Interest Rate Pass-through in Pakistan: Evidence from Transfer Function Approach

ABDUL QAYYUM, SAJAWAL KHAN, and IDREES KHAWAJA

I. INTRODUCTION

The transmission of monetary policy through the interest rate mechanism has been thoroughly discussed in economic literature for quite some time. The traditional view is that, the change in real interest rate influences the cost of capital. The change in cost of capital affects the magnitude of investment and consumption and therefore the level of, real income and prices [Mishkin (1995)].[1] Operationally the State bank of Pakistan, influences the yield on treasury bills (T-bills). This is done on the assumption that the yield on treasury bills influences other interest rates like the Money Market rate (Call money rate), banks' deposit and banks' Lending rates. The change in these rates influences the cost of capital and thus level of investment and consumption in the economy. Given this, the central bank can influence the yield on T-bills to influence the level of real income and the level of prices. The foregoing explanation of the monetary transmission mechanism makes it clear that if the changes in yield on the T-Bill rate are not passed on to the Call money rate and the bank deposit and the Lending rate then it becomes difficult for the central bank to use the channels that involve interest rate, for influencing the level of output and prices. Hence it is important to test whether the changes in the treasury bill rate are passed on to money market rate, bank deposit rate and the bank lending rate and if yes at what speed and to what extent. Therefore this study examines the pass-through of the changes in Treasury bill rate to Call Money rate, Banks' deposit rate and Banks' Lending rate.

The literature on interest rate pass-through addresses questions like (1) what is the degree of pass-through from the money market or the policy rate to the deposit

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[1]For discussion and empirical evidence regarding the impact monetary policy on the level of real economic activity see Friedman and Schwartz (1963), Romer and Romer (1989), and Bernanke and Blinder (1992).

and lending rates, (2) If the pass-through is less than complete, in the period of impact, then what are the causes of stickiness of deposit/lending rates and (3) is the pass-through symmetric for upward and downward revisions in money market/policy rate. The answers are: the pass-through from the money market/T-Bill rate to deposit/lending rate is less than complete in the period of impact, that is, the deposit and lending rate exhibit rigidity [Cottarelli and Kourelis (1994); Hanan and Berger (1991); Mojon (2000) and Bondt (2002)]. The causes of stickiness include; menu costs [Hanan and Berger (1991)] and structural features of the financial system [Cottarelli and Kourelis (1994); Hanan and Berger (1991)]. The pass-through is asymmetric for upward and downward revisions in the policy rate [Hanan and Berger (1991)].

Cottarelli and Kourelis [CK hereafter, (1994)] examines the pass-through of changes in money market rate to lending, for 31 industrial and developing countries. Their main conclusion is that the pass-through is almost complete in the long run. However in short run, that is during the month of impact the pass-through is only one third of that in the long run. In other words in order to influence lending rate by 100 basis points in the month of money market shock, the money market rate should be increased by 300 basis points. CK also find that the degree of stickiness is quite different across countries.

CK also relates the degree of lending rate stickiness to the financial structure. They identify three structural features that speed-up the pass-through. These features are: (1) absence of controls on capital mobility, (2) containment of random movements in money market rates, and (3) private ownership the banking system. Besides they find that (1) Presence of market for negotiable instruments (e.g. Commercial paper) and (2) absence of constraints on bank competition does not influence the degree of pass-through). These results were obtained after controlling for structural inflation that tends to speed up the adjustment process. Based on their findings regarding the relationship between financial structure and the degree of pass-through, CK conclude that the transmission mechanism of monetary policy can be enhanced by encouraging markets for short-term marketable instruments, by removing barriers to competition and by encouraging privatisation of banks.

Hanan and Berger [HB hereafter, (1991)] examine the setting of deposit rates by banks. The central message of HB is that menu costs are involved in changing deposits rates. Therefore, given the change in security rates, the deposit rates will be changed only if the revenue from the change is perceived to be greater than the costs involved in altering the deposit rates.

Specifically, HB tests for pass-through from policy rate (3-month T-bill rate) to deposit rate based on deposit market concentration and the size of customer's base. Besides they test for asymmetry of pass-through from policy rate to deposit rate for upward and downward revision in the policy rate.

HB's main findings are; Pass-through varies inversely with degree of market concentration and directly with the depositors' base. Secondly the pass-through to deposit rate is asymmetric for upward and downward revision in policy rate, with the pass-through for upward revision being lower. Concentration is measured by Herfindahl index and the markets are defined as metropolitan areas.

HB offers quite convincing explanation for the asymmetric pass-through from the Treasury bill rate to deposit rates. The crux of HB's argument is that existence of lags, between price changes and customers response to them is quite natural. If the deposit rates are increased today and the full desired response, in the shape of more deposits, of depositors is realised after a month, then for some period the banks pay additional interest to the depositors without mobilising more deposits. On the other hand suppose that deposit rates are decreased today, this makes return on deposits less than the required rate of return of some depositors. Such depositors are likely to withdraw their deposits. Suppose that the expected withdrawal is completed in a month after the change in interest rate, then for a while, some interest payments are saved. To sum up, HB argues that, increasing the interest rate on deposits is harmful for the banks in the immediate short run while decreasing the rate is beneficial. Given this deposit rate exhibit, upward interest rate rigidity.

Mojon's (2000) analyses differences in financial structure across euro area countries and their implications for the interest rate channel of the monetary transmission mechanism. Main findings of the study are: The volatility of money market rates lowers the pass-through from money market rates to credit rates while inflation speeds up the pass-through to credit rates. Besides competition among banks also seem to quicken the pass-through.

Mojon (2000) lists the various justifications for the common empirical finding of the rigidity of retail bank rates, discussed in the literature on interest rate pass-through. First, increase in bank credit rates makes the borrower pay more. The increase in lending rates puts greater burden on the borrowers purse, reduces his repayment ability and thus adversely affects his credit worthiness.

Second even small menu costs incurred while resetting retail rates could lead to price rigidities. Third, by not revising the rates despite change in money market rate, banks provide implicit interest rate insurance. This way, the banks invest in long run relationship with the customers. Fourth, retail bank rates being of longer maturity than money market rates lead to the problem of maturity mismatch. The higher pass-through for short-term rates and lower pass-through for long-term loans, like mortgages, tend to support this view. Finally, perhaps the volatility of the money market rates leads to uncertainty about the future path of these rates. If the banks were to adjust to the money market rates, every time these rates change, this would involve huge menu costs. This makes the banker delay the response to change in lending rate till he can work out the trend course of the money market rates.

Bondt (2002) uses an error correction model to estimate the pass-through of changes in money market rate to deposits and lending rate for Euro area countries. Estimation results suggest that within one month, the pass-through is around 50 percent. The proportion of pass-through is higher in long run, especially for lending rate it is close to 100 percent.

An explanation, referred above, forwarded for the incomplete pass-through is that of maturity mismatches problem. The problem refers to the fact that money market rates are short term in nature while the deposit and lending rates could be long term. Bondt (2002) avoids the maturity mismatches problem by examining bank and money market interest rates that have comparable maturity.

In Pakistan with the introduction of the market based monetary management in 1991 the treasury bills have been increasingly used as an instrument of monetary policy. Greater the degree of pass-through and smaller the duration of pass-through, the more and quicker will be the impact changes in monetary policy on real output and price level. Given that the policy rate, that is the Treasury bill rate, in Pakistan has seen major swings, it is important to measure the degree and duration of pass-through to deposit and lending rates.

This paper aims at determining the duration of pass-through, of the Treasury bill rate (1) to call money market rate (2) to banks' deposit and (3) banks' Lending rate. The study is exclusively focused on Pakistan.

Remainder of the Paper proceeds as follows: Section II describes the empirical model and the data used. Section III explains the econometric methodology employed. Section IV reports and analyses the estimation results and Section V concludes.

II. EMPIRICAL MODEL AND THE DATA

To analyse the dynamic reduced-form relation between the Deposit rate and Treasury bill rate, following Vega and Rebucci (2003), We specify the following simple auto-regressive distributed lag (ADL) model.

$$y_i = \alpha_o + \alpha_1 x_t + \sum \alpha_2 y_{t-i} + \sum \alpha_3 x_{t-i} \qquad \ldots \qquad \ldots \qquad \ldots \qquad (1)$$

Where:

y_i represents endogenous variables

x stands for exogenous variable

We use Six-month Treasury bill rate as the exogenous variable. Four different variables are used one by one as endogenous variables. These are Call money rate (CMR), Saving Deposit rate (SDR), Six-Month Deposit Rate (SMDR) and Lending Rate (LR).

