreign assets, real exchange rate, real GDP and consolidated government deficit.[14] For the whole

[14] NDA including revaluation account and adjusted for reserve requirements. Government Deficit including instrumental variables; constant, monthly dummies, three lags of the dependent and conditioning variables, 6 lags of net foreign assets, uncovered interest parity and three lags of it.

period, the sterilization coefficient was found as (-) 0.37, which indicated partial sterilization of 37 percent of reserve inflows (given that lags of NFA proved insignificant).

Emir et al (2000) estimated monetary policy reaction function for Turkey and calculated the offset and sterilization coefficient using simultaneous equation system for the periods of 1990 to 1993 and 1995 to 1999. The results showed that in the first period which is the pre-crisis period (1990-1993), low degree of sterilization, offset and neutralization coefficients, which suggest that the CBRT implemented a relatively accommodative policy to fiscal policy by expanding domestic credits to finance budget deficit. In contrast, in the second period which is the post-crisis period (1995-1999), the CBRT implemented more active policy by sterilizing most of the foreign assets increase and neutralizing the government credits by reducing the banking sector credits which was reflected in the high level of sterilization, offset and neutralization coefficient.

Siklos (2000) focused on short run impact of sterilization on monetary policy and found that Central Bank of Hungary (NBH) fully sterilized capital inflows during 1992:01 to 1997:03 and the sterilization coefficient thus found was 1.002 by using OLS method.

In other studies on the issues, Renhack and Mondino (1988) and Clavijo (1986) for Colombia; Blejer and Leiderman (1981) for Brazil; Fry, Lilien and Wadhwa (1991) for Pacific Basin Countries; Savvides (1998) for West and Central African countries, the offset and the sterilization coefficients were estimated to measure the degree of monetary independence or performance of monetary policy.

Patnaik (2004) used error correction procedure to analyze the sterilization practice of Reserve bank of India (RBI) using monthly data for period April 1993 to December 2003. The result suggests that RBI directly sterilized its currency intervention by a reduction in net domestic assets. However, though the extent of sterilization was large, it was not complete. The offset coefficient is estimated to be -0.8.

Korea witnessed surge in capital inflows and improvement in current account in early 90s. During this period, Bank of Korea actively intervened into the foreign exchange

market and offset the monetary impact of foreign exchange interventions through sterilization. Kim (1991) estimated 90 percent sterilization of increase in net foreign assets during the 1980s.

Cavoli and Rajan (2005) estimated sterilization coefficients for Korea, Thailand, Indonesia, Malaysia and Philippines for the monthly observation for the period January 1990 to March 1997. The estimates for Korea (-1.11) suggest possible over-sterilization as the coefficient exceeds -1 and those for Indonesia are lower than the others at -0.76. The estimates for Thailand (-0.91), Malaysia (-0.94) and Philippines (-0.97) suggests almost complete sterilization of inflows.

Qayyum and Khan (2003 used the domestic policy reaction function to gauge the degree of sterilization by investigating the long run relationship for Pakistan. They used quarterly data from 1982Q3 to 2001Q2 and concluded that State Bank of Pakistan (SBP) did sterilize 72 percent of capital inflows for the period. Asad et al. (2005) studied the degree of sterilization by using the monthly data for the period of July 2007 to December 2003. They used OLS technique and their estimated sterilization coefficient was -0.87. This study for Pakistan is different from previous studies as it focuses on the current episode of inflows that SBP encountered after 2001. In addition, contrary to this study, none of the previous studies focused on offset coefficient or tried to focus on the causes of inflows. Also the data is handled with more care in this paper. Furthermore, by using the VAR, this study tackled the issue of endogeneity of domestic credit with the foreign exchange interventions.

IV. Theoretical Framework

In order to understand and interpret the relation between inflows, sterilization and SBP's monetary policy conduct, we will use the theoretical model developed by Kouri and Porter (1974). This model is augmented by monetary policy reaction function in line with Obstfeld (1982b).[15] The sterilization and offset coefficients are calculated. The basic assumptions of the model are fixed exchange rate, small country, and wages and prices

[15] Similar techenique was used by Christensen (2004) for the Czech Republic.

are assumed as given. Also the balance of current account is exogenous. Small country assumption implies that domestic demand of foreign asset is small relative to world supply. Any change in domestic bond does not affect the price of these assets. It is also assumed that foreigners can only hold domestic bonds not domestic currency.

Assumptions:

- Fixed exchange rate.
- Small country assumption: Domestic policy actions do not affect foreign wealth and interest rates.
- Fixed prices: Wages and prices are given.
- Exogenous Current Account (CA): The balance on the current account is predetermined.
- Infinite supply of foreign assets: The small country assumption implies a relatively small size of domestic demand compared to world supply. Any change in domestic demand for foreign bond does not affect the price of these bonds.
- Foreign acquisition of domestic assets: Foreigners can only hold domestic bonds (i.e. not domestic money)

Demand for base money

(1) $M_D = L(Y, W, id, if)$ where $L_y, L_w > 0; L_{id}, L_{if} < 0$

Net domestic demand for domestic bonds

(2) $B_D = H(Y, W, id, if)$ where $H_{id}, H_w > 0; H_{if} < 0; H_y >< 0$

Domestic demand for foreign bonds

(3) $B_F = J(Y, W, id, if)$ where $J_{if}, J_w > 0; J_{id} < 0; J_y >< 0$

Net foreign demand for domestic bonds

(4) $B^*_D = J(Y^*, W^*, id, if)$ where $H_{id} > 0, H_{if} < 0, H_{w^*}, H_{y^*} >< 0$

Total money supply

(5) $M_s = NFA + NDA$

Domestic component of money supply

(6) $\Delta NDA = -\Delta B_G$ which represents open market operation

Foreign components of money supply

(7) $$\Delta NFA = K + CAB$$

Total net capital inflows

(8) $$K = \Delta B_D^* - \Delta B_F$$

Domestic wealth constraint

(9) $$L(...) + H(...) + J(...) = W$$

Money equilibrium

(10) $$M_D = M_s$$

Domestic bond equilibrium

(11) $$B_D + B_D^* = B_G$$

Endogenous variables:

M_D = Money Demand, M_s = Money Supply, id = Domestic Interest Rates, B_D = Net Domestic Demand For Domestic Bonds, B_F = Domestic Demand For Foreign Bonds, B_D^* = Net Foreign Demand For Domestic Bonds, NFA = Net Foreign Assets of the Central Bank, K = Total Net Capital Inflows

Exogenous variables:

Y, Y^* = Domestic and Foreign Nominal Income, W, W^* = Domestic and Foreign Nominal Wealth , if = Foreign Interest Rate, B_G = Stock of Government Bonds held by Private Sector, NDA = Net Domestic Assets of the Central Bank, CAB = Current Account Balance.

