ISSN 1811-5446

THE LAHORE JOURNAL OF ECONOMICS

Volume 15, No. 2 **July-Dec, 2010**

The Lahore Journal of Economics
15 : 2 (Winter 2010): pp. 1-33

Asymmetric Behavior of Inflation Uncertainty and Friedman-Ball Hypothesis: Evidence from Pakistan

Syed Kumail Abbas Rizvi* **and Bushra Naqvi****

Abstract

This paper is a first attempt to measure and analyze inflation uncertainty in Pakistan. It makes several contributions to the literature. In the first stage, using quarterly data from 1976:01 to 2008:02, we model inflation uncertainty as a time varying process using the GARCH framework. In the second stage, we analyze the asymmetric behavior of inflation uncertainty using the GJR-GARCH and EGARCH models. For further analysis of asymmetry and leverage effects, we develop news impact curves as proposed by Pagan and Schwart (1990). Finally we investigate the causality and its direction between inflation and inflation uncertainty by using the bivariate Granger-Causality test to determine which inflation uncertainty hypothesis (Friedman-Ball or Cukierman-Meltzer) holds true for Pakistani data. We obtain two important results. First, the GJR-GARCH and EGARCH models are more successful in capturing inflation uncertainty and its asymmetric behavior than the simple GARCH model. This can also be seen from news impact curves showing a significant level of asymmetry. Second, there is strong evidence that the Friedman-Ball inflation uncertainty hypothesis holds true for Pakistan.

Keywords: Inflation, uncertainty, GJR-GARCH, EGARCH, Friedman-Ball hypothesis, Pakistan.

JEL Classification: C22, E31, E37.

1. Introduction

Inflation is one of the most largely observed and tested economic variables both theoretically and empirically. Its causes, impacts on other economic variables, and cost to the overall economy are well known and understood. One cannot say with certainty whether inflation is good or bad for an economy but if the debate focuses on inflation uncertainty or inflation variability instead of just inflation, economists generally agree

* 3rd Year Doctoral Student, CES – Axe Finance, Université Paris 1 Panthéon Sorbonne.
** 2nd Year Doctoral Student, CES – Axe Finance, Université Paris 1 Panthéon Sorbonne.

on its negative impact on some of the most important economic variables—such as output and growth rate—via different channels.

Inflation uncertainty is considered one of the major costs of inflation since it not only distorts decisions regarding future saving and investment due to lower predictability of the real value of future nominal payments, but it also extends the adverse affects of these distortions to the efficiency of resource allocation and the level of real activity (Fischer 1981, Golob 1993, Holland 1993b).

One can divide the consequences of inflation uncertainty into two categories, ex-ante consequences and ex-post consequences. Ex-ante consequences are based primarily on decisions in which an economic agent rationally anticipates future inflation and its transmission can be performed via three different channels. The first channel is financial markets, where inflation uncertainty makes investment in long-term debt riskier, which increases expected returns and long-term interest rates. High long-term interest rates reduce investment in both the business and household sector via a fall in investment in plants and equipment and housing and durable goods. The second channel is through decision variables, where inflation uncertainty leads to uncertainty about the interest rate and other economic variables, due to which economic agents are unable to index contractual payments according to inflation, which in turn increases uncertainty about wages, rent, taxes, depreciation, and profits. Firms are thus forced to delay their hiring, production, and investment because these decisions are unlikely to be reversed, thus reducing the overall economic activity. The third channel is that of productive vs. protective strategies, through which inflation uncertainty forces firms to shift their allocation of resources from more productive to less productive uses such as improved forecasts about inflation and hedging activities via derivatives to cop up increased uncertainty. The firm's resources are diverted from productive strategies to protective actions, which are more costly for small enterprises and households (Golob, 1994). Ex-post effects of inflation uncertainty include the transfer of wealth due to the under- or overvaluation of real payments versus nominal payments, which disturbs the status quo between employer and employee, and lender and borrower (Blanchard, 1997).

However, the relationship between inflation and inflation uncertainty is debatable as it is still unclear whether high inflation causes uncertainty or uncertainty causes high inflation. Friedman (1977) was the first to formalize the relationship between inflation and inflation uncertainty and he strongly supported the causality running from

inflation to inflation uncertainty, generally known as the Friedman-Ball hypothesis. This hypothesis has also been extensively studied and the overall results are mixed. Ball and Cecchetti (1990), Cukierman and Wachtel (1979), Evans (1991), and Grier and Perry (1998), among others, provide evidence in support of a positive impact of the average rate of inflation on inflation uncertainty. Grier and Perry (1998) find that, in all G7 countries, inflation has a significant and positive effect on inflation uncertainty. Hafer (1985) also tested Friedman's hypothesis that high inflation uncertainty leads to higher unemployment, lower output, and slower growth in employment by considering the standard deviation of quarterly inflation forecasts obtained through the ASA-NBER survey of professional forecasters as a proxy for inflation uncertainty.

On the other hand, the causality running in the opposite direction, from inflation uncertainty to inflation, is considered the Cukierman-Meltzer hypothesis (Cukierman-Meltzer, 1986; Holland, 1995). There is some evidence in support of this hypotheses, including Baillie et al. (1996) for the UK, Argentina, Brazil, and Israel, and Grier and Perry (1998) for Japan and France.

There is also a debate on the origins of inflation uncertainty. One school of thought believes that monetary policy plays an important role in determining inflation uncertainty since it stems from the uncertainty of the monetary policy regime, known as "regime uncertainty." According to Ball (1990), when there is high inflation, policymakers face a dilemma: on one hand, they would like to reduce inflation, on the other hand, they fear that it will trigger a recession in the economy. Because the public is unaware of the inclination of policymakers, it will remain highly uncertain of the future course of inflation (Ball, 1992; Okun, 1971; Friedman, 1977). This uncertainty increases further due to the announcement of unrealistic stabilization programs by governments when there is a surge of high inflation (Fischer and Modigliani 1978). The second school of thought believes that inflation uncertainty arises because of the unknown magnitude of a change in price level due to a given change in money supply (Holland, 1993a).

The first objective of this study is to model inflation uncertainty for Pakistan. We focus on what should be a suitable proxy for inflation uncertainty. The most common way to estimate inflation uncertainty is through surveys of expectations, such as the Livingston survey in the US. Given point estimates of inflation forecasts obtained from different individual forecasters, we can proxy inflation uncertainty as a variance of inflation forecasts across cross sectional data. However, in his remarkable

contribution, Engle (1983) first modeled inflation uncertainty as autoregressive or time varying conditional hetersoscedasticity (ARCH), in which he used a conventional inflation equation with fixed parameters but allowed the conditional variance of inflation shocks (forecast errors) to vary over time, suggesting that this variance could be used as a proxy for inflation uncertainty.