II.1. Data

Measurement of pass-through requires high frequency data. However, of the variables referred above monthly data is available only for TBR and CMR. Therefore to measure the pass-through from TBR to CMR we use monthly data. Deposit and Lending rates are available, only, at six-months interval. Therefore the pass-through from TBR to Savings Deposit rate, Six-months Deposit rate and Lending rate is measured using six monthly data. The deposit and lending rates used are weighted average as only these are available. The data span is 1991:03-2004:12. Motivation for the data span is that under the market based management of monetary policy Treasury Bills were for the first time auctioned in March 1991. Thus the data for Treasury Bills prior to 1991 is obviously not available. The data source is Statistical Bulletin published by State Bank of Pakistan. It's worth mentioning here that the weighted average takes into account volume of outstanding Deposit/Loans and the interest rate at which these Deposit/Loans were contracted. On the other hand the change in Treasury bill rate, if passed on to Deposit/Lending rate, would change the rate for deposit/loans contracted after the change in rate. In sum, as the weighted average rate includes deposit/loans contracted at previous rates besides the ones contracted at the new rate, therefore pass-through worked out using weighted average rate is likely to be lower than the one worked out using only fresh deposit/loans contracted at the new rate. As the rate applicable to fresh deposit mobilised and loans extended is not available before January 2004, therefore we use the weighted average rate. This limitation has to be kept in view while interpreting the results.

III. METHODOLOGY[2]

To estimate our model we use transfer function approach developed by Box, *et al.* (1994), which is explained below. Consider the following generalisation of the intervention model:

$$y_t = a_o + A(L)y_{t-1} + C(L)z_t + B(L)\varepsilon_t \qquad \ldots \qquad \ldots \qquad \ldots \qquad \ldots \qquad (2)$$

Where $A(L)$, $B(L)$ and $C(L)$ are polynomials in the lag operator L

In a typical transfer function analysis, we have to collect data on the endogenous variable $\{y_t\}$ and the exogenous variable $\{z_t\}$. The goal is to estimate the parameter a_o and the parameters of the polynomials $A(L)$, $B(L)$ and $C(L)$. The polynomial $C(L)$ is called the transfer function in that it shows how a movement in the exogenous variable z_t affects the time path of the endogenous variable $\{y_t\}$. The coefficients of $C(L)$ denoted by c_i are called the transfer function weights. The impulse response function showing the effects of a z_t on the $\{y_t\}$ sequence is given by $\dfrac{C(L)}{[1-A(L)]}$.

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[2]For this section we make use of Enders (1995) and Box, *et al.* (1994).

It is important to note that transfer function analysis assumes that $\{z_t\}$ is an exogenous process that evolves independently of the $\{y_t\}$ sequence. Innovations in $\{y_t\}$ are assumed to have no affect on the $\{z_t\}$ sequence, so that $E_{Z_t}\varepsilon_{t-s} = 0$ for all values of s and t. Since z_t can be observed and is uncorrelated with the current innovation in $\{y_t\}$ the current and lagged values of z_t are explanatory variables for y_t. Let $C(L)$ be:

$$C(L) = c_o + c_1 L + c_2 L^2 +$$

If $c_o = 0$, the contemporaneous value z_t (in Eq. 2) does not contemporaneously affect y_t. As such, $\{z_t\}$ is called the leading indicator in that the observations $z_t, z_{t-1}, z_{t-2} \ldots$ can be used in predicting future values of the $\{y_t\}$ sequence.

Suppose that a white-noise process that is uncorrelated with $\hat{\varepsilon}_t$, at all leads and lags, generates $\{z_t\}$. Also suppose that the realisation of z_t affects $\{y_t\}$ sequence with a lag of unknown duration. Since $\{z_t\}$ and $\{\varepsilon_t\}$ are assumed to be independent white-noise processes, it is possible to separately model the effects of each type of shock. Since we can observe the various z_t values, the first step is to calculate the cross-correlation between y_t and z_{t-i}. The cross-correlation between y_t and z_{t-i} is defined to be:

$$\rho_{yz}(i) = \mathrm{cov}(y, z_{t-i})/\sigma_y \sigma_z \quad \ldots \qquad \ldots \qquad \ldots \qquad \ldots \qquad \ldots \qquad (3)$$

Where σ_y and σ_z are the standard deviations of y_t and z_t respectively. The standard deviation of each sequence is assumed to be time independent. Plotting each value of $\rho_{yz}(i)$ yields the cross-autocorrelation function (CACF) or cross-correlogram. In practice we must use the cross correlation calculated using sample data since we do not know the true covariance and the standard deviations. The key point is that sample cross-correlation provides the same type of information as the Auto Correlation Function(ACF) in an ARMA model.

It is, however, rare to work with a $\{z_t\}$ series that is a white-noise process. We, therefore, need to further generalise our discussion of transfer functions to consider the case in which the $\{z_t\}$ sequence is a stationary ARMA process. Let the model for the $\{z_t\}$ sequence be an ARMA process such that:

$$D(L)_{Z_t} = E(L)\varepsilon_{Z_t} \quad \ldots \qquad \ldots \qquad \ldots \qquad \ldots \qquad \ldots \qquad \ldots \qquad (4)$$

Where $D(L)$ and $E(L)$ are the polynomials in the lag operator L and ε_{z_t} is white-noise process.

Now estimate the ARMA process generating $\{z_t\}$ sequence. The residual from such a model, denoted by $\{\hat{\varepsilon}_{z_t}\}$ should be white noise. The idea is to estimate the innovations in the $\{z_t\}$ sequence even though the sequence itself is not a white noise process. At this point one may think about forming the cross-correlation between the $\{y_t\}$ and $\hat{\varepsilon}_{z_{t-1}}$. However this procedure would be inconsistent with the maintained hypothesis that the structure of the transfer function is given by (Equation 2).

In Equation (2) $z_t, z_{t-1}, z_{t-2} \ldots$ (and not simply the innovations) directly affect the value of y_t. Cross-correlation between y_t and the various $\hat{\varepsilon}_{z_{t-i}}$ would not reveal the pattern of the coefficients in $C(L)$. The appropriate methodology is to filter the $\{y_t\}$ sequence by multiplying (Equation 2) by the previously estimated polynomial $\dfrac{D(L)}{E(L)}$.

As such, the filtered value of y_t is $\dfrac{D(L)y_t}{E(L)}$ and is denoted by y_{ft}. Consider:

$$\frac{D(L)y_t}{E(L)} = \frac{D(L)a_\circ}{E(L)} + \frac{D(L)A(L)y_{t-1}}{E(L)} + \frac{C(L)D(L)z_t}{E(L)} + \frac{B(L)D(L)\varepsilon_t}{E(L)} \quad \ldots \quad (5)$$

Given that:

$$\frac{D(L)y_t}{E(L)} = y_{ft}, \frac{D(L)y_{t-1}}{E(L)} = y_{ft-1}, \text{ and } \frac{D(L)z_t}{E(L)} = \varepsilon_{zt}$$

$$y_{ft} = \frac{D(L)a_\circ}{E(L)} + A(L)y_{ft-1} + C(L)\varepsilon_{zt} + \frac{B(L)D(L)}{E(L)}\varepsilon_t$$

It can be seen that y_t and $C(L)z_t$ will have the same correlogram as y_{ft} and $C(L)z_t$. Thus, when we form cross-correlations between y_{ft} and ε_{zt-i}, the cross-correlations will be same as those from (Equation 2), as if $\{z_t\}$ was originally white-noise. Inspect these cross-correlations for spikes and the decay pattern. In summary the procedure for fitting a transfer function involves following steps:

Step 1:

- Fit an ARIMA model to the $\{z_t\}$ sequence in Equation (2).
- Calculate and store residuals $\{\hat{\varepsilon}_{z_t}\}$ (called the *filtered* values of the $\{z_t\}$ series) as α_t.

Step 2:

- Obtain the filtered $\{y_t\}$ sequence by applying the filter $\dfrac{D(L)}{E(L)}$ to each value

  of $\{y_t\}$; that is, use the results of step1 to obtain $\dfrac{D(L)}{E(L)} y_t = \beta_t$

Step 3:

- Obtain the cross-correlation (and cross-correlogram) between β_t and α_t .