The model can be solved for changes in domestic interest rates and changes in net foreign assets (NFA) of the central bank (see ***appendix***).

(16) $$\Delta id = -\frac{1}{(F_{id} + H_{id})}\{H_y \Delta Y + H_w \Delta W + (F_{if} + H_{if})\Delta if + \Delta NDA + F_{y^*}\Delta Y^* + F_{w^*}\Delta W^* + CAB\}$$

and

$$\Delta NFA = [-\frac{1}{(F_{id} + H_{id})}\{L_y(J_{id} - F_{id}) - L_{id}J_y\}]\Delta Y +$$
$$[-\frac{1}{(F_{id} + H_{id})}\{L_w(J_{id} - F_{id}) - L_{id}J_w\}]\Delta W +$$
(17) $$[-\frac{1}{(F_{id} + H_{id})}\{L_{if}(J_{id} - F_{id}) + L_{id}(F_{if} - J_{if}\}]\Delta if$$
$$-[\frac{1}{(F_{id} + H_{id})}(F_{id} - J_{id})]\Delta NDA +$$
$$[-\frac{1}{(F_{id} + H_{id})}\{L_{id}F_{y^*}\Delta Y^* + L_{id}F_{w^*}\Delta W^* + L_{id}CAB\}]$$

The offset coefficient is defined as the partial derivative of changes in NFA with respect to changes in NDA.

That is $\frac{\Delta NFA}{\Delta NDA} = -\frac{F_i - J_i}{F_i + H_i}$ where $-1 \le \frac{\Delta NFA}{\Delta NDA} \le 0$

The offset coefficient is often taken as the measure of monetary independence and a measure of capital mobility. There is a large degree of monetary independence, when offset coefficient is close to zero. On the other hand monetary independence is small when it is close to -1, which implies that a a change in domestic credit is completely offset by a corresponding change in opposite direction in the international reserves, leaving the domestic stock of money unchanged.

The model can be made more realistic by incorporating monetary authority reaction function [Obstfeld (1982)b] to the system comprising equations (16) and (17).

(18) $$\Delta NDA = b\Delta NFA + \Delta Z$$

where Z is the vector of exogenous variables relevant to monetary policy such as inflation, foreign interest rates, output and current account etc. The coefficient b is the coefficient of sterilization which ranges between 0 and -1. Full sterilization $(b = -1)$ means that domestic money supply is independent of net inflows of foreign exchange. Under such circumstances, domestic money supply is independent of balance of payment swings and is entirely determined by the exogenous factors Z.[16] On the other hand, $b = 0$ implies that any change in NFA will entirely be reflected in MB.

Empirical questions, Econometric methodology and data issues:

The preceding section examined the theoretical relationship between capital flows, domestic interest rates, and sterilization policies. Using the equations as the basic framework, the following questions about the experience and monetary policy management of capital inflows in the case of Pakistan can be raised. The first question is to what extent monetary authority maintained monetary independence in its attempt to insulate the money supply from the surge in foreign exchange inflows during the period under consideration. This question is examined by estimating the offset coefficient. The high degree of monetary independence means that a limited amount of capital flows will be recorded in the wake of monetary changes.

A second, and related question, is to what extent foreign or internal factors pushed or pulled foreign capital to Pakistan, respectively. This question relates to the [Frankel(1994)] conclusion that unnecessarily high domestic interest rates will prevail when sterilization is undertaken in the case of an internal shock such as higher domestic money demand or increase in exports (pull factor). On the other hand, sterilization will be more appropriate when capital is pushed by some external shock. The empirical model contains a relation for foreign reserves to answer these two questions.

A third question is whether monetary policy became endogenous to keep money supply constant. In other words, given the significant foreign exchange inflows, the State Bank of Pakistan may have responded by tightening the domestic credit. If this was indeed the

[16] This can be shown as
$\Delta MB = \Delta NDA + \Delta NFA \Rightarrow \Delta MB = b\Delta NFA + \Delta Z + \Delta NFA \Rightarrow \Delta MB = \Delta Z \ldots (if \ldots b = -1)$

case, domestic credit will be endogenous in the relation of the foreign reserves, which will give rise to sterilization bias. The sterilization bias arises if the sterilization parameter, b, is significant, implying that the authorities systematically varied domestic credit in response to foreign exchange inflows. The failure to account for such a policy in single equation regression, where the endogenous domestic credit component is treated as exogenous, would give rise to biased estimates. In order to avoid this problem, the econometric model should allow for domestic credit to be endogenous.

Therefore, a VAR is estimated, containing domestic credit, domestic interest rates, and foreign reserves as endogenous variables. In order to examine whether the foreign interest rates pushed foreign exchange inflow to Pakistan, it was included as an exogenous variable in the system. This system can be represented as following[17]

(19)

$$\Delta DC_t = \sum_{i=1}^{k}\alpha_{1i}\Delta DC_{t-i} + \sum_{i=1}^{k}\beta_{1i}\Delta R_{t-i} + \sum_{i=1}^{k}\gamma_{1i}\Delta id_{t-i} + \sum_{i=1}^{k}\delta_{1i}\Delta if_{t-i} + \sum_{i=1}^{k}\eta_{1i}inf_{t-i} + \sum_{i=1}^{k}\lambda_{1i}cam_{t-i} + \varepsilon_{1t}$$

$$\Delta R_t = \sum_{i=1}^{k}\alpha_{2i}\Delta DC_{t-i} + \sum_{i=1}^{k}\beta_{2i}\Delta R_{t-i} + \sum_{i=1}^{k}\gamma_{2i}\Delta id_{t-i} + \sum_{i=1}^{k}\delta_{2i}\Delta if_{t-i} + \sum_{i=1}^{k}\eta_{1i}inf_{t-i} + \sum_{i=1}^{k}\lambda_{1i}cam_{t-i} + \varepsilon_{2t}$$

$$\Delta id_t = \sum_{i=1}^{k}\alpha_{3i}\Delta DC_{t-i} + \sum_{i=1}^{k}\beta_{3i}\Delta R_{t-i} + \sum_{i=1}^{k}\gamma_{3i}\Delta id_{t-i} + \sum_{i=1}^{k}\delta_{3i}\Delta if_{t-i} + \sum_{i=1}^{k}\eta_{1i}inf_{t-i} + \sum_{i=1}^{k}\lambda_{1i}cam_{t-i} + \varepsilon_{3t}$$

