Does Volatility in Government Borrowing Leads to Higher Inflation? Evidence from Pakistan

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DOES VOLATILITY IN GOVERNMENT BORROWING LEADS TO HIGHER INFLATION? EVIDENCE FROM PAKISTAN

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ABSTRACT

This study analyzes the impact of volatility in government borrowing from central bank (GBCB) on domestic inflation in Pakistan. This paper utilizes Generalized Auto Regressive Conditional Hetroskedasticity (GARCH) model to estimate volatility in GBCB using monthly data from July 1992 to June 2007. The empirical results, based on auto regressive distributed lag (ARDL) with bound testing technique suggest that domestic inflation in Pakistan is related with volatility in government borrowing from central bank in the long run. Furthermore, error correction model (ECM) estimates show that in the short run, inflation is also affected by volatility in GBCB.

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"A common criticism of this stress on the budget deficit is that the data rarely shows a strong positive association between the size of the budget deficit and the inflation rate."

(Blanchard and Fischer, 1989, p. 513)

1. INTRODUCTION

Historical literature recognizes inflation as a monetary vis-à-vis fiscal phenomenon with momentous socio-economic and political consequences. Generally, inflation refers to a *sustained increase in general price level* as measured by an index such as consumer price index (CPI) or gross domestic product (GDP) deflator. It may be either demand-pull or cost-push.[1]

Economists identify inflation with different categories depending on the degree of variability in inflation. For instance, when the general price level is rising by 5% or less, they call it creeping inflation. This creeping inflation provides health to the economy by generating the forces of dynamism. If the prices become stagnant, the economic growth will stop in the economy. When the general price level is rising by a rate between 5 to 10%, it is labeled as a situation of walking inflation. This walking inflation gives a signal that something is wrong in the economic management process and proper remedial measures have to be initiated. If the increase in general price level is above 10%, the situation is called running inflation which becomes hyper inflation when it shooting more than 50%.

Presumably, inflation generates welfare cost of economic agents (i.e., inflation tax) and inflation volatility is considered as a key source of destabilizing mistakes. It frequently varies and thus increases uncertainties for macroeconomic environment. Rother (2004) argue that high variability of inflation over time makes expectations over the future price level more uncertain. In a world with nominal contracts this induces risk-premia for long-term arrangements, raises costs for hedging against inflation risks and leads to unanticipated redistribution of wealth. To some prominent economists inflation is always and everywhere a monetary phenomenon in the long run. That is why almost all over the world central banks are entrusted upon to tame inflation. For all the central banks taking care of inflation is at least one of the objectives of monetary policy. Same is the case with the State Bank of Pakistan (SBP) being central bank of the country. SBP Act, 1956 confers upon it to regulate money and credit in the country in such a way that maintains monetary stability (which leads to price stability) while fostering the utilization of country's resources in the best national interest.

A general consensus among macroeconomist is that inflation occurs when the rate of growth of the money supply is higher than the growth rate of the economy.[2] This phenomenon,

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[1] Demand-Pull Inflation is situation often described as *too much money chasing too few goods*. According to this view, an excess of aggregate demand over aggregate supply will generate inflationary pressures in prices. Cost-Push Inflation is caused by wages increase by union pressures and profit increase by producers. The basic cause of cost-push inflation is that the money wages increase more rapidly than the productivity of labor. Cost-push inflation may be due to upward adjustment of wages to compensate rise in the cost of living index. An increase in the prices of domestically produced or imported raw materials may lead to cost-push inflation. Another cause of cost-push inflation is increase in easy and non-functional profits by oligopolistic and monopolist firms.

[2] This is the conventional monetarist linkage from the creation of reserve money to inflation when Central Banks issues money at the rate that exceeds the demand for cash balances at the existing price level and the increased demand in the goods market pushes up the price level as the public tries to get rid of its excess cash holdings.

however, occurs usually in developing countries which faces high budget deficits. The central government of any developing country finances their budget deficit through monetizing process (borrowing from central bank). High monetization leads to higher inflationary pressure to the economy. Thus borrowing from the central bank is considered as a leading indicator of domestic inflation.

In line with the above phenomenon, the main motivation of this paper is to assess whether volatility in government borrowing has an impact of domestic inflation in Pakistan. For this purpose Generalized Auto Regressive Conditional Hetroskedasticity (GARCH) model is used to estimate volatility in government borrowing from central bank (GBCB) using monthly data from July 1992 to June 2007. Our main hypothesis is that GBCB has significant and positive impact on domestic inflation. It is also one of the leading indicators of price instability both in short and in the long run.

The rest of the paper is organized as follows: A review of previous empirical studies is presented in section 2. Section 3 provides data and methodology. Empirical findings are discussed in section 4 and the main conclusions are stated in section 5.

2. BRIEF REVIEW OF EMPIRICAL LITERATURE

There is an immense literature available on fiscal vis-à-vis monetary determinants of inflation. In this paper we also provide a brief review of some selected domestic and international studies. This review provides us stylized facts and a baseline for our model consistency. Therefore, we intend to categorize the literature for Pakistan into two sets including studies which used government borrowing as a determinant of inflation and those which have not incorporated this determinant in their model setup. Appendix A summarizes almost all of the local empirical literature on inflation since 1982 to date. In this study we also present evidence of international empirical literature relevant to this concept.

In the case of Turkey, Akcay, Alper and Ozmucur (1996) investigate determinants of inflation using annual data from 1948 to 1994 vis-à-vis quarterly data from 1987 to 95. Their analysis reveals that a one unit increase in the deficit GNP ratio under money neutrality will increase the long-run inflation by 1.59 units. Also a one unit increase in the deficit GNP ratio under money neutrality will increase the long-run inflation by 5.67 which is much higher than 1.59 for the whole sample indicating greater impact of deficit on inflation during pre-bond financing period.