- Obtain the sample variance of cross-correlation coefficient as $\text{var}\left[r_{\alpha\beta}(i)\right] = (T-i)^{-1}$, where T = number of usable observations and $r_{yz}(i)$ denotes the sample cross-correlation coefficient between β_t and α_t .

- To test the significance of the cross-correlations, use the ljung-box (1978) Q-statistic:

$$Q = T(T+2)\sum_{i=0}^{k}(r_{yz}^2(k)/T - k)$$

- Examine pattern of the cross-correlogram (CACF). The spikes in the cross-correlogram indicate nonsero values of c_i. The decay pattern of cross-correlogram suggest plausible candidates for coefficients of $A(L)$ in Equation (2).

- Select a model of the form $\left[1 - A(L)y_t\right] = C(L)z_t + e_t$ ... ... (6) (Best fit amongst the many suggested by the cross-correlogram), where e_t denotes the error term that is not necessarily white-noise.

- Use the $\{e_t\}$ sequence to estimate the various forms of $B(L)$ and select the "best" model for the $B(L)e_t$ ... ... (7)

Step 4:

Combine the results of (6) and (7) to estimate the full Equation (2) i.e. estimate $A(L)$, $B(L)$ and $C(L)$ simultaneously.

Step 5:

Check the properties of the model to ensure that it is well-estimated. For example quality of coefficients, parsimoniousness of the model, conformity of the error term to a white-noise process, and smallness of the forecast errors.

IV. RESULTS

The methodology developed in previous section requires that the data series be stationary. Thus any unit root that may be present need to be filtered out before

transfer function model is applied. We have used augmented Dickey-Fuller test to check the stationarity of the data series. The test fails to reject the hypothesis of unit root for all the data series. Therefore we use first difference of all the series.

IV.1. Pass-through from Treasury Bill Rate (TBR) to Call Money Rate (CMR)

Using the methodology developed in Section III, the first step in fitting a Transfer Function is to fit an ARIMA model to the {ΔTBR} series. We obtain the Autocorrelation Function (ACF), Partial Autocorrelation Function (PACF) and the respective correlograms for ΔTBR. These are respectively presented below in Table 1(a and b) and Figure 1(a and b).

Table (a)

Auto Correlation Function (ACF) of ΔTBR

	$\rho(1)$	$\rho(2)$	$\rho(3)$	$\rho(4)$	$\rho(5)$	$\rho(6)$	$\rho(7)$	$\rho(8)$	$\rho(9)$
Q-Stat.	0.178	0.118	0.176	–0.051	0.013	–0.104	–0.029	–0.032	–0.051
	$\rho(10)$	$\rho(11)$	$\rho(12)$	$\rho(13)$	$\rho(14)$	$\rho(15)$	$\rho(16)$	$\rho(17)$	$\rho(18)$
Q-Stat.	0.048	–0.089	0.09	–0.027	–0.024	–0.052	0.068	0.049	0.053

Table 1(b)

Partial Auto Correlation Function (PACF) of ΔTBR

	$\rho(1)$	$\rho(2)$	$\rho(3)$	$\rho(4)$	$\rho(5)$	$\rho(6)$	$\rho(7)$	$\rho(8)$	$\rho(9)$
Q-Stat.	0.178	0.089	0.146	–0.118	0.011	–0.129	0.040	–0.029	0.003
	$\rho(10)$	$\rho(11)$	$\rho(12)$	$\rho(13)$	$\rho(14)$	$\rho(15)$	$\rho(16)$	$\rho(17)$	$\rho(18)$
Q-Stat.	0.042	–0.095	0.118	–0.082	0.024	–0.122	0.175	–0.028	0.113

Fig. 1(a). Correlogram of ΔTBR (ACF)
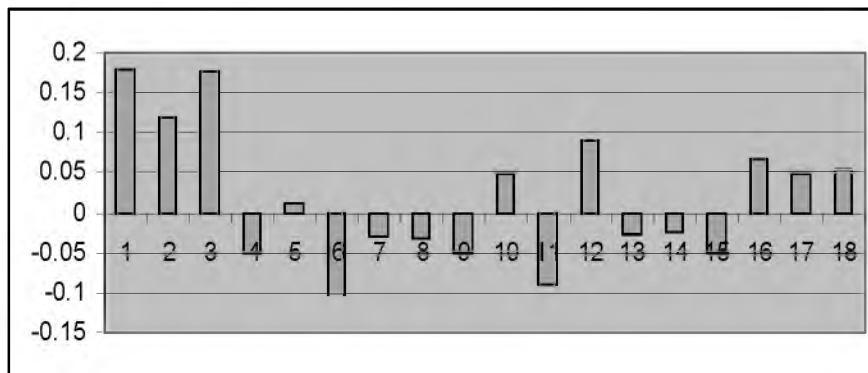
Fig. 1(b). Correlogram of ΔTBR (PACF)
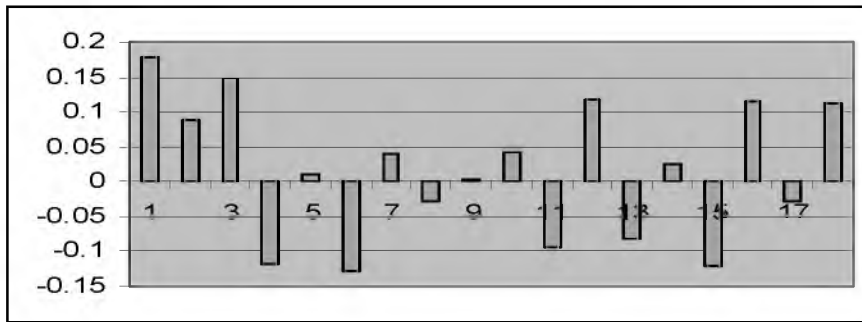
As evident from Table 1 (a and b) and Figure 1(a and b), ACF as well as PACF up to 3rd lag are significant. This suggests ARMA (3, 3) for ΔTBR. We estimate different plausible models for ΔTBR and select the best among them using Box-Jenkins (1994) methodology. The model is:

$$\Delta TBR = \beta \Delta TBR_{t-1} + \gamma \Delta TBR_{t-3} + \varepsilon_{zt}$$

Next, we filter (pre-whiten) the series, ΔTBR as:

$$\alpha_t = \Delta TBR - \beta \Delta TBR_{t-1} - \gamma \Delta TBR_{t-3} \qquad \ldots \qquad \ldots \qquad \ldots \qquad (8)$$

The pre-whitened series obtained using Equations (8) is:

$$\alpha_t = \Delta TBR - 0.15 \Delta TBR_{t-1} - 0.16 \Delta TBR_{t-3} \qquad \ldots \qquad \ldots \qquad (9)$$

Then we obtain pre-whitened series for ΔCMR as:

$$\beta_t = \Delta CMR - 0.15 \Delta CMR_{(t-1)} - 0.16 \Delta CMR_{t-3} \qquad \ldots \qquad \ldots \qquad (10)$$

Next we obtain cross-correlation and cross-correlogram between our pre-whitened series: α_t and β_t. These are presented below respectively in Table 2 and Figure 2.

Table 2

Cross-correlation between Pre-whitened Series α_t and β_t

	$\rho_{\alpha\beta}(0)$	$\rho(1)$	$\rho(2)$	$\rho(3)$	$\rho(4)$	$\rho(5)$	$\rho(6)$	$\rho(7)$	$\rho(8)$	$\rho(9)$
	0.2342	–0.014	–0.027	–0.052	–0.1133	–0.041	0.033	–0.041	0.06	–0.0379
Std. Dev.	(0.08)	(0.08)	(0.08)	(0.08)	(0.08)	(0.08)	(0.08)	(0.08)	(0.077)	(0.077)
	$\rho(10)$	$\rho(11)$	$\rho(12)$	$\rho(13)$	$\rho(14)$	$\rho(15)$	$\rho(16)$	$\rho(17)$	$\rho(18)$	$\rho(19)$
	0.0741	–0.058	0.075	0.090	–0.107	–0.076	0.122	–0.055	–0.0604	0.0867
Std. Dev.	0.077	0.077	0.077	0.076	0.076	0.076	0.076	0.076	0.076	0.076

Note: $\rho_{\alpha\beta}(0)$ shows correlation between CMR and TBR rather than cross-correlation.
The standard deviation is calculated as $(T-i)^{-1}$ where T denotes number of observations and i stands for the number of lags.