Where Δid is the change in domestic interest rates, Δif is change in foreign interest rates. inf is year on year inflation rate using monthly data. cam is the first difference of current account balance divided by MB. Foreign reserves of the SBP are used as proxy for Net Foreign Assets (NFA) of the SBP. ΔR is the change in the foreign exchange reserves of the State Bank of Pakistan (SBP). Because exchange rate fluctuations entail changes in domestic currency valuation of reserves which are not reflected as a change in monetary base, the measure ΔR excludes the periodic reserve valuation adjustment due to change in exchange rate. ΔR is constructed as following.

[17] System includes the constant term.

(20) $$R_t = [R_{t-1} * ER_{t-1} + (R_t - R_{t-1})ER_t]$$

(21) $$\Delta R_t = \Delta[R_{t-1} * ER_{t-1} + (R_t - R_{t-1})ER_t] / MB$$

where ER_t is t period exchange rate of domestic currency for 1 unit of foreign currency. ΔDC is taken as proxy for ΔNDA. DC is constructed by deducting R_t of equation (20) from monetary base (MB) according to the method of Leiderman (1984).

(22) $$\Delta DC = [DC_t - DC_{(t-1)}] / MB$$

However, the change in net domestic assets does not provide a complete picture of the stance of the domestic credit policy of the central bank. The variation in reserve requirements on banks has important implications in domestic credit expansion. The change in domestic credit ΔDC should therefore be defined as the increase in net domestic assets minus the reserve impounded by any increase in required reserves. Following [Obstfeld(1982b)], this later component is calculated as following.

$$[RREQ_t - RREQ_{(t-1)}]M2_{(t-1)}$$

However, since there is no change in reserve requirement during the period understudy (2001:1 to 2006:8) except the July 2006, we decided not to adjust the data for this (see **Table E** of Changes in Cash Reserve Requirement by SBP).

Foreign interest rate is the average of 6-Month Treasury Constant Maturity Rate and 6-Month Libor and denoted by if. Domestic interest rates id are the 6-Month Treasury bill Rate. Variable for current account balance (CAM) is constructed as follows;

$$CAM = (CAB_t - CAB_{(t-1)}) / MB$$

Inflation variable (INF) is calculated using monthly CPI on year on year basis. Data on Industrial Production Index (IPI) is taken from FBS publications to proxy the real

sector activity.[18] Data on monetary base, interest rates, and $(REER)$ is taken from IMF's International Financial Statistics.

The variables are constructed so as to avoid the non stationary. The unit root test found that for all variables used we can reject the hypothesis of unit root. Also since we are dealing with monthly data, seasonal unit root is also checked by using the methodology developed by Franses (1991), which is an extension of the HEGY test developed by Hylleberg, Engle, Granger, and Yoo (1990). The result indicated that there is no seasonal unit root (**See Table F and G**).

However, information contained in monthly data may be limited, owing to strong seasonal variation. The presence of seasonal variation in the data can severely restrict firm conclusions about the interaction of variables. The degree of seasonality in the data was examined by carrying out a simple F-test by regressing each variable on monthly seasonal dummies. The null hypothesis implied no seasonality. (All coefficients of the seasonal dummies are simultaneously tested zero), while rejection of null implied the presence of seasonality in data. The test strongly supports the null hypothesis of no seasonality in the data. Therefore subsequent estimation will not contain seasonal dummies.

V. Empirical Evidence

This section first presents the results of the VAR regressions specified in the previous section and then analyze the impact on each of the model's endogenous variables using impulse response functions.

Estimation Results

The VAR model was estimated by a standard ordinary least square (OLS) procedure, the results are shown in **Table 2**. Lag length was selected as 1, using SBC information criteria. This adjustment time, however, may be justified, because model only contains monetary variables that adjust relatively quickly. The estimation yielded intuitively

[18] Since it was not possible to obtain the monthly data for GDP, one could include monthly industrial production as the measure of real activity. Although this too has an issue; due to significant services sector in the economy, this approach of using industrial production would underestimate the true GDP.

appealing results. Firstly, domestic credit was not found to be significantly affected by any of the variables in the model, except FR. More specifically, foreign reserves were found to have significantly affected domestic credit. Sterilization was partial (sterilization

Table 2: Full Sample (2001M1 to 2006M8)

Vector Autoregression Estimates
Included observations: 67 after adjustments
Standard errors in ( ) & t-statistics in [ ]

	DC	R	ID
DC(-1)	-0.311349	0.163561	-1.342462
	(0.16752)	(0.10469)	(2.01959)
	[-1.85855]	[1.56239]	[-0.66472]
R(-1)	-0.500695	0.329985	-6.165821
	(0.28973)	(0.18105)	(3.49286)
	[-1.72816]	[1.82258]	[-1.76527]
ID(-1)	0.004764	-0.004103	0.092073
	(0.01055)	(0.00659)	(0.12720)
	[0.45153]	[-0.62232]	[0.72387]
C	-0.018117	0.025599	-0.249970
	(0.01691)	(0.01057)	(0.20389)
	[-1.07126]	[2.42222]	[-1.22603]
IF(-1)	-0.015799	-0.021269	0.517493
	(0.03813)	(0.02382)	(0.45962)
	[-0.41440]	[-0.89273]	[1.12590]
INF(-1)	0.003701	-0.002933	0.058245
	(0.00262)	(0.00164)	(0.03155)
	[1.41417]	[-1.79349]	[1.84621]
CAM(-1)	-0.248028	0.071430	4.112209
	(0.19229)	(0.12017)	(2.31822)
	[-1.28984]	[0.59443]	[1.77386]
R-squared	0.192768	0.295580	0.327643
Vector Diagnosis:			
Portmanteau 4 lags			28.39975
Vector Normality Chi^2			10.44958
White hetroskedasticity (no cross term)			72.89367
White hetroskedasticity (cross term)			174.1001

coefficient = -0.501). As discussed in previous section that in some circumstances, the central bank may want both to resist currency appreciation and to ease its monetary stance. If so, intervention would create no conflict with monetary policy and hence no need to sterilize. In case of Pakistan, after the gush of inflows in FY02, SBP sterilized heavily because of the fact that it had doubts regarding the persistence of these inflows. However, after it realized that inflows are mainly non-debt creating and that there is a

need to loosen up its monetary stance; it reduced its sterilization operation significantly in following years (see footnote 10).