Metin (1998) provide a multivariate cointegration analysis of the determinants of inflation for Turkey using annual data from 1950 to 1987. The major finding from the new equation is that budget deficits (as well as real income growth and debt monetization) significantly affect inflation. For the conditional model, an increase in the scaled budget deficit immediately increases inflation. Real income growth has a negative immediate effect and positive second-lag effect on inflation. Monetization of the deficit also affects inflation at a second lag.

Catao and Terrones (2003) studied the deficit-inflation relationship in 107 countries over the period 1960 to 2001. This study was distinctive in two respects. Firstly, it used an intertemporal optimization model to show that the equilibrium inflation is directly related to fiscal deficit which is scaled by narrow money. This approach resulted in introducing nonlinearity in the model which is better than semi-logarithm specification used earlier3. Secondly, they modeled the link between fiscal deficit and inflation "as intrinsically dynamic, explicitly distinguishing between the short run and long run". This study specified an autoregressive distributed lag (ARDL) model for each country and polled them together in a panel, and then tested the cross-equation restriction of a common long-run relationship between the two variables using pooled mean group estimator (PMG)4. As the difference between the MG and PMG estimates of long-run elasticity parameter identified sample heterogeneity, therefore the authors divided the panel into groups on the basis of financial development and inflation performance. Then estimates of MG and PMG indicated that budget deficit was significant driver of inflation in most groups except the low inflation economies and advanced economies.

The results showed that in case of developing countries, a reduction (increase) of one percent in ratio of budget to GDP lowered (raised) inflation by around 8.75 percentage points. For emerging market economies, a percentage point change in the ratio of budget balance to GDP is estimated to change inflation by 2.25 percentage points. Similarly, changes in inflation strongly impacted the high inflation economies, and less strongly on moderate inflation economies. This study concluded that fiscal deficit displayed a powerful effect on inflation in developing countries, emerging markets and high-inflation economies and a much smaller effect amongst moderate inflation countries.

Rother (2004) examined the relationship between discretionary fiscal policies and inflation volatility for fifteen industrialized countries for the period from 1967 to 2001. Their results suggested that the volatility in discretionary fiscal policies strongly contributed to inflation volatility. They found that a one standard deviation increase in discretionary fiscal policy could raise inflation volatility to range of 10-17 percentage points. These results were obtained using panel data and performing regressions for different measures of inflation volatility (conditional and unconditional variability of inflation rate5) as a function of the volatility of activist fiscal policies6 and other explanatory variables (like output gap, monetary and exchange rates). Moreover, the Generalized Least Squares (GLS) was employed in order to account for the possibility of cross-sectional Hetroskedasticity.

Alavirad and Athawale (2005) investigate determinants of inflation in Islamic Republic of Iran using annual data from 1963 to 1999. They find that budget deficits do have a significant impact on inflation rates in the long run in the Islamic Republic of Iran. The ECM results show

[3] This non-linearity in the model resulted in capturing a stronger impact of fiscal deficit in higher inflation economies.

[4] This methodology is better than earlier used static fixed-effects estimator as country-specific ARDL structure is capable of accommodating cross-country heterogeneity in inflation inertia.

[5] Unconditional variability in inflation rate is defined as the standard deviation over a calendar year of month-on-month inflation rates, thereby capturing the extent of short-term fluctuations in inflation. Moreover, conditional inflation variability is measured by the standard deviation of one-step-ahead forecast errors derived from time-series based inflation forecast model.

[6] To measure the volatility of discretionary fiscal policy, fiscal policy stance is defined as the year-on-year change in the cyclically adjusted primary balance relative to GDP.

that the budget deficit and liquidity in the short run, and related to the long run, have less of an effect on price levels. The coefficient of error correction is estimated at -0.2. This value shows that the adjustment speeds is relatively slow.

Catao and Terrones (2005), using panel of 23 emerging market countries for the period 1970-2000 to investigate determinants of inflation. They found that a one percentage point reduction in the ratio of fiscal deficit to GDP lowered long-run inflation by 1.5 to 6 percentage points. This study used an econometric specification derived from inter-temporal optimization model that relates to long-run inflation to the permanent component of fiscal deficit. One of the most distinguishing feature of this study is that it fiscal deficit is scaled by the size of inflation tax base which is measured by the ratio of narrow money to GDP. This resulted in introduced the desired non-linearity in the relationship between fiscal deficit and inflation.

Giannitsarou and Scott (2006) examined the means through which fiscal sustainability was achieved by six industrialized countries (namely US, Japan, Germany, Italy, UK and Canada) during the period 1960-2005. They assessed the relative contribution of primary deficit, inflation and GDP growth as means to counter fiscal imbalances in the countries under study. Their findings suggested that fiscal balance was achieved mainly through variations in primary deficits (80-100 percent), whereas inflation (0-10 percent) and GDP growth (0-20 percent) contributed minimally towards fiscal sustainability.