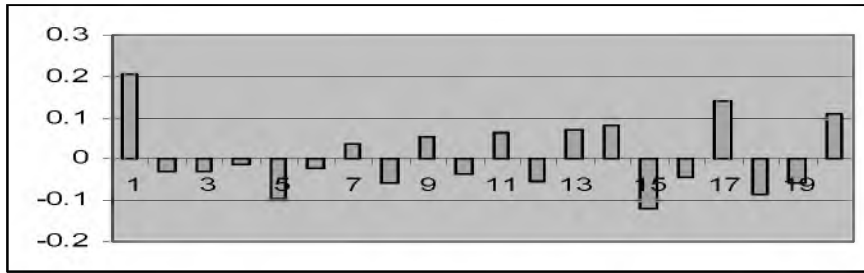**Fig. 2. Cross-correlogram between α_t and β_t**

Table 2 and Figure 2 show that only $\rho_{\alpha\beta}(0)$ is statistically significant. Next, based on cross-correlation between pre-whitened series α_t and β_t we select the model:

$$\beta_t = a_1\beta_{t-1} + c_1\beta_t + e_t \qquad \dots \qquad \dots \qquad \dots \qquad \dots \qquad \dots \qquad (11)$$

Estimation of (4.5) yields:

$$\beta_t = 0.4\beta_{t-1} - 1.26\beta_t + e_t$$

Then we obtain e_t as:

$$e_t = \beta_t - \left[\frac{1.26}{1+0.4L}\right]\alpha_t$$

The ACF, PACF of the error term e_t and the respective correlograms are presented below respectively in Table 3 (a and b) and Figure 3 (a and b).

Table 3 (a)

ACF of e_t

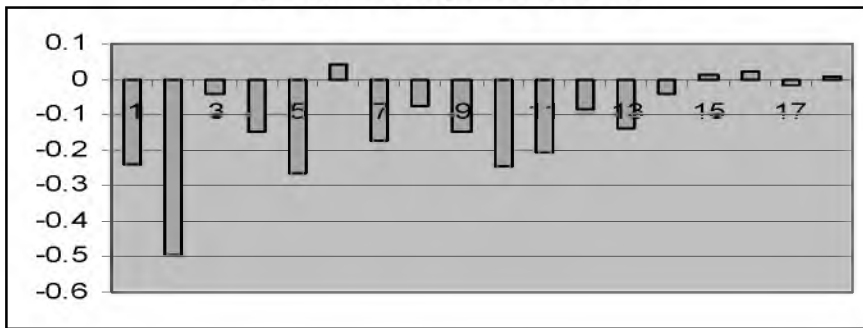|	$\rho(1)$	$\rho(2)$	$\rho(3)$	$\rho(4)$	$\rho(5)$	$\rho(6)$	$\rho(7)$	$\rho(8)$	$\rho(9)$
Q-Stat.	−0.144	−0.324	0.005	0.033	−0.177	0.191	−0.031	−0.112	−0.018
	$\rho(10)$	$\rho(11)$	$\rho(12)$	$\rho(13)$	$\rho(14)$	$\rho(15)$	$\rho(16)$	$\rho(17)$	$\rho(18)$
Q-Stat.	−0.019	−0.027	0.188	−0.016	−0.018	0.074	−0.016	−0.128	0.068

Table 3 (b)

PACF of e_t

	$\rho(1)$	$\rho(2)$	$\rho(3)$	$\rho(4)$	$\rho(5)$	$\rho(6)$	$\rho(7)$	$\rho(8)$	$\rho(9)$
Q-Stat.	−0.144	−0.495	−0.040	−0.147	−0.263	0.043	−0.174	−0.076	−0.150
	$\rho(10)$	$\rho(11)$	$\rho(12)$	$\rho(13)$	$\rho(14)$	$\rho(15)$	$\rho(16)$	$\rho(17)$	$\rho(18)$
Q-Stat.	−0.245	−0.206	−0.084	−0.137	−0.041	0.011	0.020	−0.016	0.007

Fig. 3 (a) Correlogram of e_t (ACF)

Fig. 3 (b). Correlogram of e_t (PACF)

On the basis of ACF and PACF of e_t preliminary model for e_t is:

$$e_t = \delta_1 e_{t-1} + \delta_2 e_{t-2} + \delta_3 e_{t-5} + \delta_4 e_{t-10} + (1 + \theta_1 L + \theta_2 L^2 + \theta_3 L^3 + \theta_4 L^5 + \theta_5 L^6)\varepsilon_t$$

The best-fit for e_t is:

$$e_t = -0.51 e_{t-1} - 0.33 e_{t-5} + (1 - 0.76L)\varepsilon_t$$

Therefore our tentative Transfer Function is:

$$\Delta CMR_t = \left[\frac{1.26}{1+0.4L}\right]\Delta TBR_t + \left[\frac{1-0.76L}{1+0.51L+0.33L^5}\right]\varepsilon_t \qquad \ldots \qquad \ldots \qquad (12)$$

The simultaneous estimation gives the same results. Then we expand the first term in Equation (12) using binomial expansion. This yield:

$$\Delta CMR_t = (1.26)(1+0.4L)^{-1}\Delta TBR + \left[\frac{1-0.76L}{1+0.51L+0.33L^5}\right]\varepsilon_t$$

or: $\Delta CMR_t = (1.26 - 0.5L) + \left[\dfrac{1 - 0.76L}{1 + 0.51L + 0.33L^5} \right] \varepsilon_t$ ...   ...   (13)

The Equation (13) shows that the call money rate fully responds to changes in T-Bill rate without any delay. The slightly more than 100 percent response of call money rate could be due to other factors and this seems to be corrected in the very next period. In Pakistan, banks are the major players in money market. Therefore the central bank can use the very fast pass-through to call money rate to influence the behaviour of the banks.

IV.2. Pass-through from TBR to Savings Deposit Rate (SDR)

The ACF and PAFC of ΔTBR (six months average) and the corresponding Correlograms are presented in Table 4(a and b) Figure 4 (a and b) below.

Table 4 (a)

ACF of ΔTBR (Six-month Average)

	$\rho(1)$	$\rho(2)$	$\rho(3)$	$\rho(4)$	$\rho(5)$	$\rho(6)$	$\rho(7)$	$\rho(8)$	$\rho(9)$
Q-Stat.	0.132	–0.04	0.055	–0.231	–0.206	0.063	0.229	0.137	0.193
	$\rho(10)$	$\rho(11)$	$\rho(12)$	$\rho(13)$	$\rho(14)$	$\rho(15)$	$\rho(16)$	$\rho(17)$	$\rho(18)$
Q-Stat.	–0.037	–0.068	–0.056	–0.255	–0.229	0.049	–0.062	–0.026	0.2

Table 4 (b)

PACF of ΔTBR (Six-month Average)

	$\rho(1)$	$\rho(2)$	$\rho(3)$	$\rho(4)$	$\rho(5)$	$\rho(6)$	$\rho(7)$	$\rho(8)$	$\rho(9)$
Q-Stat.	0.132	–0.058	0.07	–0.257	–0.138	0.085	0.255	0.072	0.108
	$\rho(10)$	$\rho(11)$	$\rho(12)$	$\rho(13)$	$\rho(14)$	$\rho(15)$	$\rho(16)$	$\rho(17)$	$\rho(18)$
Q-Stat.	–0.138	0.072	0.03	–0.197	–0.308	–0.014	–0.128	–0.027	0.035