Empirical research on the ARCH model often identifies long lag processes for the squared residuals, showing the persistent effects of shocks on inflation uncertainty. To model this persistence, many researchers subsequently suggested variations or extensions to the simple ARCH model to test the inflation uncertainty hypothesis. Bollerslev (1986) and Taylor (1986) independently developed the generalized ARCH (GARCH) model, in which conditional variance is a function of the lagged values of forecast error and the conditional variance. Beside Bollerslev (1986), there are several studies which have modeled inflation uncertainty through GARCH frameworks, such as Bruner and Hess (1993) for US CPI data, Joyce (1995) for UK retail prices, Della Mea and Peña (1996) for Uruguay, Corporal and McKiernan (1997) for the annualized US inflation rate, Grier and Perry (1998) for G-7 countries, Grier and Grier (1998) for Mexican inflation, Magendzo (1998) for inflation in Chile, Fountas et al. (2000) for G-7 countries, and Kontonikas (2004) for the UK. All these studies modeled have inflation uncertainty through the GARCH model in some way.

The major drawback of the ARCH or GARCH models is that both models assume the symmetric response of conditional variance (uncertainty) to positive and negative shocks. However, it has been argued that the behavior of inflation uncertainty is asymmetric rather than symmetric. Brunner and Hess (1993), Joyce (1995), Fountas et al. (2006), and Bordes et al. (2007) are of the view that positive inflation shocks increase inflation uncertainty more than negative inflation shocks of equal magnitude. If this is correct, the symmetric ARCH and GARCH models might provide misleading estimates of inflation uncertainty (Crawford and Kasumovich, 1996). The three most commonly used GARCH formulations to capture the asymmetric behavior of conditional variance, are the GJR or threshold GARCH (TGARCH) models of Glosten, Jagannathan, and Runkle (1993) and Zakoïan (1994), the asymmetric GARCH (AGARCH) model of Engle and Ng (1993), and the exponential GARCH (EGARCH) model of Nelson (1991).

The second objective of this study is to model and analyze the asymmetric behavior of inflation uncertainty in Pakistan, if it exists. We use the GRJ-GARCH and EGARCH models to capture leverage effects and also estimate the "news impact curve" for further analysis of the asymmetric behavior of inflation uncertainty.

The third objective of this study is to determine causality and its direction between inflation and inflation uncertainty, using the bivariate Granger causality test. This is carried out to determine which inflation uncertainty hypothesis (Friedman-Ball or Cukierman-Meltzer) holds for Pakistani data. We follow the two-step procedure suggested by Grier and Perry (1998), in which they first estimate conditional variance by GARCH and component GARCH methods and then conduct the Granger causality test between these conditional variances and the inflation series.

This paper is a first attempt to measure and analyze inflation uncertainty in Pakistan and it makes several contributions to the literature. We model inflation uncertainty as time varying conditional variance through the GARCH framework. Following Fountas and Karanasos (2007) and Bordes and Maveyraud (2008), we also extract inflation uncertainty using the GJR-GARCH (TGARCH) and EGARCH models to analyze and capture the asymmetric behavior of inflation uncertainty (leverage effects), if it exists. We also present "news impact curves" as proposed by Pagan and Schwart (1990) for different GARCH models to estimate the degree of asymmetry of volatility to positive and negative shocks of previous periods. Finally, we test the Friedman-Ball and Cukierman-Meltzer inflation uncertainty hypotheses using the bivariate Granger causality test.

The paper is organized as follows: A description of the data and preliminary analysis of time series is provided in Section 2; Section 3 presents the theoretical framework; Section 4 provides estimation and results. Section 5 concludes the study.

2. Description and Preliminary Analysis of Data

2.1. Data Set

Data availability and authenticity of available data are among the major hurdles one faces when working on Pakistan. There are two possible sources of data with reference to Pakistan: internal sources, which include the State Bank of Pakistan and the Federal Bureau of Statistics, and external sources, which include the IMF, World Bank, and other databases. For this

paper, we have taken all data from the IMF's International Financial Statistics database due to its relatively broader coverage of different time series variables. The following variables are included in our data set.

Table-1: Variables Used

DATA	IFS Series
CPI	ifs:s56464000zfq
GDP (Nominal)	ifs:s56499b00zfa
GDP Deflator	ifs:s56499bipzfa
M2	ifs:s56435l00zfq

Our sample ranges from 1976:1 to 2008:2. We use quarterly data because of its additional relevance and usability in the context of inflation in less developed countries as observed by Ryan and Milne (1994) and calculated quarterly growth rates on a Year-on-Year (Y-o-Y) basis for different variables by taking the fourth lagged difference of their natural logarithms. In other words, we calculate the percentage change in the concerned variable with its value from the corresponding quarter in the previous year.

$$Quarterly\ Growth\ Rate\ of\ \mathrm{Y}_t on\ Year - on - Year\ Basis = \ln\mathrm{Y}_t - \ln\mathrm{Y}_{t-4}$$

Where t represents Number of Quarters of Each Year

There are several advantages to using this method for the calculation of growth rates as compared to traditional annualized Quarter-on-Quarter (Q-o-Q) growth rates. Most importantly, growth rates calculated on a Y-o-Y basis are implicitly seasonally adjusted as each quarter is compared with the corresponding quarter in the previous year, thus growth rates not only show the underlying trend but remain sensitive to irregular shocks as well as capable of capturing deviations from expected seasonal behavior (Cheem, 2003).

Four different types of price indicators are available in Pakistan: the consumer price index (CPI), wholesale price index (WPI), sensitive price index SPI), and GDP deflator. For our analysis, we choose the CPI as it represents the cost of living in Pakistan more accurately and because it has been regularly updated in its composition and calculations (Bokhari and Faridun, 2006).

2.2. Descriptive Statistics of Data

Using quarterly CPI data obtained from IFS, we calculate quarterly inflation on a Y-o-Y basis. Figure 1 shows clearly that inflation in Pakistan has been constantly high (above 5 percent) except for a very short period between 1982 and 1984, and 1999 and 2003. There is also a clear increasing trend in inflation from 2003 onward, which becomes extremely sharp near the end of our sample (2008Q2).

Figure 1: Graphical Representation of Inflation, M2 Growth and Real GDP Growth

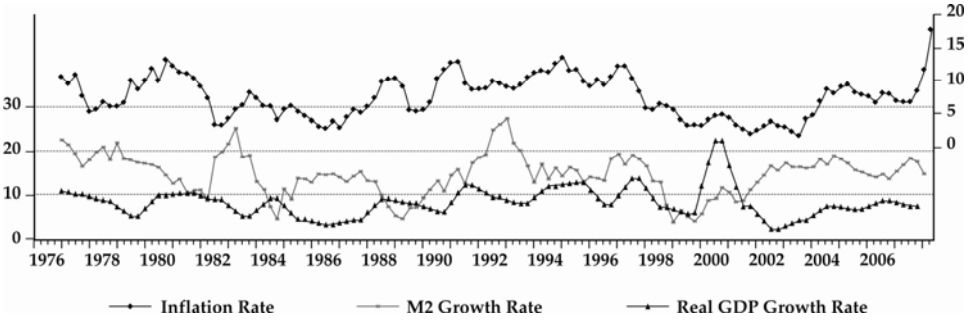


Table-2 provides descriptive statistics of the variables concerned, showing high variability in all three variables, despite the implicit smoothing built into the calculation of Y-o-Y rates. We are unable to reject the null of normality under Jarque-Bera statistics for inflation and the M2 growth rate, but we can reject the same for RGDP growth with high significance. The non-normal distribution of RGDP growth is also evident from the values of its skewness and kurtosis, which are higher than the normal benchmarks of 0 and 3, respectively.