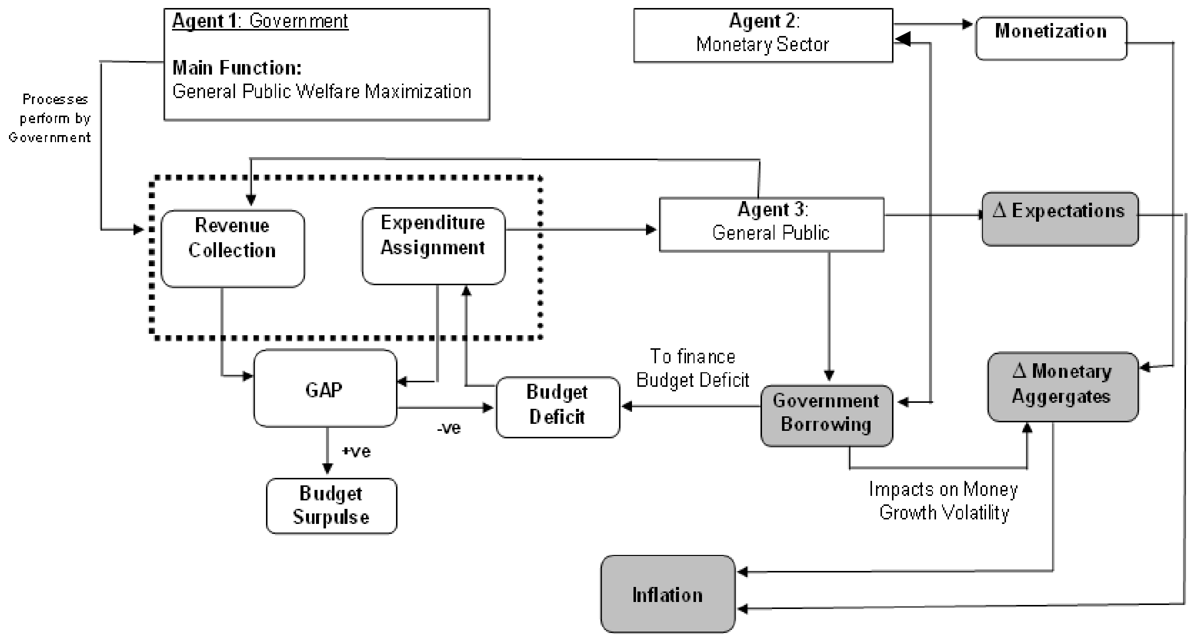
The empirical results suggested that fiscal imbalances and weak forecaster for future inflation in economies under study. More specifically, they found that the predicted rise in fiscal deficit scenario in future could possibly impact in an insignificant manner towards increasing inflation in the economy. The authors further observed that their results should be used with much caution as econometrically evaluating the inter-temporal budget constraint is vulnerable to non-stationarity and time dependence problems.

3. Methodology and Data Description

3.1 Theoretical Framework

To study the adverse impact of volatility in government borrowing from central bank on domestic inflation, it is necessary to observe its functional channel (see, flow chart 1). Theoretically speaking, budget deficit (*BD*) weakly causes inflationary pressures, but rather impacts strongly on general price level through the impact on money aggregates (say, M1 and M2) and public expectations, which in turn trigger volatility in prices. Since, government borrows from different sources to finance budget deficits, so it is necessary to observe its dynamics which generate volatility in money growth. To do this, we adopted a theoretical model introduced by Sachs and Larrain (1993).

Flow Chart 1 - Functional Channel of Government Borrowing and Money Growth Volatility



The budget constraint of the public sector government as introduce by Sachs and Larrain (1993) can be expressed as follows:

$$BDF = \Delta GD^{g} = GD^{g} - GD^{g}_{-1} = P \cdot (G + I^{g} - T) + i \cdot GD^{g}_{-1} \qquad (3.1)$$

Where:

- $GD^{g} - GD^{g}_{-1}$, is the change in government debt between the current and previous periods,
- P is the price level,
- $G + I^{g}$, is Government expenditures
- T is taxes
- $i \cdot GD^{g}_{-1}$, is the interest payments on previously issued debt.

Government debt, in the form of either bonds or credits, can be held by the public (domestic and foreign) and by the central bank. Let's assume for the purposes of the present report that the central bank's credit to banking system doesn't alter over time. Then the change in monetary base ΔMB equals the change in the stock of government debt held by central bank $(GD^{g}_{c} - GD^{g}_{c-1})$ plus the change in foreign exchange reserves, $E \cdot (B^{*}_{c} - B^{*}_{c-1})$, where E stands for the nominal exchange rate, we obtain:

$$\Delta GD^{g} = \Delta MB + (GD^{g}_{p} - GD^{g}_{p-1}) - E \cdot (B^{*}_{c} - B^{*}_{c-1}) \qquad (3.2)$$

Equation (3.2) gives us information that there are three ways to cover a budget deficit; [a]: by "monetization" of the deficit (i.e. by increasing monetary base or by so called "printing" money); [b]: by increase in the public's (foreign and domestic) holdings of debt; and [c]: by running down foreign exchange reserves at the central bank. Since, our target is to find the volatility in government borrowing from central bank on domestic inflation. So for simplicity in our model, we assumed that government only borrows from central bank[7]. In this case, equation (3.2) becomes:

$$\Delta GD^{g} = \Delta MB \tag{3.3}$$

Where;

$$(GD_{c}^{g} - GD_{c-1}^{g}) = 0 \quad \text{and} \quad E \cdot (B_{c}^{*} - B_{c-1}^{*}) = 0$$

Let:

$$\Delta GD^{g} = GB_{g} \quad \text{and} \quad \Delta MB = M_{g}$$

Where:

- GBg is growth in government borrowing;
- Mg is the money growth

This type of borrowing is called "monetizing" [8] the deficit. Because this phenomenon always leads to the growth of monetary base (MB) and money supply, it is often defined as "printing money". From equation (3.3), we can observe that an increase in the high-powered money is the source of financing budget deficit.

Lastly, from equation (3) we can define general functional form as:

$$Mg = f(GB)$$

Or

$$volt(Mg) = volt(GB_{g}) \tag{3.4}$$

Equation (3.4) implies that volatility in government borrowing impacts directly on money growth via monetization channel. Quantity theory also identify that the volatility in money growth is the key factor that effect the changes in price level [Walsh (2003) and Romer (2006)]. So, we also have the following relationship:

$$\pi_{t} = volt(MB_{g}) \tag{3.5}$$

[7] Ouanes and Thakur (1997) argues that there exist five different ways of financing budget deficit: (a) borrowing from the central bank (or "monetization" of the deficit); (b) borrowing from the rest of the banking system; (c) borrowing from the domestic non-bank sector; (d) borrowing from abroad, or running down foreign exchange reserves; and (e) accumulation of arrears.

8 Monetization occurs (i) when the central bank directly finances budget deficit by lending funds needed to pay government bills; or (ii) when the central bank purchases government debt at the time of issuance or later in the course of open market operations.