In addition the negative sign of CAM coefficient (-0.248) according to theory is correct which says ; that current account balance inflow results in the negative change in the domestic credit (DC); however remained insignificant. This too is an evidence of the sterilization practice; *albeit* partial, undertaken by the State Bank of Pakistan. This result is in line with the stylized facts and anecdotes.

The reserve equation also reveals interesting results. The changes in foreign reserves following the changes in domestic credit are often used as a measure of monetary independence. There is a large degree of independence, when offset coefficient is close to zero given that only small proportion of a change in reserve money will be offset by balance of payment movement of capital flows. Interestingly, the offset coefficient is very small and insignificant (0.16) implying that changes in credit resulted in almost insignificant offsetting reserve flows. It could also be an evidence of low capital mobility due to capital controls and the absence of capital account convertibility. Another explanation can be the low substitutability between Pakistani and foreign assets. It can also be augured that since majority of foreign exchange inflows were non-debt creating, the chances of changes in reserves in the presence of changes in domestic credit (DC) were minimal.

A second, and related question, is to what extent foreign or internal factors pushed or pulled foreign capital to Pakistan, respectively. This question relates to the (Frankel 1994) conclusion that unnecessarily high domestic interest rates will prevail when sterilization is undertaken in the case of an internal shock from higher domestic money demand or increase in exports (pull factor). On the other hand, sterilization will be more appropriate when capital is pushed by some external shock. Interestingly results show the insignificant coefficients of the domestic and foreign interest rates which imply that interest rates had not played any role in the foreign exchange inflows in Pakistan. That means inflows were neither pulled into the country due to high interest rates because of

some domestic policy,[19] nor they are pushed into Pakistan due to low interest rates abroad. Rather it supports the assertion that inflows were a result of an exogenous shock. It would seem that external factors played a crucial role in brining home these foreign exchange inflows. Most noteworthy was the big upsurge in workers' remittances through official channels that resulted from the global crack down on illegal channels of money transfer. This led to the collapse of *Hundi* system and demise of kerb market premium over official rate. Another contributing factor was the reverse capital flight as the balances of Pakistani's came under scrutiny abroad. In addition, debt rescheduling and new large aid inflows to Pakistan for siding with US and its allies in the war against terrorism augmented the net inflows. Moreover the coefficient of lag of current account balance CAM (0.07) in reserve equation has plausible sign and but is insignificant.

The results of domestic interest rate equation too have some interesting points. The coefficient of reserves (-6.17) in this equation is significant and has plausible sign. It reflects on the fact that sterilization of foreign exchange intervention was not complete and that had exerted negative pressures on the domestic interest rates. This was in line with the anecdotes.[20] The coefficient of inflation in domestic interest rate equation is very low (0.058245), however it is significant and has conceivable sign. Inflation remained subdued till end 2004 and only surfaced afterwards. SBP tightened its monetary policy only after mid 2005. This perhaps explain small coefficient size if inflation in domestic interest rate equation. Vector Diagnosis reveals that all assumptions regarding the error term were met.

We also estimated same model for two sub samples. Break date is taken as March 2004 on the basis of the fact that inflation started accelerating after this date. Therefore sub-

[19] Frankel (1994) argues that inflows could be the result of a increase in domestic money demand after some kind of stabilization program. Although Pakistan at that time was under IMF's stabilization program, yet we found no evidence of this connection.

[20] As the governor of the SBP stated in March 2004 in his paper presented in Pakistan Administrative Staff College "Despite some mopping up, the Central Bank has left excess liquidity with the banks which has driven down the cost of credit to historically low levels of 5 percent average. The banks are, therefore, reaching out to new customers particularly the middle and lower income groups by providing them agriculture credit, SME loans, mortgage loans and consumer loans. This is the most direct way the reserve accumulation is benefiting the common man…."[20]

sample one represents the low inflation period while sub-sample two represents when the State Bank of Pakistan encountered inflation threat and tightened its monetary stance.

Table 3: Sub-Sample 1 (2001M01 to 2004M03)

Vector Autoregression Estimates
Included observations: 41 after adjustments
Standard errors in ( ) & t-statistics in [ ]

	DC	FR	ID
DC(-1)	-0.513300	0.253115	-1.513182
	(0.19104)	(0.12350)	(2.56506)
	[-2.68693]	[2.04952]	[-0.58992]
FR(-1)	-0.665530	0.567175	-11.33087
	(0.31063)	(0.20082)	(4.17092)
	[-2.14249]	[2.82435]	[-2.71663]
ID(-1)	0.005347	-0.006203	0.068718
	(0.01104)	(0.00713)	(0.14819)
	[0.48447]	[-0.86939]	[0.46371]
IF(-1)	-0.026825	-0.031151	0.686114
	(0.04120)	(0.02663)	(0.55314)
	[-0.65115]	[-1.16970]	[1.24040]
INF(-1)	-0.001227	0.002464	0.032997
	(0.00229)	(0.00148)	(0.03070)
	[-0.53657]	[1.66684]	[1.07488]
CAM(-1)	-0.627931	0.119317	7.997240
	(0.26523)	(0.17147)	(3.56132)
	[-2.36746]	[0.69586]	[2.24558]
R-squared	0.265868	0.207706	0.266033
Vector Diagnosis:			
Portmanteau 4 lags			26.77141
Vector Normality Chi^2			8.602368
White hetroskedasticity (no cross term)			72.10327
White hetroskedasticity (cross term)			155.8985

Table 3 represents results regarding sub-sample one. Sterilization is almost 66% which is more than the full sample estimate and in line with our expectation. In addition to this the negative sign of CAM coefficient (-0.628) is correct and significant.