Table-2: Descriptive Statistics of Variables

	INFLATION	M2_GROWTH	RGDP_GROWTH
Mean	7.54	14.62	8.41
Median	7.41	14.78	8.17
Maximum	17.69	27.25	22.23
Minimum	1.76	3.93	2.43
Std. Dev.	3.13	4.66	3.32
Skewness	0.23	-0.14	1.23
Kurtosis	2.52	3.08	6.64
Jarque-Bera	2.30	0.42	99.62
Probability	0.32	0.81	0.00
Observations	126	125	124

2.3. Stationarity of Variables and Preliminary Cointegration Analysis

To check the order of integration in the considered time series, we conduct unit root tests in this section. The Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) tests were used and the results (Table 3) show that inflation is seriously affected by the problem of unit roots, and is thus nonstationary. On the other hand, for M2 growth, we have strong evidence rejecting the presence of the unit root, forcing us to believe its behavior to be stationary. The values of the Durbin-Watson statistic also strengthen our conclusion about the stationarity of M2 growth. However, the results for real GDP growth are somewhat ambivalent. The ADF test clearly rejects the possibility of its stationarity, showing strong presence of the unit root. However, the Phillips-Perron test rejects the null of the unit root at 10% and 5% but this rejection is questionable due to the low values of the Durbin-Watson statistics, pointing to the possible deterioration of results due to serial correlation. Interestingly, if we rely on the Kwiatkowski-Phillips-Schmidt-Shin (KPSS) test to check the stationarity of inflation, M2 growth, and real GDP growth, we do not have enough evidence to reject the null hypotheses of stationarity for all variables (results not reported), which is contradictory to the results of the ADF and PP tests for inflation and real GDP growth.

Table-3: Unit Root Testing

INFLATION	**Statistic**	**Prob**	**Lags/ BW**	**AIC**	**SIC**	**DW Stats**
ADF (constant term)	-1.52	0.52	4(SIC)	3.40	3.54	1.79
ADF (constant, trend)	-1.37	0.86	4(SIC)	3.41	3.58	1.80
PHILLIPS PERRON (constant term)	-2.20	0.21	6	3.60	3.65	1.34
PHILLIPS PERRON (constant, trend)	-1.92	0.64	7	3.61	3.67	1.36
MONEY GROWTH	**Statistic**	**Prob**	**Lags/ BW**	**AIC**	**SIC**	**DW Stats**
ADF (constant term)	-3.56	0.01	4(SIC)	4.47	4.61	2.01
ADF (constant, trend)	-3.55	0.04	4(SIC)	4.49	4.65	2.01
PHILLIPS PERRON (constant term)	-3.34	0.01	1	4.62	4.67	2.01
PHILLIPS PERRON (constant, trend)	-3.29	0.07	1	4.64	4.71	2.01
RGDP GROWTH	**Statistic**	**Prob**	**Lags/ BW**	**AIC**	**SIC**	**DW Stats**
ADF (constant term)	-2.46	0.13	6(SIC)	2.37	2.56	1.94
ADF (constant, trend)	-2.48	0.34	6(SIC)	2.39	2.60	1.94
PHILLIPS PERRON (constant term)	-3.30	0.02	6	3.62	3.67	0.66
PHILLIPS PERRON (constant, trend)	-3.30	0.07	6	3.64	3.71	0.66

Note: ***,**,* respectively indicates rejection of the null at 1%, 5% and 10% significance levels.

The above mentioned results prompt us to conduct a cointegration test, under the assumption of I(1) covariance stationarity of all variables to estimate any long-run relationship among them.

Table-4: Johansen Cointegration Test for $\pi, M2G$ and RG

No. of Cointegrating Vectors under the Null Hypothesis	Trace Test			Maximum Eigenvalue Test		
	λ_{trace}	5% Critical Value	Prob.	λ_{max}	5% Critical Value	Prob.
None	44.54	35.19	0.0037	22.67	22.30	0.04
At most 1	21.87	20.26	0.03	18.04	15.89	0.02
At most 2	3.83	9.16	0.44	3.83	9.16	0.44

The Johansen test statistics (Table 4) reject the null hypothesis of no cointegrating vectors under both the trace and maximal eigenvalue forms of the test. Moving on to test the null of at most one cointegrating vector, the trace statistic is 21.87, while the 5% critical value is 20.26, so the null is just rejected at 5% (and not at 1%). Finally, examining the null that there are at most two cointegrating vectors, the trace statistic is now well below the 5% critical value, suggesting that the null should not be rejected, i.e., there are at most two cointegrating vectors ($1 \leq r \leq 2$).

We also apply Engle-Granger (EG) approach to testing the cointegrating relationship among variables, according to which the equilibrium errors of the cointegrating regression must be stationary for the variables to be cointegrated in the long run.

$$\pi_t = \lambda + \theta M2G_t + \varphi RG_t + \varepsilon_t \quad (1)$$

The estimated long-run coefficients of $M2G_t$ and RG_t calculated from Equation 1 are reported in Table-5.

Table-5: Regression Results of Equation (1)

Variables	Coefficients
Constant	2.116**
M2 growth rate ($M2G$)	0.168***
Real GDP growth rate (RG)	0.339***
Adjusted R-Square	0.183
D-W stat	0.286
Akaike info criterion	4.86
Schwartz info criterion	4.924
F-statistics	14.79***

Note: ***,**,* respectively indicates rejection of the null at 1%, 5% and 10% significance levels.

Unit root tests of ε_t, obtained from Equation 1 are given in Table-6, indicating that the residuals of the cointegrating regression are I(0) according to the ADF and PP tests at 10% and 5%, respectively. However, we cannot reject the presence of the unit root in the residuals of the cointegrating regression if we introduce a trend term.

Table-6: Unit Root Test for Residuals of Cointegrating Regression

	Statistic
ADF (constant)	-2.61*
ADF (constant, trend)	-2.71
PHILLIPS PERRON (constant)	-3.03**
PHILLIPS PERRON (constant, trend)	-3.02

Note: ***,**,* respectively indicates rejection of the null at 1%, 5% and 10% significance levels.