Where; π_t Domestic inflation

Hence, from relationship (4) and (5) we can also establish a direct relationship that volatility in government borrowing have an impact on domestic inflation as:

$$\pi_t = volt(GB_g) \tag{3.6}$$

In order to estimate the functional relationship (3.6), we use ARCH/ GARCH model introduced by Engle (1982) and Bollerslev (1986), respectively. To apply this methodology, it is necessary to search for appropriate type of ARCH/ GARCH specifications to model the dynamics of GBCB volatility. We apply LM test developed by Engle [1982] to determine time varying volatility behavior as well as searching for the asymmetric effects of shocks on volatility.

Consider an information set Ω about GBCB. So, jointly estimated standard ARCH/ GARCH model is given as:

$$GB_t = \mu + \varepsilon_t \tag{3.7}$$

Where; $\varepsilon_t = \sigma_t z_t$ and $z_t \sim iid\,(0,1)$

$$\sigma_t^2 = \omega + \psi\varepsilon_{t-1}^2 + \phi\sigma_{t-1}^2$$

Using model specifications (3.6) and (3.7), we have a final version of our complete econometric model.

$$\left.\begin{aligned} \pi_t &= \alpha + \beta\, vol(GB_t) + \xi_t \\ GB_t &= \mu + \varepsilon_t \\ \sigma_t^2 &= \omega + \psi\varepsilon_{t-1}^2 + \phi\sigma_{t-1}^2 \end{aligned}\right\} \tag{3.8}$$

Where; $\varepsilon_t = \sigma_t z_t$ and $\xi_t, z_t \sim iid\,(0,1)$

3.2 Data Description

This paper uses Auto Regressive Distributed Lag (ARDL) test with bound testing technique to investigate the long run relationship between volatility in GBCB[9] and domestic inflation using Pakistan's time series data taken from the *Pakistan Economic Survey* and *Annual Reports* (various issues) and SBP monthly statistical bulletins (various issues) . This data series is on monthly basis from 1992 to 2007. In line with our hypothesis, we also provide some stylized facts in Appendix B. (Figure 1 to Figure 3) shows a positive correlation between government borrowing from central bank and domestic inflation. Furthermore, the process of monetization

[9] Generalized Auto Regressive Conditional Hetroskedasticity (GARCH) model is used to estimate volatility in GBCB.

is also be observed from growth in monetary aggregates which also leads domestic inflation in Pakistan. The whole graphical representation clearly provide us a sketch that government finance its budget deficit with borrowing from central bank which lead pressure on monetary aggregates and hence rises domestic inflation in Pakistan. This also shows that recent higher government borrowing from central bank leads higher domestic inflation in Pakistan, since FY07.

4. EMPIRICAL RESULTS AND DISCUSSION

In line with our study hypothesis, we estimate model (3.8) using monthly data from July 1992 to June 2007. Estimation results of model (3.8) are presented in Table 1. We use log difference form of consumer price index as a proxy of domestic inflation for Pakistan. The results in Table 1 provide us important information that the impact of volatility in government borrowing from central bank on domestic inflation is economically and statistically significant. The estimated coefficient of government borrowing shows that one standard deviation change in (volatility) government borrowing from central bank leads 8.5% change (increase) in domestic inflation Pakistan.

Now in order to investigate long run dynamics (cointegration) between domestic inflation and volatility in government borrowing, we use ARDL model as introduce by Pesaran et al (1999). Detail methodological description is also available in Appendix C. In line with this methodology we are going to introduce cointegration functional form as:

$$\begin{aligned}\Delta\pi_t = \alpha_0 + \sum_{i=1}^{k}\alpha_i\pi_{t-i} + \sum_{i=0}^{k}\beta_i volt(GB)_{t-i} \\ + \sum_{i=1}^{k}\gamma_i\Delta\pi_{t-i} + \sum_{i=0}^{k}\delta_i\Delta volt(GB)_{t-i}\end{aligned} \qquad (3.9)$$

Two further aspects of the regression equation (3.9) need specifying in practice. First we specify the lag order 'k' in the regression. We started testing with a maximum lag of 12 and used information criteria and sequential *F tests* along with tests for residual autocorrelation to guide our lag choice. Since this is monthly data and we wish to preserve as many degrees of freedom as possible, this seems a reasonable maximum lag order. The second decision regards the inclusion of deterministic constant and trend terms. We report here tests based on a model with an unrestricted constant, since we found no evidence of a significant deterministic trend in the relationship. We based our decision on lag order on the observation of information criteria, F test of the reduction (from 12 lags to 1 lag) and the autocorrelation test. Tests of the null hypothesis of no long run relationship can thus be carried out using an F test of the null that

$\alpha_i = \beta_i = 0$.

Results in Table 2 suggest there is a strong long run relationship between domestic inflation and volatility in government borrowing from central bank. The value of F-statistic shows a significance of the rejection of null hypothesis of no cointegration as suggested in Pesaran, Shin and Smith (1999)[10].

Finally, since the above result appears to confirm the existence of a long run relationship, we use the estimated regression to form an error correction term and estimate a simple dynamic ECM for domestic inflation. The estimated regression is reproduced below with a standard range of diagnostics. The results of ECM model are presented in Table 3.

The error correction term is correctly signed and significant. The value of the coefficient on the ECM indicates that a change in volatility in government borrowing from central bank brings about a 77% change in domestic inflation in Pakistan in the span of twelve months. The ECM also passes a range of diagnostic tests.