Fig. 4(a). Correlogram of ΔTBR (ACF)
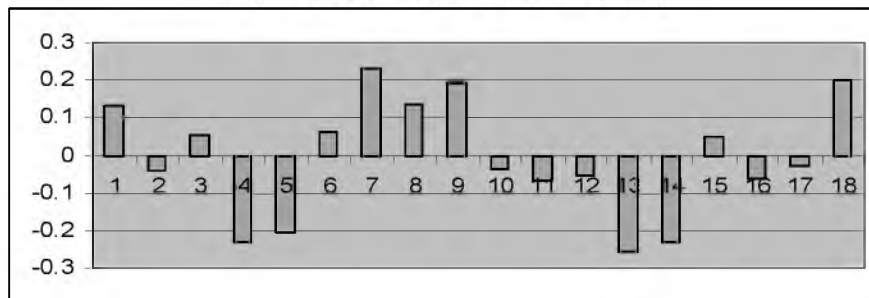
Fig. 4(b). Correlogram of ΔTBR (PACF)
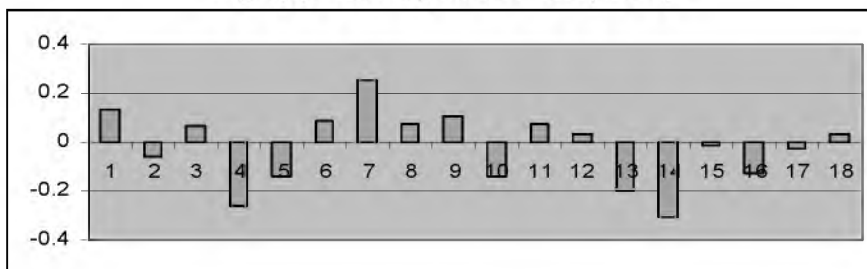
The Figure 4 (a and b) show that ACF and PAFC up to 14th lag are significant. We estimate different plausible models and select the best among them using Box-Jenkins methodology (1994). Next, we filter (pre-whiten) the series, ΔTBR by the best-fitted ARIMA model of ΔTBR. The model is:

$$\Delta TBR = \beta_1 \Delta TBR_{t-1} + \beta_2 \Delta TBR_{t-7} + \gamma ma_1 + \delta ma_6$$

or

$$\alpha_t = \Delta TBR - \beta_1 \Delta TBR_{t-1} - \beta_2 \Delta TBR_{t-7} - \gamma ma_1 - \delta ma_6 \quad \dots \quad \dots \quad (14)$$

The pre-whitened series for ΔTBR is obtained using Equation (4.8) is:

$$\alpha_t = \Delta TBR - (0.39 \Delta TBR_{t-1} + 0.4 \Delta TBR_{t-7}) + 0.51 ma_1 - 0.54 ma_6 \quad \dots \quad (15)$$

Then we filtered the saving deposit rate as:

$$\beta_{1t} = \Delta SDR - (0.39 \Delta SDR_{t-1} + 0.4 \Delta SDR_{t-7}) + 051 ma_1 - 0.54 ma_6 \quad \dots \quad (16)$$

Next we obtain the cross-correlation and cross-correlogram between our pre-whitened series α_t and β_{1t}. These are presented below in Table 5 and Figure 5 respectively.

Table 5

Cross-correlation between Pre-whitened Series α_t and β_{1t}

	$\rho_{\alpha\beta}(0)$	$\rho(1)$	$\rho(2)$	$\rho(3)$	$\rho(4)$	$\rho(5)$	$\rho(6)$	$\rho(7)$	$\rho(8)$	$\rho(9)$
	0.3983	−0.433	−0.07	0.334	−0.11	−0.11	0.481	−0.12	0.16	−0.03
S.D.	0.204	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.205	0.2024
	$\rho(10)$	$\rho(11)$	$\rho(12)$	$\rho(13)$	$\rho(14)$	$\rho(15)$	$\rho(16)$	$\rho(17)$	$\rho(18)$	$\rho(19)$
	−0.37	0.25	−0.07	0.039	−0.02	0.103	−0.098	−0.01	−0.031	−
S.D.	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	−

Note: $\rho_{\alpha\beta}(0)$ shows correlation between α_t and β_{1t}, rather than cross-correlation.
The standard deviation (S.D.) is calculated as $(T-i)^{-1}$ where T denotes number of observations and i stands for the number of lags.

Fig. 5. Cross-correlogram between α_t and β_{1t}
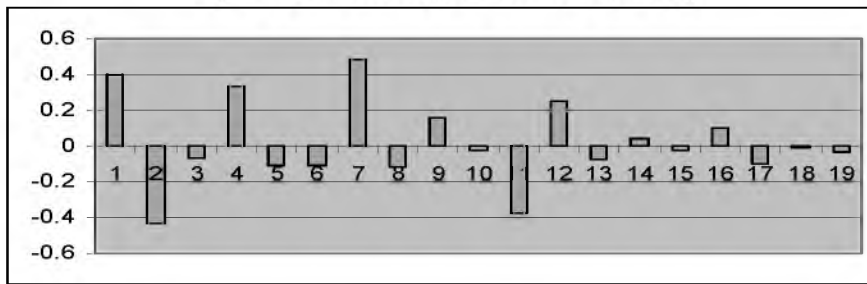

Table 5 and Figure 5 show that the Cross-correlations between pre-whitened series α_t and β_{1t} are significant up to 6th lag. On the basis of the cross-correlations we estimate various plausible models and select the best among them. The model is:

$$\beta_{1t} = a_1\beta_{1t-1} + c_0\alpha_t + c_1\alpha_{t-4} + c_2\alpha_{t-6} + e_{t1} \qquad \ldots \qquad \ldots \qquad \ldots \qquad (17)$$

Next we obtain the estimates of coefficients as given below:

$$\beta_{1t} = -0.44\beta_{1t-1} + 0.18\alpha_t + 0.12\alpha_{t-4} + 0.25\alpha_{t-6} + e_{t1} \qquad \ldots \qquad \ldots \qquad (18)$$

Then we obtain e_{1t} as:

$$e_{1t} = \beta_{1t} - \frac{0.18 - 0.0.12L^4 + 0.0.25L^6}{1 + 0.44L}\alpha_t \qquad \ldots \qquad \ldots \qquad \ldots \qquad (19)$$

The ACF and PAFC of the error term e_{1t} and the corresponding Correlograms are presented below in Table 6 (a and b) and Figure 6 (a and b) respectively:
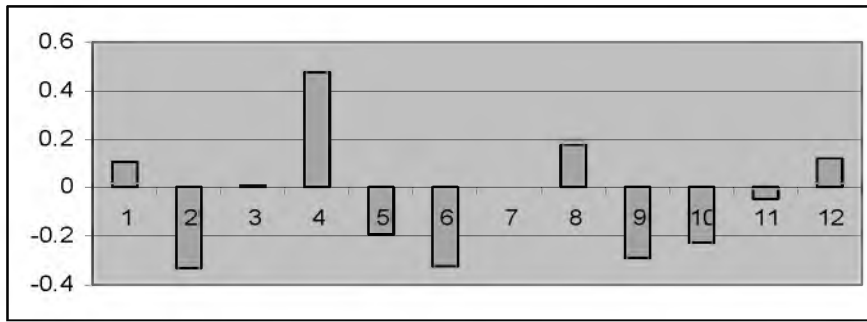
Table 6 (a)

ACF of e_{1t}

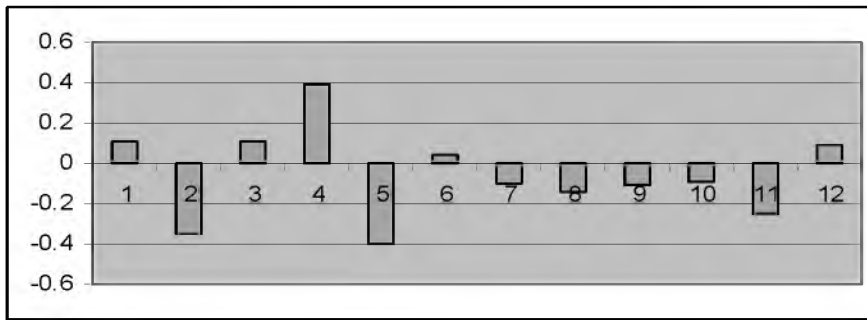|	$\rho\, e_{1t}(1)$	$\rho\,(2)$	$\rho\,(3)$	$\rho\,(4)$	$\rho\,(5)$	$\rho\,(6)$	$\rho\,(7)$	$\rho\,(8)$	$\rho\,(9)$
Q-Stat.	0.109	−0.331	0.011	0.472	−0.194	−0.322	0.005	0.176	−0.292
	$\rho\,(10)$	$\rho\,(11)$	$\rho\,(12)$	$\rho\,(13)$	$\rho\,(14)$	$\rho\,(15)$	$\rho\,(16)$	$\rho\,(17)$	$\rho\,(18)$
Q-Stat.	−0.226	−0.046	0.121	–	–	–	–	–	–

Table 6 (b)