3. Inflation Uncertainty Framework

In this section, we discuss the ARCH model and its extensions (GARCH, asymmetric GARCH [AGARCH], threshold GARCH [TGARCH], and exponential GARCH [EGARCH]) to analyze the relationship between inflation and inflation uncertainty. The formal presentation of the ARCH(q) model given by Engel (1982) is:

$$\pi_t|\psi_{t-1} \sim N(\kappa X_{t-1}, h_t) \quad (2)$$

$$E_{t-1}\varepsilon_t^2 = h_t = \alpha_o + \sum_{i=1}^{q} \alpha_i \varepsilon_{t-i}^2 \quad (3)$$

Equation 2 represents the conditional mean of inflation at time t, which depends on the information set at time period t-1 (ψ_{t-1}). Equation 3 is the conditional variance of unanticipated shocks to inflation which is equal to $\varepsilon_t = \pi_t - \kappa X_{t-1}$ and is actually the expected value of conditional variance at time t-1, conditioned on the information set available at time t-1.

If $\alpha_1 = \alpha_2 = \alpha_3 = \alpha_q = 0$ then the conditional variance of errors is constant. However, to allow conditional variance as a time varying measure of inflation uncertainty (presence of ARCH), at least one of the $\alpha_i \geq 0$ where $(i = 1,2, \ldots\ldots, q)$. By applying the restriction $\sum_{i=1}^{q} \alpha_i < 1$ we ensure that the ARCH process is covariance stationary. The non-negativity of all ARCH parameters α_i is a sufficient but not necessary condition to ensure that the conditional variance does not become negative.

However, evidence of long lag processes of squared residuals in the ARCH model suggest that shocks have persistence affects on inflation uncertainty, thus Bollerslev (1986) and Taylor (1986) independently suggest the alternative GARCH approach to modeling persistence, according to which the linear GARCH (p, q) process in Equation 4 represents the conditional variance of inflation forecast error, which is a function of the lagged values of both one-period forecast error and the conditional variance.

$$h_t = \alpha_o + \sum_{i=1}^{q} \alpha_i \varepsilon_{t-i}^2 + \sum_{j=1}^{p} \beta_j h_{t-j} \quad (4)$$

Where $\alpha_o > 0, \alpha_i \geq 0$ and $i = 1,2, \ldots\ldots, q$

$\beta_j \geq 0$ and $j = 1,2, \ldots\ldots, p$

GARCH is more economical than ARCH as it has only three parameters and allows an infinite number of past squared errors to influence the current conditional variance (Brooks, 2002). It is also less likely to breach nonnegativity constraints, but the primary restriction of GARCH is that it enforces a symmetric response of volatility to positive and negative shocks. According to Brunner and Hess (1993) and Joyce (1995), a positive inflation shock is more likely to increase inflation uncertainty via the monetary policy mechanism, as compared to a negative inflation shock of equal size. If this is true, then we cannot rely on estimates of the symmetric ARCH and GARCH models and will have to go for the

asymmetric GARCH models. Two popular asymmetric formulations are the GJR model and the EGARCH model proposed by Nelson (1991).

GJR-GARCH is simply an extension of GARCH (p, q) with an additional term to capture possible asymmetries (leverage effects). The conditional variance is now

$$h_t = \alpha_o + \alpha_1 \varepsilon_{t-1}^2 + \beta_1 h_{t-1} + \gamma \varepsilon_{t-1}^2 I_{t-1} \tag{5}$$

Where I_{t-1}= 1, if $\varepsilon_{t-1} < 0$, otherwise I_{t-1}= 0. If the asymmetry parameter γ is negative then negative inflationary shocks result in the reduction of inflation uncertainty (Bordes et al. 2007).

There are various ways of expressing the conditional variance equation, but one possible specification is

$$logh_t = \alpha_o + \sum_{j=1}^{q} \beta_j \, logh_{t-j} + \sum_{i=1}^{p} \alpha_i \left| \frac{\varepsilon_{t-i}}{\sqrt{h_{t-i}}} \right| + \sum_{k=1}^{r} \gamma_k \frac{\varepsilon_{t-k}}{\sqrt{h_{t-k}}} \tag{6}$$

The EGARCH model has several advantages over the traditional ARCH and GARCH specifications. First, the variance specification represented in Equation 6 makes it possible to capture the asymmetric effects of good news and bad news on volatility, which is preferable in the context of inflation and inflation uncertainty. Second, since $logh_t$ is modeled, then even in the presence of negative parameters, h_t will be positive, thus relieving the nonnegativity constraints artificially imposed on GARCH parameters.

4. Estimation and Results

4.1. Construction of Mean Equation

Though the initial unit root tests and cointegration analysis show that π_t, $M2G_t$ and $RG_t$are stationary and might be cointegrated in the long run, the results are not highly significant and we have equal reason (rejection of null of unit root at 10% significance level) to formulate a model in the original form of variables instead of their detrended series. We choose to model inflation in autoregressive distributed lag (ADL) form:

$$\delta(L)\pi_t = \lambda + \theta(L)M2G_t + \varphi(L)RG_t + \varepsilon_t \tag{7}$$

Where $\delta(L)$, $\theta(L)$, and $\varphi(L)$ are appropriate lag polynomials of π_t, $M2G_t$, and RG_trespectively. There is strong evidence that inflation in Pakistan is a

monetary phenomenon. Qayyum (2006) and Kemal (2006) suggest that excess money supply growth has been a significant contributor to the rise in inflation in Pakistan. Khalid (2005) uses bivariate VAR analysis to conclude that seigniorage and money depth can be considered major determinants of inflation in Pakistan. Ahmad et al. (1991) finds that the major determinants of inflation include lagged inflation and nominal money growth. In an IMF working paper, Schimmelpfennig et al. (2005) has developed three different models to forecast inflation: the univariate model (ARIMA-based), unrestricted VAR model, and leading indicators model (LIM). They found the LIM based on broad money growth, private sector credit growth and lags in inflation worked best for ex-post inflation forecasts in Pakistan. π_t and $M2G_t$ have a correlation of 0.23 which increases to 0.29, 0.34 and 0.36 if we take $M2G_{t-1}$, $M2G_{t-2}$and $M2G_{t-3}$ respectively instead of $M2G_t$, which clearly indicates the transmission delay in monetary stance, thus making us more confident about the selection of the ADL model. In this scenario we expect θs to be positive and significant.

The bidirectional relationship between inflation and growth is widely accepted. However, according to the classical quantity theory of money, under the assumption of constant velocity and M2 growth, real GDP growth should have a negative impact on inflation. Domac and Elbrit (1998) carried out a cointegration analysis and developed an ECM for Albanian data, finding evidence to support classical supply shocks theory, which shows that growth, through structural reforms and improved infrastructure, can significantly reduce inflation. Handerson (1999), Becker and Gordon (2005), Murphy (2007), and Robert McTeer (2007) are among many who strongly believe that increasing growth leads to the strong impact of inflation in an opposite direction. Recently in 2008, the ECB's and Bundesbank presidents said that, "Slowing growth may not be sufficient to reduce inflation in Eurozone," thus negating the positive relationship between inflation and growth. Therefore, despite obtaining a strong, positive, and significant relationship between π_t and RG_t from the cointegrating regression (Equation 1), we still expect a negative sign for φs in our model explaining the negative impact of supply shocks on inflation, especially with lagged values of RG_t.