Table 1- ARCH/ GARCH Model Estimation Results
Impact of volatility in GBCB on Domestic inflation

Parameters	μ	ω	ψ	•
Estimated Coefficients	-1.031	96.984	2.651	-0.013
S.E	0.610	9.321	0.183	0.008
t-ratios	-1.982	10.505	14.508	-1.998

$$\pi_t = 0.518 + 0.085 vol(GB_t)$$

(7.232) (1.994)

*Note: Values in prentices shows t-statistics

Table 2- F test for the existence of a long run relationship

Test Statistic	Value	df	Probability
F-statistic	40.150	(4, 137)	0.0000
Chi-square	80.301	4	0.0000

*Note: 95% critical bounds for the F test: 4.94 - 5.73[11]

Table 3- Error correction model Results

Variable	Coefficient	S.E	t-value
Constant	-0.005	0.051	-0.113
$\Delta volt(GB)_t$	0.018	0.034	0.532
$\Delta \Pi_{t-1}$	0.161	0.094	1.686
$\Delta volt(GB)_{t-1}$	0.023	0.034	0.664
ECM_{t-1}	-0.767	0.085	-9.849

$R^2 = 0.4208$, D.W = 2.02

[10]This method is, once again, applicable irrespective of whether the regressors are I(0) or I(1). The long run estimates and their standard errors were obtained using EViews 5.0.
[11] Critical bounds are from Table C1.iii of Pesaran *et al*., (1999).

5. CONCLUSION

This study supports the fiscal dominance hypothesis in determining inflation in the case of Pakistan economy. In connection with this hypothesis, the results depict important information that the impact of volatility in government borrowing from central bank on domestic inflation is economically and statistically significant. Further, the empirical evidence suggests that there is a strong long run relationship between domestic inflation and volatility in government borrowing from central bank. The estimated coefficient of government borrowing shows that one standard deviation change in (volatility) government borrowing from central bank leads 8.5% change (increase) in domestic inflation. In particular, it suggests incorporating the trend effects of government borrowing from monetary authorities in inflation modeling. Finally these findings may help in understanding inflation experience in different developing economies like Pakistan.

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Appendix- A

Table A1- Selected Pakistan Empirical Studies of Inflation and Monetary Policy

Section (i): Pakistan Studies which used Government Borrowing as a determinant of Inflation

Authors	Empirical Approach	Dependent Variable(s)	Regressors	Sample Period	Findings
Agha, Asif Idrees and Khan, Muhammad Saleem (2006)	Johansen cointegration analysis, VECM model	consumer price index	consolidated fiscal deficit, total bank borrowing	1973 to 2003	The empirical results suggest that in the long-run inflation is not only related to fiscal imbalances but also to the sources of financing fiscal deficit.
Khan, A. Aleem, Bukhari, S. K. Hyder and Ahmed, Q. Masood (2006)	Ordinary least square (OLS) method and verifying results through Breusch-Godfrey Serial Correlation LM and Augmented Dickey-Fuller tests	consumer price index	Governmnet sector borrowing (plus NFA and other items) as ratio to real GNP, real demand relative to real supply, non-government sector borrowing (pluc borrowing of autonomous bodies) as ratio of real GNP, price index of imports, exchange rate, government taxes as a ratio of manufacturing sector value added, lagged CPI and support price of wheat.	1972 to 2005	The most important determinants of inflation are adaptive expectations, private sector credit and rising import prices whereas fiscal policy's contribution to inflation was minimal. Specifically, if government sector borrowing as a ratio to GNP chnaged by 10 percent, then the resulting change in CPI will be around 1 percent.
Chaudhary, M. Aslam and Anjum, S. Waseem (1996)	Sustainable deficit econometric model for Pakistan is estimated.	Growth rate of GNP, inflation rate, interest rate of foreign debt etc.	A number of assumptions regarding growth rate of GNP, inflation rate and interest rate on foreign debt	Three time periods- 1980s, 1985-95 and 1993-98	Throughout the period under analysis, fiscal defict was not sustainable.
Chaudhary, M. Aslam and Ahmed, Naved (1995)	Simultaneous model and OLS i.e regressions of money supply equation, real cash balance equation, price equation, output equation and export supply equation.	Consumer Price index, money supply, demand for real cash balances, exports	(1) Money supply equation- international reserves, domestic financing of budget deficit including banking and non-banking system, commercial banks credit to private sector (2) Demand for real cash balances- income, proxy for cost of holding real balances (3) Price equation-income, money supply, import price (4) Output equation- governmnet expenditures, commercial credit (5) Export supply equation- income, export price	1973-92, 1973-82 and 1982-92	Domestic financing of budget defict, particularly from the banking system is inflationary in long run. Money supply is not exogenous, rather it depends on the position of international reserves and fiscal deficit and it has emerged as an endogenous variable.

Section (ii): Pakistan Studies which did not consider Government Borrowing as a determinant of Inflation

Authors	Empirical Approach	Dependent Variable(s)	Regressors	Sample Period	Findings
Hyder, Zulfiqar and Sardar Shah (2004)	VAR		CPI inflation, WPI inflation, PR/USD, M2, LSM index, oil prices	1988:1 to 2003:9	Little exchange rate pass through to domestic CPI inflation.
Choudhri, Ehsan U. and Mohsin S. Khan (2002)	Single equation and VAR in first differences	CPI and WPI	U.S. dollar exchange rate, foreign price index	1982–2001	There is no exchange rate pass-through to domestic prices.
Ahmad, Eatzaz and Muhammad Munirs (2000)	OLS, cointegration analysis	M1, M2	Index of industrial production, interbank call money rate, CPI inflation	1972:I to 1996:I	Find that inflation is a better measure of opportunity cost than interest rate, money demand adjusts sluggish, and there was a structural break in the early 1990s.
Ahmad, Eatzaz and Saima Ahmed Ali (1999a)	Single equation, including Engle/Granger cointegration test, 2-equation model with 2SLS	CPI and exchange rate	Exchange rate, import prices, world prices, money supply, GDP, forex reserves	1982:II to 1996:IV	CPI reacts to changes in import prices (due to change in world prices or exchange rate) and money supply. Exchange rate responds to domestic and world prices.
Ahmad, Eatzaz and Saima Ahmed Ali (1999b)	2-equation model with 2SLS	CPI and exchange rate	Exchange rate, import prices, world prices, money supply, GDP, forex reserves	1982:II to 1996:IV	CPI reacts to changes in import prices (due to change in world prices or exchange rate) and money supply. Exchange rate responds to domestic and world prices.
Price, Simon and Anjum Nasim (1999)	Johansen (VECM), and SUR	CPI and exchange rate	Broad money, world prices, GDP, deposit rate	1974 to 1994	PPP and money demand relation are identified that are connected through cointegrating relationships.
Hsing, Yu (1998)	Single equation	Real M2	Real GDP, deposit rate	n.a.	Real GDP elasticity is close to unity whereas interest elasticity is low.
Shamsuddin, Abul F.M. and Richard A. Holmes (1997)	Johansen procedure, VARMA, ARMA	CPI	Broad money, real output	1972:II to 1993:IV	Rejects a cointegrating relationship between inflation, broad money and GDP and concludes that a univariate ARMA yields the best forecasts.
Tariq, Syed Muhammed and Kent Matthews (1997)	Johansen, single equation ECM	M2, M1, divisia	Real GDP, opportunity costs	1974:IV to 1992:IV	Identifies a cointegration vector that is interpreted as a money demand function. Short-run parameters of money demand equation are stable.
Chaudhary, M. Aslam and Naved Ahmad (1996)	OLS	CPI inflation	Broad money, GDP growth, share of service sector, public debt, import prices	1972 to 1992	Inflation results from money growth and structural factors such as growth, share of service sector, public debt, and import prices.