PACF of e_{1t}

	$\rho\, e_{1t}(1)$	$\rho\,(2)$	$\rho\,(3)$	$\rho\,(4)$	$\rho\,(5)$	$\rho\,(6)$	$\rho\,(7)$	$\rho\,(8)$	$\rho\,(9)$
Q-Stat.	0.109	−0.347	0.112	0.393	−0.397	0.042	−0.099	−0.142	−0.106
	$\rho\,(10)$	$\rho\,(11)$	$\rho\,(12)$	$\rho\,(13)$	$\rho\,(14)$	$\rho\,(15)$	$\rho\,(16)$	$\rho\,(17)$	$\rho\,(18)$
Q-Stat.	−0.093	−0.251	0.091	–	–	–	–	–	–

Fig. 6 (a). Correlogram of e_{1t} (ACF)

Fig. 6 (b). Correlogram of e_{1t} (PACF)

On the basis of ACF, PACF and the respective cross-correlograms of e_{1t} we estimate different models for e_{1t} and select the best-fit, using Box-Jenkins methodology. Then e_{1t} is estimated as ARMA process, where best fitted ARMA model for e_{1t} is:

$$e_{1t} = 0.648e_{1t-2} + 1.7e_{t-4} - 0.8e_{t-5} + (1-0.98L)\varepsilon_{t1} \qquad \dots \qquad \dots \qquad (20)$$

Therefore our Transfer Function is:

$$\Delta SDR_t = \frac{0.18 + 0.12L^4 + 0.25L^6}{1+0.44L}\Delta TBR_t + \frac{(1-0.98L)}{(1-0.64L^2 - 1.7L^4 - 0.8L^5)}\varepsilon_{t1} \qquad (21)$$

We expand the first term in (22) using binomial expansion as under:

$$SDR_t = (0.18 + 0.12L^2 + 0.25L^6)(1+0.44L)^{-1}\Delta TBR_t +$$

$$\frac{(1-0.98L)}{(1-0.64L^2 - 1.7L^4 - 0.8L^5}\varepsilon_{t1}$$

$$\Delta SDR_t = (0.18 - 0.08L + 0.034L^2 - 0.015L^3 + 0.13L^4 - 0.053L^5 + 0.027L^6)$$

$$\Delta TBR + \frac{(1 - 0.98L)}{(1 - 0.64L^2 - 1.7L^4 - 0.8L^5)}\varepsilon_{t1} \qquad \cdots \qquad \cdots \qquad \cdots \qquad (22)$$

Equation (22) shows that 18 percent of the change in Treasury Bill rate is passed on to Savings Deposit Rate (SDR) during the period of change, that is, the first six months. As the pass-through is not completed during the period of change Treasury Bill rate, using the language of relevant literature on pass-through, we would say that SDR exhibits rigidity.

IV.3. Pass-through from TBR to Six-months Deposit Rate (SMDR)

We filter (pre-whiten) ΔTBR and $\Delta SMDR$ series by the best-fitted ARIMA model of ΔTBR given in previous section. The pre-whitened series' obtained are:

$$\alpha_t = \Delta TBR - (0.39\Delta TBR_{t-1} + 0.4\Delta TBR_{t-7}) + 0.51ma(1) - 0.54ma(6) \ldots \qquad (23)$$

$$\beta_{2t} = \Delta SMDR - (0.39\Delta SMDR_{t-1} + 0.4\Delta SMDR_{t-7}) + 051ma(1) - 0.54ma(6) \qquad (24)$$

Next we obtain cross-correlations between our pre-whitened series α_t and β_{2t}. The cross-correlations and the corresponding cross-correlogram are presented below in Table 7 and Figure 7.
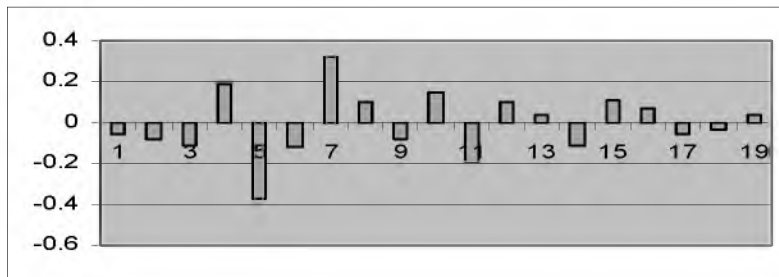
Table 7

Cross-correlation between Pre-whitened Series' α_t and β_{2t}

	$\rho_{\alpha\beta}(0)$	$\rho(1)$	$\rho(2)$	$\rho(3)$	$\rho(4)$	$\rho(5)$	$\rho(6)$	$\rho(7)$	$\rho(8)$	$\rho(9)$
	0.25	−0.18	−0.08	0.28	−0.45	−0.39	0.34	−0.07	0.18	0.04
S.D.	0.204	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.205	0.2024
	$\rho(10)$	$\rho(11)$	$\rho(12)$	$\rho(13)$	$\rho(14)$	$\rho(15)$	$\rho(16)$	$\rho(17)$	$\rho(18)$	$\rho(19)$
	−0.28	0.21	−0.08	−0.18	0.19	−0.10	−0.06	0.03	0.04	–
S.D.	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	–

Note: $\rho_{\alpha\beta}(0)$ shows correlation between TBR and SDR, rather than cross-correlation.

The standard deviation is calculated as $(T-i)^{-1}$ where T denotes number of observations and i stands for the number of lags.

Fig. 7. Cross-correlogram between α_t and β_{2t}

An examination of the Table 7 and Figure 7 shows that the cross-correlations between, pre-whitened series α_t and β_{2t}, are significant up to 7th lags. Based on the cross-correlation, we estimate different plausible models and select the best among them. The best-fit for β_{2t} is:

$$\beta_{2t} = c_0\alpha_{t-4} + c_1\alpha_{t-5} + e_{2t} \qquad \ldots \qquad \ldots \qquad \ldots \qquad \ldots \qquad \ldots \qquad (25)$$

Estimation of Equation (4.19) yields the following:

$$\beta_{2t} = -0.210.19\alpha_{t-4} + 0.26\alpha_{t-5} + e_{2t} \qquad \ldots \qquad \ldots \qquad \ldots \qquad \ldots \qquad (26)$$

Next we obtain e_{2t} as:

$$e_{2t} = \beta_{2t} - (-0.21L^4 + 0.26L^5)\alpha_t \qquad \ldots \qquad \ldots \qquad \ldots \qquad \ldots \qquad (27)$$

The ACF and PAFC of the error term e_{2t} and the corresponding correlograms are presented below in Table 8 (a and b) and Figure 8 (a and B) respectively.
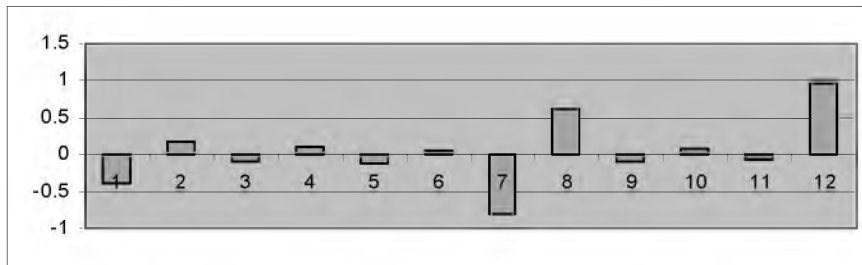
Table 8 (a)

ACF of e_{2t}

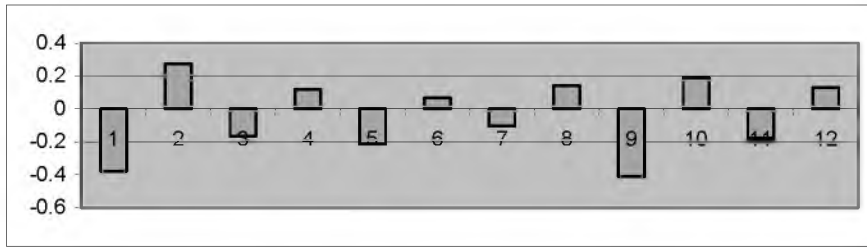|	$\rho\,e_{2t}(1)$	$\rho(2)$	$\rho(3)$	$\rho(4)$	$\rho(5)$	$\rho(6)$	$\rho(7)$	$\rho(8)$	$\rho(9)$
Q-Stat.	−0.378	0.274	−0.165	0.118	−0.213	0.067	−0.104	0.141	−0.111
	$\rho(10)$	$\rho(11)$	$\rho(12)$	$\rho(13)$	$\rho(14)$	$\rho(15)$	$\rho(16)$	$\rho(17)$	$\rho(18)$
Q-Stat.	0.188	−0.178	0.129	–	–	–	–	–	–

Table 8 (b)