Contrary to the full sample, the offset coefficient although very small (0.253) but is insignificant, implying that changes in credit resulted in very small offsetting reserve flows. The results of domestic interest rate equation too have some interesting points. The coefficient of reserves (-11.331) in this equation is significant and has plausible sign.

It reflects on the fact that sterilization was only partial and that had exerted negative pressures on the domestic interest rates. This was also evident from unprecedented fall in bench mark 6-Month Treasury bill rates from 10.96 at the start of the sample to 1.74 by the end of the sample period.

Table 4: Sub-Sample 2 (2004M04 to 2006M08)

Vector Autoregression Estimates
Included observations: 29
Standard errors in ( ) & t-statistics in [ ]

	DC	FR	ID
DC(-1)	0.324633	-0.146249	1.875059
	(0.32683)	(0.23520)	(2.57829)
	[0.99328]	[-0.62180]	[0.72725]
FR(-1)	-0.104731	-0.041484	7.177507
	(0.52389)	(0.37702)	(4.13291)
	[-0.19991]	[-0.11003]	[1.73667]
ID(-1)	0.017699	-0.013937	0.386944
	(0.02640)	(0.01900)	(0.20826)
	[0.67043]	[-0.73360]	[1.85801]
C	0.008347	0.002607	-0.894786
	(0.05917)	(0.04258)	(0.46677)
	[0.14107]	[0.06123]	[-1.91698]
IF(-1)	0.002665	-0.004771	2.127052
	(0.09916)	(0.07136)	(0.78227)
	[0.02687]	[-0.06686]	[2.71909]
INF(-1)	-0.000484	0.000109	0.103263
	(0.00731)	(0.00526)	(0.05766)
	[-0.06618]	[0.02076]	[1.79101]
CAM(-1)	0.158100	0.003674	-0.318915
	(0.23576)	(0.16966)	(1.85983)
	[0.67061]	[0.02166]	[-0.17148]
R-squared	0.158728	0.073261	0.514652
Vector Diagnosis:			
Portmanteau 4 lags			29.71896
Vector Normality Chi^2			9.268957
White hetroskedasticity (no cross term)			65.67934
White hetroskedasticity (cross term)			161.9859

Table 4 represents the results of the high inflation sample period. The sign of sterilization coefficient (-0.105) is true, but it turned out to be statistically insignificant. However, this was consistent with the overall monetary stance of the central bank. From April 2004 onwards, almost all the intervention by the State Bank of Pakistan in the forex market

was in the form of net sales to support the exchange rate (see **Figure 3**). However, SBP not sterilizing its forex intervention was also consistent with its tight monetary stance during this period due to inflation concern[21]. With almost no sterilization, the insignificant offset coefficient (-0.1462) is close to zero reflecting almost complete independence of monetary policy conduct from the balance of payment concerns. The results of domestic interest rate equation too have some interesting points. The coefficient of reserves (7.177) in this equation is significant and has plausible sign. It reflects on the fact of tight monetary stance in the period. Inflation too have impacted the domestic interest rates by jacking them up.

The VAR can be used to analyze the impact of shocks to its endogenous variables on other variables in the system using impulse response analysis. The impulse response function traces the effect of a one standard deviation (OSD) innovation in the endogenous variables to current and future values of all endogenous variables. **Figure 4** shows the impulse responses for the full sample data.

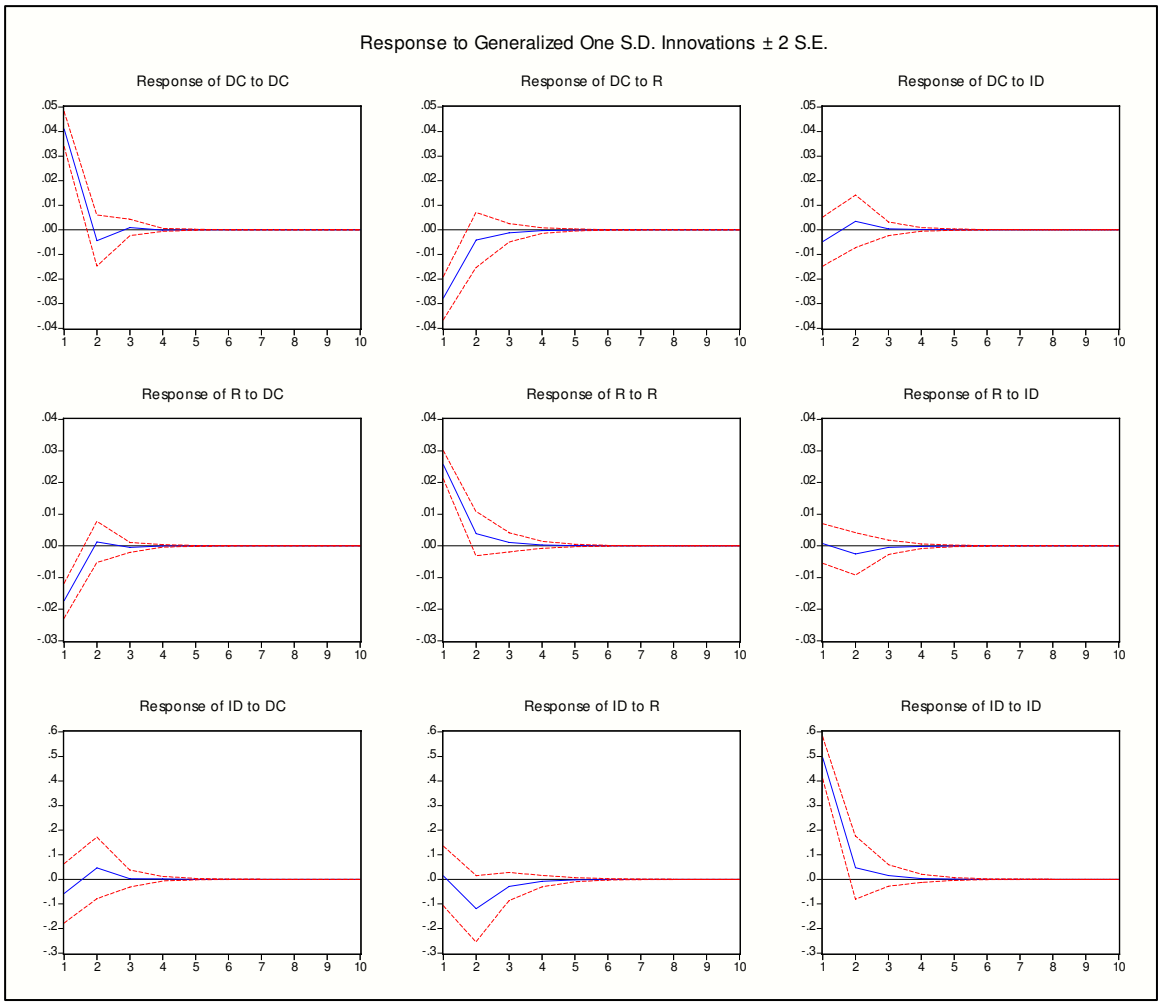
A shock in domestic credit levels leads to an immediate reduction in domestic interest rates, followed by a converging toward zero in the remaining four months (the first column of graphs). In terms of reserves, a tighter credit policy is followed by a surge in capital inflows, albeit of smaller magnitude.