Section (ii): continued…

Arize, A.C. (1994)	OLS of ECM	M1, M2	GDP, inflation rate, call money rate, government bond yield, expected rate of depreciation (foreign interest differential)	1973:I to 1990:I	Finds that money demand is a function of GDP, inflation, interest rate and exchange rate expectations. Also, dummies for the oil shocks, and structural free banking and floating the rupee matter. account of introduction of partial interest- breaks in 1981 on
Hossain, Akhtar (1994)	Engle/Granger 2-stage, Johansen	M1, M2	GDP, yield on government bonds, market call rate, CPI inflation	1951–91	Meaningful cointegration relationship (money demand function) for the post- 1972 period.
Khan, Ashfaque H. (1994)	Engle/Granger 2-stage	M1, M2	Real income, real interest rate (short-term and medium-term), nominal interest rate (short-term and medium-term), inflation	1971:III to 1993:III	Finds cointegrating relationship between M2 (or M1) and real income, real interest rate and inflation.
Dhakal, Dharmendra and Magda Kandil (1993)	OLS of distributed lag specification (AIC)	CPI inflation	M1, industrial production, interest rate, foreign interest rate, import prices	1970:I to 1987:IV	Import prices, industrial production, and U.K. interest rate explain inflation. M1 is insignificant.
Khan, Imran Naveed (1992)	OLS	M1, M2	GNP, call rate, CPI	n.a.	Money demand in Pakistan is a function of income and inflation, but not of interest rate.
Ahmad, Eatzaz and Harim Ram (1991)	OLS	WPI, CPI, GNP deflator, and absorption deflator inflation	Real GNP growth, growth rate of unit value of imports, growth rate of M1/M2, lagged inflation	1960 to 1988	Inflation is determined by real GNP growth, unit value of import growth, nominal money growth, and lagged inflation.
Ahmad, Mushtaq and Ashfaque H. Khan (1990)	ML (Cooley/Prescott 1976 varying parameter technique)	M1, M2	Income, inter-bank call rate, time deposit rate	1959 to 1987	Demand for real money was unstable at th time of delinking the Pakistani rupee from the U.S. dollar and introduction of interest- free deposit accounts.
Burney, Nadeem A. and Mohammad Akmal (1990)	NLLS	Real money stock	Income, CPI inflation, CPI inflation volatility	n.a.	Real money adjusts instantaneously to the desired level of money demand which is driven by income, and expected inflation.
Khan, Ashfaque H. and Bilquees Raza (1989)	OLS	M1, M2	Real GNP, interest rate, expected inflation	1972:II to 1987:II	Larger than unity income elasticities of money demand and the expected influence of expected inflation and interest rates.

Section (ii): continued…

Huq, M.D. Shamsul and Majumdar, Badiul A. (1986)	OLS	M1, M2	GNP, call money rate, government bond rate, CPI inflation	1955 to 1977	Structural breaks in the demand for money in 1965 and 1971.
Nisar, Shaheena and Naheed Aslam (1983)	OLS	M1, M2	GNP, term structure, GNP deflator	1959 to 1978	Term structure matters for money demand besides income.
Khan, Ashfaque (1982a)	OLS	M1, M2	GNP, interest rate on time deposits	1959/60 to 1979/80	Income elasticity of 1.7 and interest elasticity of 0.5.
Khan, Ashfaque H. (1982b)	OLS	M1, M2	GNP, expected inflation, inflation variability	n.a.	Including the variability of inflation improves the estimate of the money demand function.
Naqvi, Syed Nawab, A.R. Kemal, and Rashid Aziz (1982)	53-equation macro model			1959/60 to 1978/79	Inflation is not imported. Money demand is interest-sensitive. The GNP elasticity of money demand is fairly large.