PACF of e_{2t}

	$\rho\,e_{2t}(1)$	$\rho(2)$	$\rho(3)$	$\rho(4)$	$\rho(5)$	$\rho(6)$	$\rho(7)$	$\rho(8)$	$\rho(9)$
Q-Stat.	−0.378	0.174	−0.105	0.109	−0.113	0.047	−0.80	0.61	−0.101
	$\rho(10)$	$\rho(11)$	$\rho(12)$	$\rho(13)$	$\rho(14)$	$\rho(15)$	$\rho(16)$	$\rho(17)$	$\rho(18)$
Q-Stat.	0.088	−0.078	0.96	–	–	–	–	–	–

Fig. 8 (a) Correlogram of e_{1t} (ACF)

Fig. 8 (b). Correlogram of e_{1t} (PACF)

On the basis of ACF, PACF and the respective cross-correlograms of e_{2t} we estimate different models for e_{1t} and select the best-fit, using Box-Jenkins methodology. Then e_{2t} is estimated as ARMA process, where best fitted ARMA model for e_{2t} is:

$$e_{2t} = 0.6e_{t-2} + (1-0.45)\varepsilon_{2t}$$

or
$$e_{2t} = \frac{1-0.45L^2}{1-0.60L^2}\varepsilon_{2t} \quad \dots \quad \dots \quad \dots \quad \dots \quad \dots \quad \dots \quad (28)$$

Therefore our Transfer Function is:

$$\Delta SMDR_t = (0.12L^4 + 0.26L^5)\Delta TBR_t + \frac{1-0.45L^2}{1-0.60L^2}\varepsilon_{2t} \quad \dots \quad \dots \quad (29)$$

Equation (29) shows that changes in T-Bill rate are passed on to Six-month deposit rate after a lag of 4-5 periods that is around two years. There is no pass-through during the impact period. One reason for the absence of pass-through, during the impact period, could be that six-months deposits are of fixed maturity and the rate would change only when the previous contracts, contracted at old rates, mature. Besides as different depositors would have deposited money at different dates; their contracts would mature at different dates. Thus the full impact will not be felt till all the contracts, contracted at the previous rate have matured.

Second Hanan and Berger (1991) argument, based on empirical evidence, regarding asymmetric pass-through, could be valid here. HB suggests that, pass-through to deposit rates is slower for upward revisions as compared to downward revisions in policy rate because banks stand to loose, at least in the short-run, when deposit rates are revised upward. Out of the 166 observations that we have of the T.Bill rate, 86 represent increase, 73 decrease and 7 no change in the rate. The fact that more than half of the observations represent an increase in T.Bill rate, could be one reason for the slow pass-through noticed in case of Bank Deposit rates, assuming that the pass-through is asymmetric. However, to be sure that the pass-through is asymmetric, calls for further econometric investigation.

IV.4. Pass-through from TBR to Lending Rate (LR)

We filter (pre-whiten) ΔTBR and ΔLR series' by the best-fitted ARIMA model of ΔTBR given in Section IV.2. The pre-whitened series obtained are:

$$\alpha_t = \Delta TBR - (0.39\Delta TBR_{t-1} + 0.4\Delta TBR_{t-7}) + 0.51 ma_1 - 0.54 ma_6 \quad \dots \qquad (30)$$

$$\beta_{3t} = \Delta LR - (0.39\Delta LR_{t-1} + 0.4\Delta LR_{t-7}) + 051 ma_1 - 0.54 ma_6 \qquad \dots \qquad (31)$$

Next, we obtain the cross-correlation between our pre-whitened series α_t and β_{3t}. The cross-correlation and the corresponding correlogram presented below in Table 9 and Figure 9.

Table 9

Cross-correlation between Pre-whitened α_t and β_{3t}

	$\rho_{\Delta TBR, LR}(0)$	$\rho(1)$	$\rho(2)$	$\rho(3)$	$\rho(4)$	$\rho(5)$	$\rho(6)$	$\rho(7)$	$\rho(8)$	$\rho(9)$
	−0.057	−0.078	−0.10	0.193	−0.37	−0.12	0.32	0.10	−0.08	0.15
S.D.	0.204	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.205	0.2024
	$\rho(10)$	$\rho(11)$	$\rho(12)$	$\rho(13)$	$\rho(14)$	$\rho(15)$	$\rho(16)$	$\rho(17)$	$\rho(18)$	$\rho(19)$
	−0.19	0.10	0.04	−0.11	0.11	0.07	−0.06	−0.027	0.039	−
S.D.	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	−	−

Note: $\rho_{\alpha\beta(0)}$ shows correlation between TBR and SDR, rather than cross-correlation.
The standard deviation is calculated as $(T-i)^{-1}$ where T denotes number of observations and i stands for the number of lags.

Fig. 9. Cross-correlogram between α_t and β_{3t}

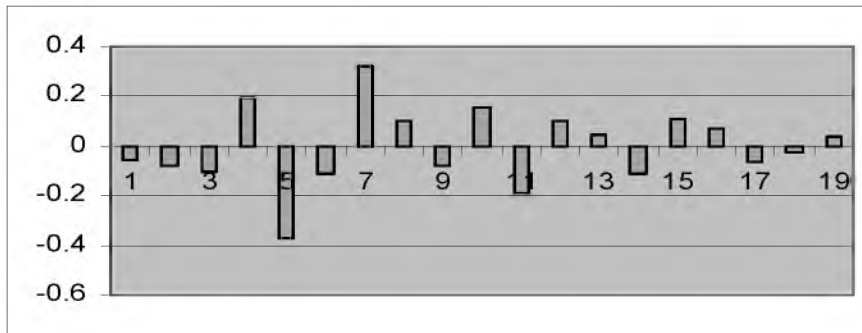Table 9 and Figure 9 show that, cross-correlation between pre-whitened series α_t and β_{3t}, are significant up to 7th lag. Based on the cross-correlation, we estimate different plausible models and select the best among them. The best-fit for β_{3t} is:

$$B_{3t} = c_0\alpha_{t-3} + c_1\alpha_{t-4} + e_{t3} \quad \dots \qquad \dots \qquad \dots \qquad \dots \qquad \dots \qquad (32)$$

Estimation of Equation (4.26) yields the following:

$$\beta_{3t} = -0.34 + 0.13\alpha_{t-3} + 0.28\alpha_{t-4} + e_{3t} \quad \ldots \qquad \ldots \qquad \ldots \qquad \ldots \qquad (33)$$

Next, we obtained e_{3t} as:

$$e_{3t} = \beta_{3t} - 0.34 + 0.13\alpha_{t-3} + 0.28\alpha_{t-4} \quad \ldots \qquad \ldots \qquad \ldots \qquad \ldots \qquad (34)$$

The ACF and PAFC of the error term e_{3t} and the corresponding correlograms are presented below in Table 10 (a and b) and Figure 10 (a and b) respectively.

Table 10

ACF of e_{3t}

	$\rho_{e3t}(1)$	(2)	ρ (3)	ρ (4)	ρ (5)	ρ (6)	ρ (7)	ρ (8)	ρ (9)
Q-Stat.	0.051	0.105	0.052	−0.12	−0.036	0.077	0.021	0.064	−0.262
	ρ (10)	ρ (11)	ρ (12)	ρ (13)	ρ (14)	ρ (15)	ρ (16)	ρ (17)	ρ (18)
Q-Stat.	−0.181	−0.036	−0.302	−	−	−	−	−	−

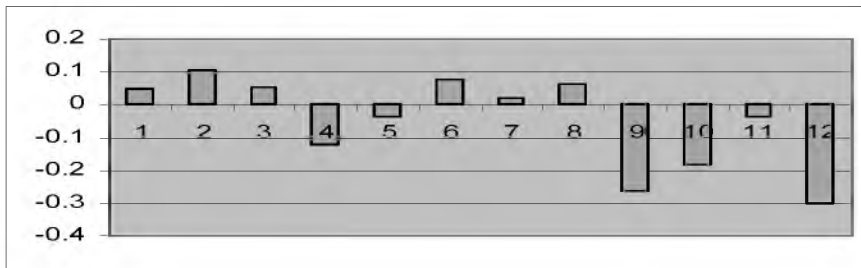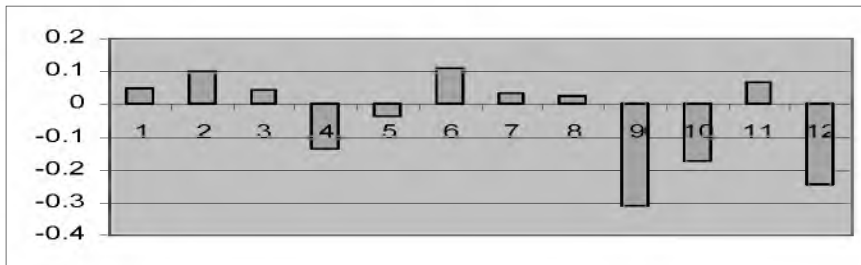**Fig. 10 (a). Correlogram of e_{3t} (ACF)**