The reason for including an autoregressive term $\delta(L)\pi_t$ is straightforward. Inflation, like many other economic variables, has shown strong inertia in various studies. There may be many reasons for this inertia, such as the inability of market agents to interpret and respond in a timely manner after the arrival of a particular announcement or news, or the probability of uncertainty linked to that news, or the overreaction

of market participants following herd behavior. In case of the presence of strong inflationary inertia, as is evident from many studies, we expect δs to be positive and highly significant.

The optimal number of lags is obtained by using Akaike and Schwartz's information criteria (AIC) and BIC. In this case, it is 1, both for the autoregressive term and distributed lag term. Thus, we finalize the ADL (1, 1) model to estimate mean inflation.

$$\pi_t = \lambda + \delta_1 \pi_{t-1} + \theta_1 M2G_{t-1} + \varphi_1 RG_{t-1} + \varepsilon_t \quad (8)$$

Regression results for Equation 8 are reported in Table-7:

Table-7: Regression Results of ADL (1, 1) Model

Variables	**Coefficients**
λ	0.335
δ_1	0.898***
θ_1	0.058**
φ_1	-0.0497
Adjusted R-Square 0.8103	AIC = 3.41, BIC = 3.501
F-Statistic 176.15***	DW-Stat 1.588
Breusch-Godfrey Serial Correlation LM Test: Lag 4 = 20.13***	ARCH LM Test: Lag 4 = 6.24

Note: ***,**,* respectively indicates rejection of the null at 1%, 5% and 10% significance levels.

Due to the presence of significant serial correlation in the residuals of the above model as indicated by the Breusch-Godfrey test and Ljung-Box Q statistics, we introduce AR (1) and AR (4) error terms in Equation 7. Lag orders of the error term are identified through the partial autocorrelogram function (PAF) of residuals. So the model becomes:

$$\pi_t = \lambda + \delta_1 \pi_{t-1} + \theta_1 M2G_{t-1} + \varphi_1 RG_{t-1} + u_t$$

$$u_t = \rho_1 u_{t-1} + \rho_4 u_{t-4} + \varepsilon_t \quad (9)$$

Table-8: Results of Equation 9

Variables	Coefficients
λ	0.1303
δ_1	0.929***
θ_1	0.051**
φ_1	-0.038
ρ_1	0.168*
ρ_4	-0.374***
Adjusted R-Square 0.850537	AIC=3.203545, BIC=3.343
F-Statistic 136.44***	DW-Stat 1.91
Breusch-Godfrey Serial Correlation LM Test: Lag 4=5.76	ARCH LM Test: Lag 4=5.14

Note: ***,**,* respectively indicates rejection of the null at 1%, 5% and 10% significance levels.

After introducing AR specification of residuals, we find no evidence of serial correlation in the DW Stat, Breusch-Godfrey test, and Ljung Box Q-Statistics (reported in Table-9). The R-square term also improves by about 4% due to the inclusion of autoregressive components of errors.

Table-9: Q-Stat Table for Residuals

Lag	Q-Stat	Prob.
3	0.75	0.39
5	2.18	0.54
10	5.13	0.74
15	14.80	0.32
20	19.23	0.38
25	20.99	0.58
30	22.75	0.75
35	25.97	0.803

4.2. Estimation of Uncertainty

As far as the variance equation is concerned, we do find any ARCH model from ARCH(1) to ARCH(4) with significant estimated parameters along with conformity of constraints imposed on ARCH(p) process. Thus, we decide to opt for GARCH estimation. Table 10 provides the results of two different models.

Table-10: GARCH Estimates of Conditional Variance

	Model 1	**Model 2**
Mean Equation		
Variables	**GARCH (1, 1)**	**GARCH (1, 1)**
λ	0.148	-0.235
δ_1	0.937***	0.936***
θ_1	0.046*	0.048**
φ_1	-0.031	
ρ_1	0.176	0.202*
ρ_4	-0.411784***	-0.419***
Variance Equation		
α_o	1.645***	0.208
α_1	0.235*	0.315***
β_1	-0.438	0.609***
γ		
R-Square	0.85	0.83
DW Stat	1.93	1.69
Akaike criterion	3.21	3.32
Schwarz criterion	3.424	3.501
F-Stat	82.503***	85.387***

Note: ***,**,* respectively indicates rejection of the null at 1%, 5% and 10% significance levels.

4.3. Tests for Asymmetries in Volatility

Engle and Ng (1993) have devised a set of tests to confirm the asymmetry present in volatility, if any. These tests are generally known as sign and size bias tests. We use these tests to determine whether an asymmetric model is required to capture inflation uncertainty or whether the GARCH model is an adequate model.

We apply the sign and size bias tests to the residuals of GARCH (1, 1) (Model 2), whose mean and variance equations are given below.

Mean Equation:

$$\pi_t = \lambda + \delta_1 \pi_{t-1} + \theta_1 M2G_{t-1} + u_t$$

$$u_t = \rho_1 u_{t-1} + \rho_4 u_{t-4} + \varepsilon_t$$

Variance Equation:

$$h_t = \alpha_o + \sum_{i=1}^{q} \alpha_i \varepsilon_{t-i}^2 + \sum_{j=1}^{p} \beta_j h_{t-j}$$

Where $\alpha_o > 0, \alpha_i \geq 0$ and $i = 1,2, \ldots \ldots, q$

$\beta_j \geq 0$ and $j = 1,2, \ldots \ldots, p$

The test for sign bias is based on the significance or otherwise of ϕ_1 in equation 10.

$$\hat{\varepsilon}_t^2 = \phi_o + \phi_1 S_{t-1}^- + v_t \qquad (10)$$

$S_{t-1}^- is\ 1\ if\ \varepsilon_{t-1} < 0$ and 0 otherwise

Where v_t is an iid error term. If positive and negative inflation shocks have different impacts on conditional variance, then ϕ_1 will be statistically significant.