The impact of a shock to foreign reserves on domestic interest rates causes a significant reduction in interest rates initially. This perhaps indicates partial sterilization and resulting intentional gush of liquidity in the market following the interventions. Impact of shock of foreign reserves on domestic credit levels too show a fall of domestic credit (graphs in first and third row of the second column). As previously found, the empirical analysis finds support for the sterilization bias hypothesis.

The impact of a shock to domestic interest rates on foreign reserves and domestic credit is relatively insignificant. More importantly, this confirms the previous results that flows were not a result of domestic interest rates.

[21] The bench mark 6-Month treasury bill rate rose from 1.84 percent at the start of the period to 8.81 percent by the end of the sample period.

Figure 4: Impulse Response Function (Full Sample)



VI. Conclusion:

This paper analyzed three empirical questions. The first question is to what extent monetary authority maintained monetary independence in its attempt to insulate the money supply from the surge in foreign exchange inflows during the period under consideration. This question is examined by estimating the offset coefficient. Interestingly, the offset coefficient for full sample is very small and insignificant (0.16) implying that changes in credit resulted in very minimal offsetting reserve flows. It is also an evidence of low capital mobility in the absence of capital account convertibility. Another explanation can be the low substitutability between Pakistani and foreign assets. It can also be argued that since majority of foreign exchange inflows were non-debt

creating, the chances of changes in reserves in the presence of changes in domestic credit (DC) were minimal.

We also analyzed was the sterilization policy of SBP. We found out that for the full sample period, SBP only partially sterilized the inflows. Generally, the central bank would want *both* to resist currency appreciation and to control inflationary pressures. If so, foreign exchange intervention would be in direct conflict with monetary policy of the country and the monetary authorities will find it harder to prevent appreciation pressure while at the same time raising the interest rate. Thus, a first challenge the monetary authority faces is to coordinate intervention with monetary policy. However, in case of Pakistan, the economy was very slow and the inflationary pressures were almost absent at the beginning of the period under study. Thus SBP resorted to expansionary monetary policy. For this reason, foreign exchange intervention need not be sterilized fully (only 50 percent). This resulted in gush of liquidity in market and interest rates in fact dipped. This is also in accord with the [Frankel(1994)] conclusion that unnecessarily high domestic interest rates will prevail when sterilization is undertaken in the case of an internal shock such as higher domestic money demand or increase in exports (pull factor). On the other hand, sterilization will be more appropriate when capital is pushed by some external shock. Interestingly results show the insignificant coefficients of the domestic and foreign interest rates which imply that interest rates had not played any role in the foreign exchange inflows in Pakistan. That mean inflows were neither pulled into the country due to some domestic policy, interest rates nor they are pushed into Pakistan due to low interest rates abroad. Rather it supports the assertion that inflows were a result of an exogenous shock i.e, September 11, 2001. It would seem that external factors played a crucial role in brining home these foreign exchange inflows. Most noteworthy was the big upsurge in workers' remittances through official channels that resulted from the global crack down on illegal channels of money transfer.

The analyses of sub-samples show that there was no sterilization done post April 2004 period. This was because of the fact that during that period SBP intervened in the forex market as a net seller, and with the need of tightening of monetary policy arising out of inflationary pressures, no sterilization policy was in full agreement with tight monetary

policy. Hence we can argue that during the period under study, SBP's domestic credit policy was in no conflict with its intervention in forex market.

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Appendix

Demand for base money

(1) $M_D = L(Y, W, id, if)$ where $L_y, L_w > 0; L_{id}, L_{if} < 0$

Net domestic demand for domestic bonds

(2) $B_D = H(Y, W, id, if)$ where $H_{id}, H_w > 0; H_{if} < 0; H_y >< 0$

Domestic demand for foreign bonds

(3) $B_F = J(Y, W, id, if)$ where $J_{if}, J_w > 0; J_{id} < 0; J_y >< 0$

Net foreign demand for domestic bonds

(4) $B^*_D = F(Y^*, W^*, id, if)$ where $H_{id} > 0, H_{if} < 0, H_{w^*}, H_{y^*} >< 0$

Total money supply

(5) $M_s = NFA + NDA$

Domestic component of money supply

(6) $\Delta NDA = -\Delta B_G$ which represents open market operation

Foreign components of money supply

(7) $\Delta NFA = K + CAB$

Total net capital inflows

(8) $K = \Delta B^*_D - \Delta B_F$

Domestic wealth constraint

(9) $L(...) + H(...) + J(...) = W$

Money equilibrium

(10) $M_D = M_s$

Domestic bond equilibrium

(11) $B_D + B^*_D = B_G$

The model can be solved for changes in domestic interest rates and changes in net foreign assets (NFA) of the central bank.

Using the money equilibrium equation (10), we have

$NFA + NDA = L(Y, W, id, if)$

(12) $\Delta NFA + \Delta NDA = \Delta L(Y, W, id, if)$

using (7), we get

(13) $K + CAB + \Delta NDA = \Delta L(Y, W, id, if)$

Also $\Delta NFA = K + CAB$

$\Delta NFA = \Delta F(Y^*, W^*, id, if) - \Delta J(Y, W, id, if) + CAB$ by using (8).