Appendix- B

Fig 1: Government Borrowing from SBP and Inflation

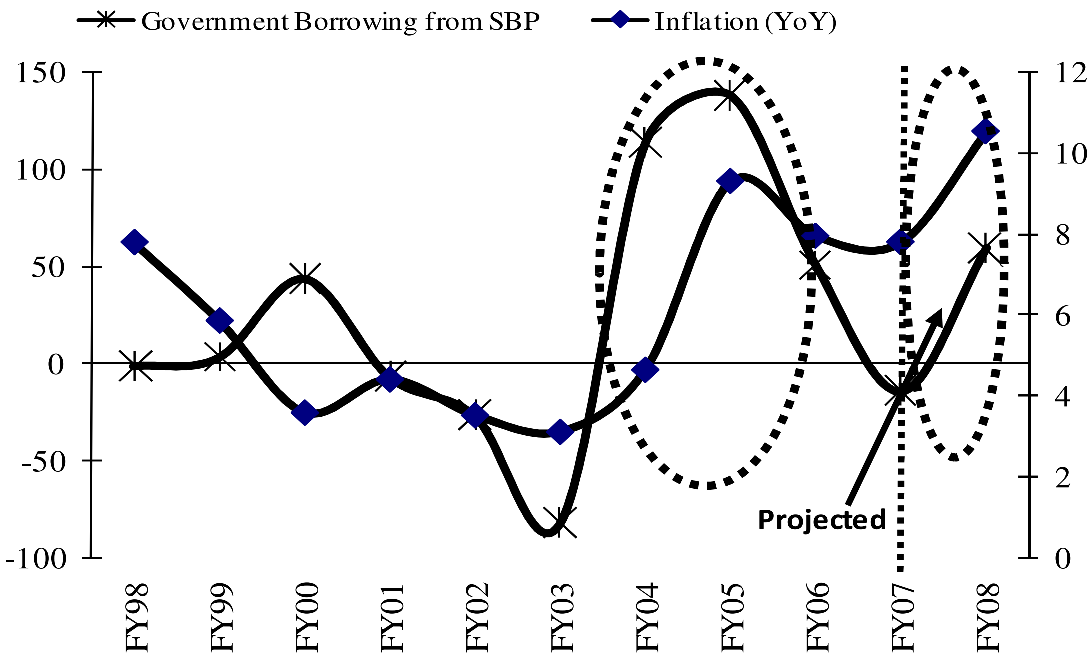


Fig 2: Budget Deficit Growth and Inflation

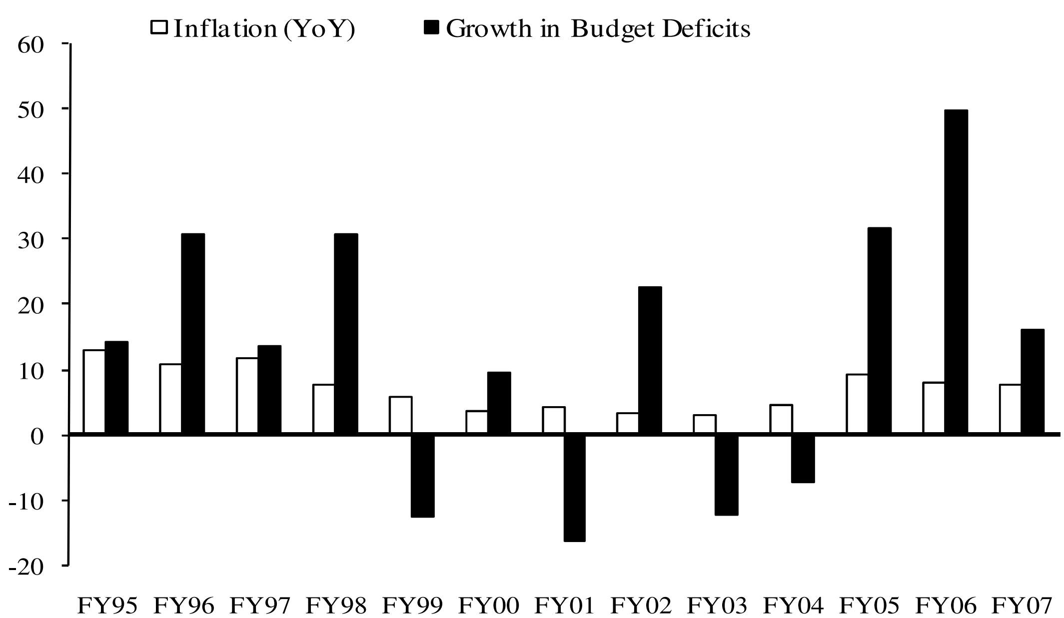
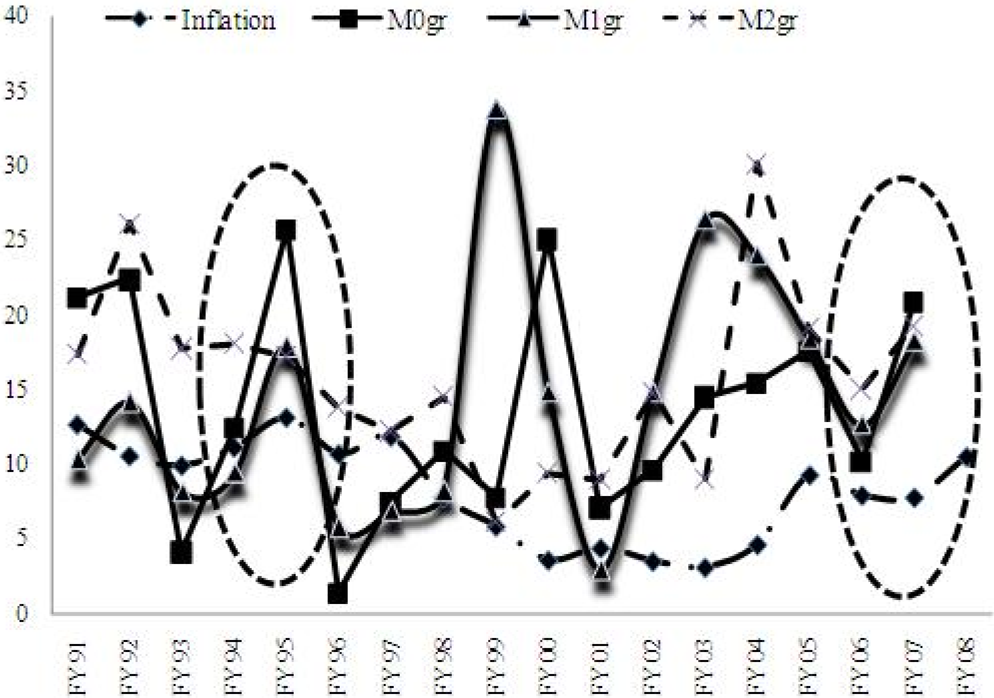


Fig 3: Inflation and Monetary Aggergates



Note: M0gr := Growth in Reserve Money; M1gr := Growth in M1 and M2gr := Growth in M2

Appendix- C

Auto Regressive Distributed Lag Model (ARDL MODEL)

Following Pesaran, Shin and Smith (1999) cointegration methodology using Auto Regressive Distributed Lag model this paper try to find long run relationship between inflation and volatility in government borrowing from central bank in Pakistan.