It is most likely, especially in the case of inflation, that the magnitude or size of the inflation shock will have an effect whether or not the response of volatility to a shock is symmetric. Engle and Ng originally suggested a negative sign bias test, based on a regression where S_{t-1}^- is

now used as a slope dummy variable. Negative sign bias is argued to be present if ϕ_1 is statistically significant in Equation 11.

$$\hat{\varepsilon}_t^2 = \phi_o + \phi_1 S_{t-1}^- \varepsilon_{t-1} + v_t \quad (11)$$

However we made little change in that and conducted the above test as positive sign bias test additionally.

$$\hat{\varepsilon}_t^2 = \phi_o + \phi_1 S_{t-1}^+ \varepsilon_{t-1} + v_t \quad (12)$$

$S_{t-1}^{\mp} is\ 1\ if\ \varepsilon_{t-1} > 0$ and 0 otherwise

Finally setting $S_{t-1}^+ = 1 - S_{t-1}^-$ so that S_{t-1}^+ would become the dummy to capture positive inflation shocks, Engle and Ng (1993) proposed a joint test for size and sign bias based on following regression:

$$\hat{\varepsilon}_t^2 = \phi_o + \phi_1 S_{t-1}^- + \phi_2 S_{t-1}^- \varepsilon_{t-1} + \phi_3 S_{t-1}^+ \varepsilon_{t-1} + v_t \quad (13)$$

The significant value of ϕ_1 in Equation 13 indicates the presence of sign bias, i.e., positive and negative inflation shocks have different impacts on future uncertainty. On the other hand, significant values of ϕ_2 and ϕ_3 suggest the presence of size bias, where both the sign and magnitude of shock are important. A joint test statistic is TR^2 which will asymptotically follow a χ^2 distribution with three degrees of freedom under the null hypothesis of no asymmetric effects.

Table-11: Tests for Asymmetries in Volatility

	Sign Bias Test Eq. 10	**Negative Sign Bias Test Eq. 11**	**Positive Sign Bias Test Eq. 12**	**Joint test for Sign and Size Bias Eq. 13**
ϕ_o	1.901***	1.68***	1.001***	0.48
ϕ_1	-0.66	0.22	1.23***	0.56
ϕ_2				-0.23
ϕ_3				1.57***
TR^2				8.92**

The individual regression results of the sign bias test and negative sign bias test does not reveal any evidence of asymmetry as the value of ϕ_1 is insignificant. But we can see that the coefficient indicating positive sign bias is significant in individual as well as joint tests. Although none

of the other coefficients except ϕ_2 are significant in the joint regression, the χ^2 test statistic is significant at 5%, suggesting a rejection of the null hypothesis of no asymmetries.

The above results lead us to opt for asymmetric GARCH models instead of symmetric and in Table-12 we report the results of three asymmetric GARCH models.

Table-12: GJR-GARCH and EGARCH Estimations of Conditional Variance

	Model 3	Model 4	Model 5
Variables	**GJR-GARCH**	**GJR-GARCH**	**EGARCH**
$\boldsymbol{\lambda}$	-0.024	-0.237	0.066
$\boldsymbol{\delta_1}$	0.913***	0.914***	0.917***
$\boldsymbol{\theta_1}$	0.064**	0.063	0.054***
$\boldsymbol{\varphi_1}$	-0.0301		-0.036*
$\boldsymbol{\rho_1}$	0.204**	0.188	0.161***
$\boldsymbol{\rho_4}$	-0.425***	-0.339855**	-0.402***
$\boldsymbol{\lambda}$	0.415*	1.437	0.22
$\boldsymbol{\delta_1}$	0.071	0.078	0.265***
$\boldsymbol{\theta_1}$	0.672***	0.478	-0.954***
$\boldsymbol{\varphi_1}$	-0.151	-0.293**	0.14**
R-Square	0.84	0.83	0.843
DW Stat	1.93	1.65	1.844
Akaike criterion	3.22	3.49	3.16
Schwarz criterion	3.45	3.7	3.4
F-Stat	71.5***	73.4***	71.8***

Note: ***,**,* respectively indicates rejection of the null at 1%, 5% and 10% significance levels.

Results from GJR-GARH (Models 3 and 4) confirm that these models are successful in modeling the asymmetric (leverage) effects of lagged inflation shocks on one period ahead of conditional variance. From both models, we obtain the negative values of γ as expected, thus

concluding that negative inflation shocks (good news) reduce inflation uncertainty. On the other hand, the value of γ is positive and significant in EGARCH estimation (Model 5) suggesting that when there is an unexpected increase in inflation, resulting in positive inflation shocks (bad news), inflation uncertainty increases more than when there is an unanticipated decrease in inflation.

4.4. News Impact Curves

To further investigate the asymmetric behavior of inflation uncertainty, we have analyzed the effect of news on volatility or inflation uncertainty with the help of news impact curves. By keeping constant all the information at t-2 and earlier, we can examine the implied relation between ε_{t-1} and h_t which we called a news impact curve. This is a pictorial representation of the degree of asymmetry of volatility to positive and negative shocks and it plots the next period uncertainty h_t that will arise from various positive and negative values (news) of past inflation shocks (ε_{t-1}) (Pagan and Schwert, 1990). For the GARCH model, this curve is a quadratic function centered at $\varepsilon_{t-1} = 0$.. Equations for the news impact curve for the GARCH, GJR-GARCH and EGARCH models are provided in Table-13.

Table-13: News Impact Curve for different GARCH processes

GARCH(1,1)	$h_t = A + \alpha_1 \varepsilon_{t-1}^2$ Where $A = \alpha_o + \beta_1 \bar{\sigma}^2$ And $\bar{\sigma}^2 = \alpha_o / [1 - \alpha_1 - \beta_1]$
GJR-GARCH(1,1) **Or** **TGARCH(1,1)**	$h_t = A + (\alpha_1 + \gamma_1 I_{t-1}) \varepsilon_{t-1}^2$ Where $A = \alpha_o + \beta_1 \bar{\sigma}^2$ And $\bar{\sigma}^2 = \alpha_o / [1 - \alpha_1 - \beta_1 - \left(\frac{\gamma_1}{2}\right)]$
EGARCH(1,1)	$h_t = A \exp\left\{\frac{\alpha_1(\lvert\varepsilon_{t-1}\rvert + \gamma_1 \varepsilon_{t-1})}{\bar{\sigma}}\right\}$ Where $A = \bar{\sigma}^{2\beta_1} \exp\{\alpha_o\}$ $\bar{\sigma}^2 = \exp\left\{\frac{\alpha_o + \alpha_1\sqrt{2/\pi}}{1 - \beta_1}\right\}$

Source: Eric Zevot (2008), "Practical Issues in the Analysis of Univariate GARCH Models".

Where $h_t$is the conditional variance at time t, ε_{t-1} is the inflation shock at time t-1, $\bar{\sigma}$ is the unconditional standard deviation of inflation shocks, α_o and β_1 are the constant term and parameter corresponding to h_{t-1} in GARCH variance equation respectively.

The resulting news impact curves for GARCH, GJR-GARCH and EGARCH models are given in Figure-5.