(14) $$\Delta NFA = (F_{y^*}\Delta Y^* + F_{w^*}\Delta W^* + F_{id}\Delta id + F_{if}\Delta if) - (J_y\Delta Y + J_w\Delta W + J_{id}\Delta id + J_{if}\Delta if) + CAB$$

Again utilizing (12)

$$\Delta NFA + \Delta NDA = L_y\Delta Y + L_w\Delta W + L_{id}\Delta id + L_{if}\Delta if$$

substituting (14), we get

$$(F_{y^*}\Delta Y^* + F_{w^*}\Delta W^* + F_{id}\Delta id + F_{if}\Delta if) - (J_y\Delta Y + J_w\Delta W$$

$$+J_{id}\Delta id + J_{if}\Delta if) + CAB + \Delta NDA = L_y\Delta Y + L_w\Delta W$$

$$+L_{id}\Delta id + L_{if}\Delta if$$

$$(F_{id} - J_{id})\Delta id - L_{id}\Delta id = L\,\Delta Y + L\,\Delta W + L_{if}\Delta if - \Delta NDA -$$

$$(F_{if} - J_{if})\Delta if - F_{y^*}\Delta Y^* - F_{w^*}\Delta W^* + J_y\Delta Y + J_w\Delta W - CAB$$

(15) $$(F_{id} - J_{id} - L_{id})\Delta id = (L_y + J_y)\Delta Y + (L_w + J_w)\Delta W + (L_{if} - F_{if} + J_{if})\Delta if - \Delta NDA - F_{y^*}\Delta Y^* - F_{w^*}\Delta W^* - CAB$$

Invoking wealth constraint (9), we have

$$L_w + H_w + J_w = 1$$

and $$L_a + H_a + J_a = 0 \text{ where } a = Y, id, if$$

Therefore (15) implies

$$(F_{id} + H_{id})\Delta id = -H_y\Delta Y + (1 - H_w)\Delta W - (F_{if} + H_{if})\Delta if -$$

$$\Delta NDA - F_{y^*}\Delta Y^* - F_{w^*}\Delta W^* - CAB$$

(16) $$\Delta id = -\frac{1}{(F_{id} + H_{id})}\{H_y\Delta Y + H_w\Delta W + (F_{if} + H_{if})\Delta if + \Delta NDA + F_{y^*}\Delta Y^* + F_{w^*}\Delta W^* + CAB\}$$

Again using (12)

$$\Delta NFA = \Delta L(Y, W, id, if) - \Delta NDA$$

$$\Delta NFA = L_y\Delta Y + L_w\Delta W + L_i\Delta id + L_{i^*}\Delta if - \Delta NDA$$

substituting (16), we have

$$\Delta NFA = L_y\Delta Y + L_w\Delta W + L_{if}\Delta if - \Delta NDA + L_{id}[-\frac{1}{(F_{id} + H_{id})}$$

$$\{H_y\Delta Y + H_w\Delta W + (F_{if} + H_{if})\Delta if + \Delta NDA +$$

$$F_{y^*}\Delta Y^* + F_{w^*}\Delta W^* + CAB\}]$$

$$\Delta NFA = [L_y - \frac{L_{id} H_y}{(F_{id} + H_{id})}]\Delta Y + [L_w - \frac{L_{id} H_w}{(F_{id} + H_{id})}]\Delta W$$

$$+[L_{if} - \frac{L_{id}(F_{if} - H_{if})}{(F_{id} + H_{id})}]\Delta if - [1 + \frac{L_{id}}{(F_{id} + H_{id})}\Delta NDA +$$

$$L_{id}[-\frac{1}{(F_{id} + H_{id})}\{F_{y^*}\Delta Y^* + F_{w^*}\Delta W^* + CAB\}]$$

Again invoking wealth constraint (9), we have

$$L_w + H_w + J_w = 1$$

and $L_a + H_a + J_a = 0$ where $a = Y, id, if$

By utilizing these in previous equation, we have

$$\Delta NFA = [-\frac{1}{(F_{id} + H_{id})}\{L_y(J_{id} - F_{id}) - L_{id} J_y\}]\Delta Y +$$

$$[-\frac{1}{(F_{id} + H_{id})}\{L_w(J_{id} - F_{id}) - L_{id} J_w\}]\Delta W +$$

(17)
$$[-\frac{1}{(F_{id} + H_{id})}\{L_{if}(J_{id} - F_{id}) + L_{id}(F_{if} - J_{if}\}]\Delta if$$

$$-[\frac{1}{(F_{id} + H_{id})}(F_{id} - J_{id})]\Delta NDA +$$

$$[-\frac{1}{(F_{id} + H_{id})}\{L_{id} F_{y^*}\Delta Y^* + L_{id} F_{w^*}\Delta W^* + L_{id} CAB\}]$$

Table A: Selected Macroeconomic Indicators

	FY98	FY99	FY00	FY01	FY02	FY03	FY04	FY05
				Growth rates				
Real GDP (fc)[1]	3.5	4.2	3.9	2.5	3.6	5.1	6.4	8.4
Agriculture	4.5	1.9	6.1	-2.6	1.4	4.1	2.6	7.5
Major crops	8.3	0	15.4	-9.8	-0.5	5.8	2.8	17.3
Manufacturing	6.9	4.1	1.5	7.6	4.4	7.7	13.4	12.5
Large-scale	7.6	3.6	0	8.6	4	8.7	17.1	15.6
Services sector	1.6	5	4.2	4.8	5.1	5.3	5.2	7.9
Consumer price index (FY01=100)	7.8	5.7	3.6	4.4	3.5	3.1	4.6	9.3
Sensitive price indicator (FY01=100)	7.4	6.4	1.8	4.8	3.4	3.5	6.8	11.6
Domestic credit	15	3.5	9	3.7	2.4	0.6	23.7	22.4
Monetary assets (M2)	14.5	6.2	9.4	9	14.8	18	19.6	19.3
Exports (f.o.b.)	3.7	-9.8	10.1	7.4	-0.7	22.2	10.3	16.9
Imports (f.o.b.)	-15	-6.8	9.3	4.1	-3.6	17.8	27.6	32.3
Liquid foreign exchange reserves with SBP[2] (million US Dollar)	930.0	1,729.7	1,352.3	2,075.8	4,804.9	9,993.0	11,107.0	10,481.0
				As percent of GDP				
Total investment	17.7	15.6	17.4	17.2	16.8	16.9	17.3	16.8
National savings	14.7	11.7	15.8	16.5	18.6	20.8	18.7	15.1
Tax revenue	13.2	13.3	12.9	10.6	10.9	11.5	11	10.1
Total revenue	16	15.9	16.3	13.3	14.2	14.9	14.3	13.7
Budgetary expenditure	23.7	22	22.5	17.2	18.8	18.6	17.3	18.3
Budgetary deficit	7.7	6.1	6.6	4.3	4.3	3.7	3	3.3
Current account deficit (Including official transfers)	-2.7	-3.8	-0.3	0.5	4	4.9	1.9	-1.4
Domestic debt	43.9	47.4	41.6	41.6	39	38.4	35.8	32.5
External debt	55.4	54.9	44.4	49.5	45.6	40	35	31
Explicit liabilities[3]	0.5	2.4	2	2.3	1.4	0.9	0.6	0.4
Total debt (Including external liabilities)	99.8	104.7	88	93.3	85.9	79.3	71.4	63.9