Fig. 10 (b). Correlogram of e_{3t} (PACF)

e_{3t} is then estimated as ARMA process, where best-fit ARMA model for e_{3t} is selected on the basis of ACF of e_{3t}. The best-fit is:

$$e_{3t} = (1-0.79)\varepsilon_{3t} \quad \dots \qquad \dots \qquad \dots \qquad \dots \qquad \dots \qquad \dots \qquad (35)$$

Therefore our Transfer Function is:

$$\Delta LR_t = -0.34 + (0.13L^3 + 0.28L^4)\Delta TBR_t + (1-0.79)\varepsilon_{3t} \quad \dots \qquad \dots \qquad (36)$$

Equation (36) shows that there is no pass-through in the impact period that is the first six months. The Lag structure evident from Equation (36) above, shows that lending rate responds to changes in Treasury bill rate after one and a half to two years. The rather slow response of the lending rate to changes in Treasury Bill rate, should be viewed in the backdrop that the Lending rate examined is all inclusive, that is, includes the interest rate applicable to short term loans as well as long term loans, the pass–through to the rate for short term loans is expected to be relative quicker than reflected in Equation (36). Secondly, like deposit rates, the asymmetric pass-through argument could be valid here as well. Banks, at least in the short run, stand to loose when the lending rate declines. Therefore they are reluctant to change the rate consequent upon decrease in the Treasury Bill rate. Out of the 168 observations that we have 73 reflect decrease in the Treasury Bill rate. Assuming that asymmetric pass-through is a fact, there are sufficient downward revisions in the Treasury Bill rate to slow-down the pass-through to lending rate. However to be sure on this count, further econometric investigation is called for. Third, the slower pass-through to lending rate is due to the use of weighted average lending rate rather than the rate applicable to fresh disbursements. As discussed in Section II.1 this tends to tone-down the pass-through.

V. CONCLUSION

The influence of monetary policy upon real output and the inflation rate is well established. The influence is exercised through the transmission mechanism of monetary policy. Perhaps the important element in the bank-lending channel of the transmission mechanism is the change in Bank deposit and Bank lending rates, in response to change in the policy rate (Treasury Bill rate in Pakistan). Given the above, this study has examined the pass-through of Treasury Bill rate to money market rate (Call Money rate), Banks' Deposit rate and Banks' Lending rate.

The broader conclusion is that pass-through from Treasury Bill rate to Call money rate is completed during the impact period, that is in the very first month. However pass-through from Treasury Bill rate to Deposit rates and the Lending rate takes much longer, that is, these rates exhibit rigidity. The results are in

conformity with the empirical evidence in the relevant literature for other countries. In practice, the pass-through to the deposit and the lending rates is expected to be quicker than evidenced in this study. The reason is that the study uses weighted average deposit and lending rate. Given that the weighted average rate takes into account outstanding deposit/loans contracted at previous rates as well, (besides the fresh deposit/loans contracted at new rates) this tends to tone down the pass-through.

A possible reason for slow pass-through to the deposit/lending rates could be the asymmetry in pass-through for upward and downward revisions in Treasury Bill rate. When the Treasury Bill rate is revised upward banks are reluctant to revise the deposit rates upward as this may adversely affect their profit, at least, in the short-run. The same is true for lending rates when the Treasury Bill rate is revised downward. Out of 161 revisions in Treasury Bill rate, during the data span, upward revisions are 86 and remaining 73 are downward revisions. This might explain the slower pass-through noticed for the deposit and the lending rate. However to count on the asymmetry argument for explaining rigidity in pass-through, econometric investigation specifically focused on this aspect is called for. Other reasons for the rigidity of the deposit and lending rate could be menu costs involved in revising the rates and oliogopolistic structure of the banking industry. The exact answers demand further research.

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Comments

The study on interest rate pass-through is important both as an academic research question as well as for its implications for monetary policy. The authors, in this way have studies a very important issue in the context of Pakistan especially at a time when the State Bank of Pakistan is evaluating the alternative models of monetary policy that suits Pakistan's economic environment. The paper empirically investigates the pass-through of the changes in the interest rate on Treasury bills, to money market rate (call money rate), banks' deposit rate and banks' lending rate using data from Pakistan. More specifically, the paper estimates the duration of pass-through from changes in Treasury bill rate to money market rate, the deposit rate and the lending rate. The findings of this study suggest that the pass-through of the changes in Treasury bill to Call money is completed in one month, while the pass-through to Savings deposit rate starts during the first six months and continues for a long time. The study does not find any pass-through for six-month deposit rate and lending rate during the first six months. The pass-through in both cases, according to this paper, occurs between one-and-a-half to three years.

Although, the paper has studied a very important issue and has used an empirical methodology to test it, some improvement is needed to fix a few missing links. I, therefore, suggest authors to take a note of the following comments.

(1) The main problem with the paper is its empirical methodology. The paper is investigating the effect of changes in Treasury bill rate (TBR) on Call money rate (CMR), Deposit rate (DR) and Lending rate (LR). Authors rightly claim (on page 6) that 'measurement of pass-through requires high frequency data'. They, however, use two different data sets: monthly data for TBR and CMR and bi-annual (six-monthly) data on DR and LR. There are a couple of concerns here. First, either of the data may not be called high-frequency data. The common definition of high-frequency data on variables in empirical literature (on variables such as interest rate) is weekly or daily observations. Such data may be obtained through Data Stream. Second, the results may not be compared directly or generalized using two different data frequencies. A lot of important information is lost while using six-monthly data on interest rate. The results reported in the paper such as pass-through for CMR takes one month (using monthly data) and for DR and LR takes 1.5 to 3 years (using six-montly data) also indicate towards these inconsistencies.

(2) It surprising to note that the sample period (the data span) used for empirical estimation is not mentioned anywhere in the paper. Not only that such information is important, it is also needed to assess the impact of financial reform process initiated in early 1990s on the monetary policy transmission mechanism.

(3) Pages 2-5 review the empirical literature. Surprisingly again, the paper focuses on four papers only published between 1994 and 2002. It is hard to believe that such an important issue has not been investigated by both theoretical and empirical economists. The authors should have done a through literature review before initiating this study. Furthermore, the literature review is very long, proving details of each study. The literature review should focus on the main findings and the limitations of the existing literature to make a case for work under study.

(4) Section II on empirical model and data (on page 5) starts with a reference of Vega and Rebucci (2003) which has not been mentioned in the literature review. Data problems are discussed in points 1 and 2 above.

(5) Section III on methodology (page 6-10) is standard Box-Jenkins (1994) methodology. Authors do not need to discuss the details of this (spanned over 5 pages). On page 11, authors incorrectly state "using the methodology developed in Section III". Authors just discussed the B-J methodology and did not modify it or developed a new methodology.

(6) There are also some oversights or typos in this section. Take a note of the following:

   (a) On page 9 in Step 2 y_t should be in the numerator rather than in the denominator. Moreover, the exponent of (T–i) is –1 rather than 1 or- 1/2. While in formula for the significance of cross-correlations k is seemed to be dropped and in formula of Q-statistic $(T–k)$ is in denominator.

   (b) On page 11 authors should use TBR while using ARIMA and ΔTBR when they use ARMA (as the series are in first difference).

   (c) The paper suggests certain results to be significant without reporting any p-values or indicating any test of statistical significance.

   (d) The estimated version of Equation 11 seems to be incorrect. Authors need to check this result.

   (e) No explanation is provided on how authors obtained (or estimated) Equation 13.

   (f) On page 21, authors discuss the results assuming asymmetric pass-through while no empirical tests are performed for asymmetric pass-through.

Finally, I appreciate the effort made in this paper and commend the author for choosing an important area of research. However, the paper needs a major revision to fill the gaps and clarify some important results. I believe that the comments made in this report would help to improve the quality of paper.

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