Figure 5(a)

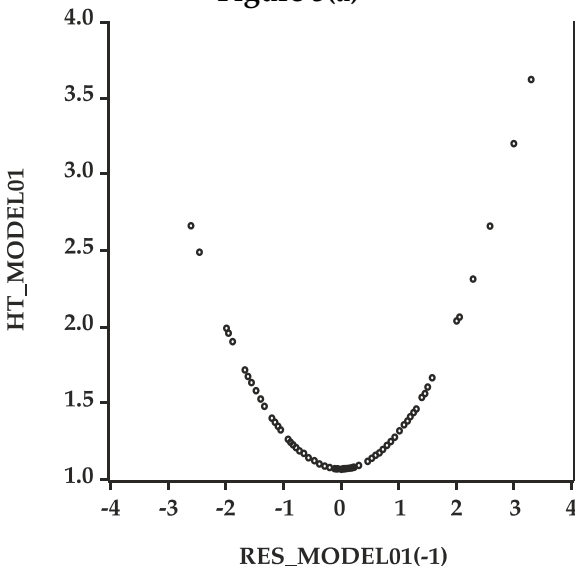
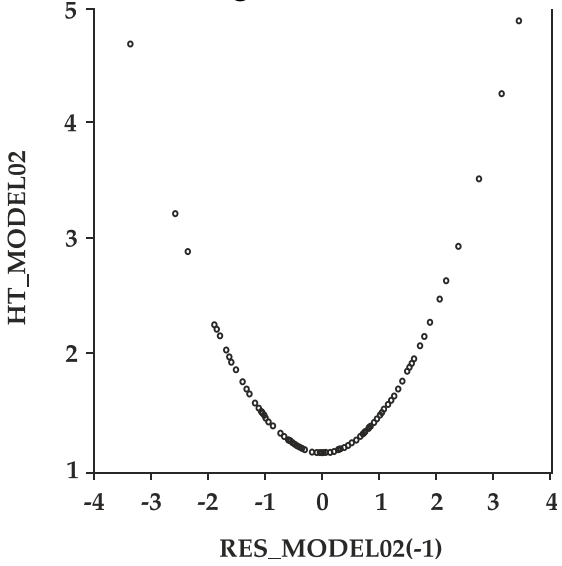


Figure 5(b)



It can be seen in Figures 5(a) and 5(b), that the GARCH news impact curves are symmetrical at about zero, so that a shock of given magnitude will have the same impact on future volatility, irrespective of its sign. On the other hand GJR news impact curves (Figures 5(c) and 5(d)) are asymmetric where negative inflation shocks reduce future volatility exactly as was described in Equation 5.

Figure 5(c)

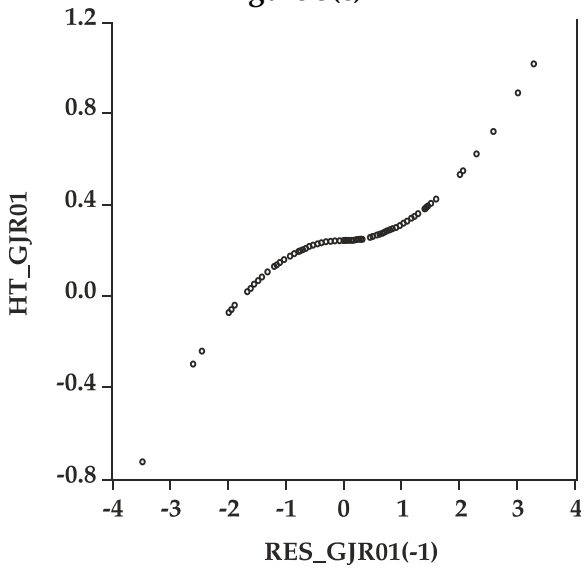


Figure 5(d)

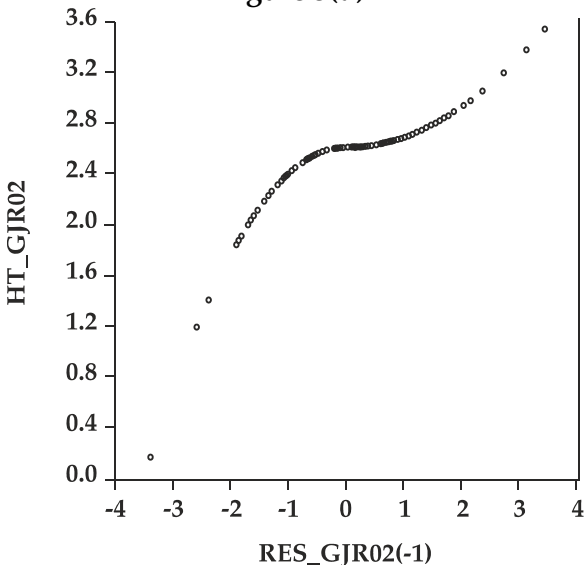


Figure 5(e)

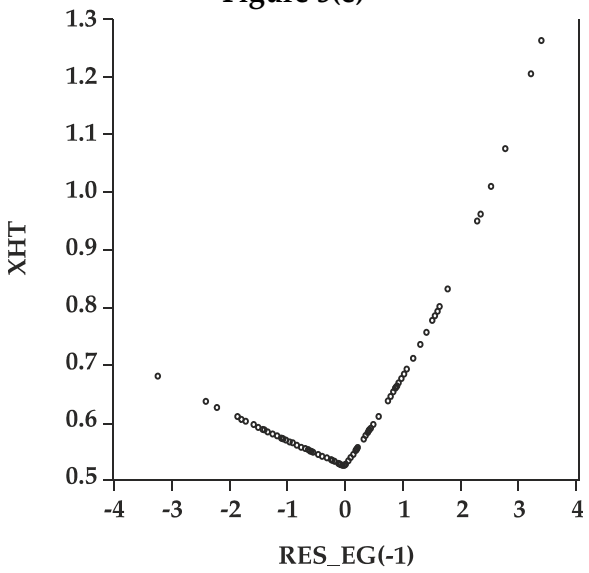


Figure 5(e) is also in accordance with our expectations; we see that an unexpected increase in inflation (positive inflation shocks) increases volatility more than when there is a decrease in inflation, that is, what we can also interpret from the positive and significant value of γ reported for the EGARCH model in Table-12.

4.4. Testing of Friedman-Ball Hypothesis (Granger Causality)

In order to assess the Friedman-Ball and Cukierman-Meltzer hypotheses, we implement the bivariate Granger causality test up to 10 lags, between inflation and inflation uncertainty (one period ahead of conditional forecast of variance) derived from models 1 to 5. The results for the GARCH models (models 1 and 2) are reported in Table-14(a). We report only p-values for Wald statistics for the null hypothesis that inflation does not cause uncertainty in the first column and that uncertainty does not cause inflation in the second column for each model. The results reported in Table-14(a) are not very encouraging and reject both the Friedman-Ball and Cukierman-Meltzer hypotheses. It appears that neither inflation nor inflation uncertainty causes the other.