[1] During FY02, sectoral shares in GDP were as follows: agriculture (24.1 percent), industry (25.0 percent) and services (50.9 percent).
[2] Foreign exchange reserves for FY99 and FY00 include FE-13 deposits with SBP, whereas for FY01 and FY02, these include CRR/SLR on FE-25 deposits.
[3] Explicit liabilities include Special US Dollar bonds, FEBCs, FCBCs and DBCs.

Table B: Balance of Payment

	Balance on goods, services and private transfers*	Balance on capital account*	Balance on capital account plus errors and omission*	Overall Balance**
FY92	-1346	1510	1476	130
FY93	-3688	3073	3099	-589
FY94	-1965	3471	3550	1585
FY95	-2484	2797	2722	238
FY96	-4575	4195	4144	-431
FY97	-3846	2748	2814	-1032
FY98	-1921	1268	1615	-306
FY99	-2819	-1315	-323	-3142
FY00	-1931	-2464	-1963	-3894
FY01	-513	196	822	309
FY02	1338	388	1316	2654
FY03	3028	1113	1561	4589
FY04	1300	-823	-601	699
FY05	-1807	816	736	-1071
FY06	-5683	6576	6576	1132

Source: State Bank of Pakistan

*A minus sign indicate a deficit in the pertinent account. Balance on goods, services and private transfers are equal to the current account balance minus official transfers. The latter are treated in this table as external financing and are included in the capital account.

**Overall balance equals the sum of row 2 and 4. A positive entry indicates the accumulation of international reserves by monetary authority.

Table C: External cash flow Position

million UD Dollar

	FY00	FY01	FY02	FY03	FY04	FY05	FY06
Researves at the beginning of the year+	**1,740**	**2,163**	**3,244**	**6,398**	**11,667**	**12,389**	**12,621**
Inflows*	**16,845**	**20,020**	**22,228**	**25,239**	**25,623**	**32,556**	**40,508**
of which							
Exports	8,190	8,933	9,140	10,974	12,459	14,482	16,506
Services	1,501	1,367	1,929	2,712	2,644	3,319	3,748
Remittences	983	1,087	2,390	4,237	3,871	4,168	4,600
Kerb purchases	1,634	2,157	1,376	0	0	0	0
Foreign investment	546	146	358	607	1,179	1,852	3,132
Official grants	940	844	1,500	1,051	619	391	865
Loan disbursments	1,588	2,740	2,910	2,208	1,726	2,438	2,782
Exceptional financing	3,965	692	138	620	221	-7	239
Outflow*	**17,227**	**18,939**	**19,074**	**19,970**	**24,901**	**32,324**	**39,832**
of which							
Imports	9,598	10,202	9,434	11,333	13,738	18,996	24,948
Services	2,766	2,332	2,214	2,714	3,960	6,612	8,150
Interest payments	1,596	1,369	1,111	976	1,056	1,037	1,233
Amortization	1,828	1,714	1,551	1,231	3,089	1,339	1,202
Repayment of liabilities	652	1,940	3,590	1,192	392	154	461

Source: State Bank of Pakistan

*only major heads are included

+ Reserves comprises SBP forex Reserves and Reserves with the banks

Table D: Financial Account

million US Dollar

Items	FY01	FY02	FY03	FY04	FY05	FY06
Financial account	**-1,114**	**-2,423**	**-471**	**-1,335**	**446**	**5,855**
1. Direct investment abroad	-37	-2	-27	-45	-66	-70
2. Direct investment in Pakistan	323	485	798	951	1,525	3,521
3. Portfolio investment	-140	-491	-239	314	620	985
4. Other investment	-1,260	-1,932	-1,003	-2,555	-1,633	1,419

Source: Statistics Department, SBP

Table E : Cash Reserves Requirements (CRR)

With effect from	Rate as % of Time and Demand Liabilities
19-Jan-68	5
24-Oct-91	5
15-Jan-92	5
9-Feb-95	5
18-Jul-95	5
19-Dec-95	5
1-Jul-96	5
26-Jul-97	5
22-Jun-98	3.75 on Rupee and 5 on Foreign Currency
5-Sep-98	5
19-May-99	3.5
12-Jul-99	5
7-Oct-00	7
16-Dec-00	5
30-Dec-00	5
5-Jan-01	5
22-Jul-06	7 of Demand Liabilities and 3 of Time Liabilities[#]

Source: State Bank of Pakistan

Table F: Unit Root Testing

		ADF		Conclusion
1	DC	-8.857968	[0]	No unit root
2	R	-4.044513	[3]	No unit root
3	ID	-4.310869	[1]	No unit root
4	IF	-4.450789	[3]	No unit root
5	INF	-4.459543	[10]	No unit root
6	CAM	-6.958482	[6]	No unit root

Critical value at 5 percent significance level is -3.478 for ADF test

Table G: Monthly seasonal unit root testing [Franses (1990)]

		FR	DC	ID	IF	INF	CAM
Π1	t-test	-1.580106	-1.967853	-1.433631	-2.28186	-3.011124	-3.193934
Π2 to Π12	Joint F-test	7.497773	3.277999	10.30495	20.13872	86.2958	4.266772
	Probability	0.0000	0.0026	0.0000	0.0000	0.0000	0.0003

Note: critical t value for Π1 with trend at 5% and 10 % are -3.34 and -2.92 respectively.