This tests procedure is applicable irrespective of whether the regressors are I(0), I(1) or mutually cointegrated. The test is based upon estimation of the underlying VAR model, re-parameterised as an ECM(error correction model)[12].

The VAR(p) model

$$\mathbf{z}_t = \mathbf{b} + \mathbf{c}t + \sum_{i=1}^{p} \mathbf{\Phi}_i \mathbf{z}_{t-i} + \boldsymbol{\varepsilon}_t \qquad \text{(A2.1)}$$

where **z** represents a vector of variables. Under the assumption that the individual elements of **z** are at the most I(1), or do not have explosive roots, equation (A2.1) can be written as a simple Vector ECM.

$$\Delta \mathbf{z}_t = \mathbf{b} + \mathbf{c}t + \Pi \mathbf{z}_{t-1} + \sum_{i=1}^{p-1} \mathbf{\Gamma}_i \Delta \mathbf{z}_{t-i} + \boldsymbol{\varepsilon}_t \qquad \text{(A2.2)}$$

where $\mathbf{\Pi} = -(\mathbf{I}_{k+1} - \sum_{i=1}^{p} \mathbf{\Phi}_i)$ and $\mathbf{\Gamma}_i = -\sum_{j=i+1}^{p} \mathbf{\Phi}_j$, i = 1,....p - 1 are the (k+1)×(k+1) matrices of the long run multipliers and the short run dynamic coefficients. By making the assumption that there is only one long run relationship amongst the variables, Pesaran *et al* focus on the first equation in (A2.2) and partition $\mathbf{z}_t$ into a dependant variable y_t and a set of forcing variables **x**. This is one of the key assumptions of their paper. Under such conditions the matrices **b, c** Γ and, most importantly, Π**,** the long run multiplier matrix can also be partitioned conformably with the partitioning of z.

$$\mathbf{\Pi} = \begin{bmatrix} \pi_{11} & \boldsymbol{\pi}_{12} \\ \boldsymbol{\pi}_{21} & \mathbf{\Pi}_{22} \end{bmatrix} \qquad \mathbf{b} = \begin{bmatrix} b_1 \\ \mathbf{b_2} \end{bmatrix} \qquad \mathbf{c} = \begin{bmatrix} c_1 \\ \mathbf{c_2} \end{bmatrix} \quad \mathbf{\Gamma_i} = \begin{bmatrix} \gamma_{11,i} & \boldsymbol{\gamma}_{\mathbf{12,i}} \\ \boldsymbol{\gamma}_{\mathbf{21,i}} & \boldsymbol{\gamma}_{\mathbf{22,i}} \end{bmatrix}$$

The key assumption, that **x** is long run forcing for y, then implies that the vector $\gamma_{21}=0$, that is that there is no feedback from the level of y on Δ**x**. As a result the conditional model for Δy and Δ**x** can be written as

$$\Delta y_t = b_1 + c_1 t + \pi_{11} y_{t-1} + \pi_{12} \mathbf{x}_{t-1} + \sum_{i=1}^{p-1} \gamma_{11,i} \Delta y_{t-i} + \sum_{i=0}^{p-1} \gamma_{12,i} \Delta \mathbf{x}_{t-i} + \varepsilon_{1t} \qquad \text{(A2.3)}$$

$$\Delta \mathbf{x}_t = \mathbf{b_2} + \mathbf{c_2} t + \mathbf{\Pi}_{22} \mathbf{x}_{t-1} + \sum_{i=1}^{p-1} \gamma_{21,i} \Delta y_{t-i} + \sum_{i=1}^{p-1} \mathbf{\Gamma_{22,i}} \Delta \mathbf{x}_{t-i} + \boldsymbol{\varepsilon}_{2t} \qquad \text{(A2.4)}$$

Under standard assumptions about the error terms in (A2.3) and (A2.4)[13] Pesaran *et al* re-write (A2.3) as

[12] Most of the following is based on Pesaran, Shin and Smith (1999) and follows their original notation.

[13] Essentially that they are independently normally distributed with a positive definite variance covariance matrix.

$$\Delta y_t = a_0 + a_1 t + \phi y_{t-1} + \delta \mathbf{x}_{t-1} + \sum_{i=1}^{p-1} \upsilon_i \Delta y_{t-i} + \sum_{i=0}^{p-1} \varphi_i \mathbf{\Delta x}_{t-i} + \varpi_t \qquad \text{(A2.5)}$$

which they term an unrestricted error correction model. Note that in (A2.5) a long run relationship will exist amongst the levels variables if the two parameters ϕ and δ are both non zero in which case, for the long run solution of (A2.5) we obtain

$$y_t = -\frac{a_0}{\phi} - \frac{a_1}{\phi} - \frac{\delta}{\phi} x_t \qquad \text{(A2.6)}$$

Pesaran *et al* choose to test the hypothesis of no long run relationship between y and x by testing the joint hypothesis that $\phi = \delta = 0$ in the context of equation (A2.5). The test they develop is a bounds type test, with a lower bound calculated on the basis that the variables in **x** are I(0) and an upper bound on the basis that they are I(1). Pesaran et al (1999) provide critical values for this bounds test from an extensive set of stochastic simulations under differing assumptions regarding the appropriate inclusion of deterministic variables in the ECM. If the calculated test statistic (which is a standard F test for testing the null that the coefficients on the lagged levels terms are jointly equal to zero) lies above the upper bound, the result is conclusive and implies that a long run relationship does exist between the variables. If the test statistic lies within the bounds, no conclusion can be drawn without knowledge of the time series properties of the variables. In this case, standard methods of testing would have to be applied. If the test statistic lies below the lower bound, no long run relationship exists.