Table-14(a): Granger Causality Test (P-values of Wald Statistics)

Lags	GARCH (Model 01)		GARCH (Model 02)	
	π *does not cause* h_t	h_t *does not cause* π	π *does not cause* h_t	h_t *does not cause* π
1	0.269	0.726	0.089	0.620
2	0.565	0.256	0.077	0.725
3	0.734	0.390	0.189	0.518
4	0.642	0.464	0.092	0.296
5	0.915	0.301	0.171	0.125
6	0.951	0.127	0.295	0.104
7	0.484	0.188	0.428	0.210
8	0.619	0.370	0.452	0.180
9	0.423	0.532	0.317	0.213
10	0.436	0.317	0.374	0.211

However, the results reported in Table-14(b) for GJR-GARCH (models 3 and 4) and EGARCH (model 5) are consistent and strongly reject the null that inflation does not cause uncertainty, thus supporting the Friedman-Ball hypothesis.

Table-14(b): Granger Causality Test (P-values of Wald Statistics)

Lags	GJR-GARCH (Model 03)		GJR-GARCH (Model 04)		EGARCH (Model 05)	
	π *does not cause* h_t	h_t *does not cause* π	π *does not cause* h_t	h_t *does not cause* π	π *does not cause* h_t	h_t *does not cause* π
1	2.6E-05	0.418	0.004	0.634	0.001	0.074
2	2.2E-25	0.846	3.0E-17	0.544	9.9E-08	0.025
3	4.3E-27	0.841	7.4E-20	0.175	1.5E-08	0.071
4	1.3E-27	0.001	9.4E-24	0.086	1.2E-08	0.004
5	6.7E-33	0.948	1.2E-25	0.9998	4.9E-08	0.277
6	1.5E-35	0.393	4.7E-26	0.858	2.1E-09	0.527
7	1.4E-33	0.084	2.5E-25	0.691	7.5E-08	0.177
8	1.7E-32	0.185	1.2E-23	0.081	1.4E-07	0.214
9	1.4E-30	0.029	1.3E-22	0.166	3.7E-06	0.451
10	9.3E-32	0.12	1.6E-23	0.339	1.3E-05	0.456

5. Policy Implications

The above analysis provides many insights for policymakers regarding inflation and inflation uncertainty. Most important is the recognition of asymmetric behavior in inflation uncertainty, which is captured by the GJR-GARCH and EGARCH models and can be viewed with the help of corresponding news impact curves (Figures 5c to 5e). This identification of asymmetry is extremely important for monetary authorities and highlights the importance of inflation stabilization programs or inflation targeting policies, which, if successful in reducing the inflation level, could eventually reduce the next period price volatility (Jonhson, 2002). It is also worth noting that both asymmetric specifications (GJR-GARCH and EGARCH) strongly support the Friedman-Ball hypothesis, leading us to believe that higher inflation rates lead to a higher level of uncertainty, which could negatively affect the economy through financial markets, decision variables, and productive vs. protective strategy channels, thus potentially curbing real economic activity. However, as mentioned earlier, the successful implementation of inflation stabilization programs can equally reduce the next period uncertainty due to the presence of causality running between inflation and inflation uncertainty (Friedman-Ball hypothesis).

The strong rejection of the Cukierman-Meltzer hypothesis implicitly rejects the so-called stabilizing hypothesis by Holland (1995), which says that high inflation uncertainty can have a negative causal impact on succeeding average inflation rates because the natural stance of policymakers, in the presence of high inflation and high uncertainty, would be to contract the growth of the money supply, which could reduce average inflation rates in upcoming periods. This should draw the attention of policymakers, especially in the context of Pakistan. We have already established that, because of the simultaneous existence of asymmetry and causality running from inflation to inflation uncertainty, Pakistan strongly needs stabilization programs to keep the welfare cost of inflation as low as possible by curbing inflation when there is higher inflation uncertainty. So far, Pakistan has implemented few such programs. However the straightforward rejection of the Cukierman-Meltzer hypothesis (causality running from uncertainty to inflation) identifies the inability and/or unsuccessful implementation of such programs, which should have been considered seriously by monetary authorities in Pakistan since these programs are very costly to the economy by default.

6. Conclusion

This study provides several interesting results. First, we have estimated inflation uncertainty as a time varying conditional variance of inflation shocks and found that asymmetric GARCH models (GJR-GARCH and EGARCH) perform better than simple GARCH models. GJR-GARCH estimates the negative and significant value of the leverage effect parameter, which suggests that the negative shock of inflation tends to decrease next period uncertainty; this conclusion is also supported by the results of the EGARCH models. Second, news impact curves graphically reflect the asymmetric behavior of inflation uncertainty from GJR-GARCH and EGARCH models. Finally, the bivariate Granger causality test strongly supports the Friedman-Ball hypothesis for GJR-GARCH and EGARCH models, i.e., high inflation causes inflation uncertainty and the causality runs from inflation to inflation uncertainty. We do not find any evidence in support of the Cukierman-Meltzer hypothesis.

References

Andersen, T.G., and Bollerslev, T. (2006). Volatility and Correlation Forecasting. *Handbook of Economic Forecasting*, 1.

Apergis, N. (2006). Inflation, Output Growth, Volatility and Causality: Evidence from Panel Data and G7 Countries. *Economic Letters*, 83, 185-191.

Ball, L. (1992). How does Inflation Raise Inflation Uncertainty? *Journal of Monetary Economics*, 29, 371-388.

Berument, H. et al. (2001). Modeling Inflation Uncertainty using EGARCH: An Application to Turkey. Bilkent University Discussion Paper.

Bilquees, F. (1988). Inflation in Pakistan: Empirical Evidence on the Monetarist and Structuralist Hypotheses. *Pakistan Development Review*, 27 (2), 109-130.

Bollerslev, T. (1986). Generalized Autoregressive Conditional Heteroscedasticity. *Journal of Econometrics*, 31, 307-327.

Bollerslev, T., and Wooldridge, J.M. (1992). Quasi-Maximum Likelihood Estimation and Inference in Dynamic Models with Time-Varying Covariances. *Econometric Review*, 11, 143-172.

Bokil, M., and Schimmelpfennig, A. (2005). *Three Attempts at Inflation Forecasting in Pakistan*. IMF Working Paper, WP/05/105.

Bordes, C. et al. (2007). Money and Uncertainty in the Philippines: A Friedmanite Perspective. Conference paper, Asia-Link Program.

Bordes, C., and Maveyraud, S. (2008). The Friedman's and Mishkin's Hypotheses (re)considered. Unpublished.

Brunner, A. D., and Hess, G.D. (1993). Are Higher Levels of Inflation less Predictable? A State-Dependent Conditional Heteroscedasticity Approach. *Journal of Business and Economic Statistics*, 11 (2), 187-197.

Brunner, A.D., and Simon, D.P. (1996). Excess Returns and Risk at the Long End of the Treasury Market: An EGARCH-M Approach. *Journal of Financial Research*, 14 (1), 443-457.

Caporale, T., and McKiernan, B. (1997). High and Variable Inflation: Further Evidence on the Friedman Hypothesis. *Economic Letters*, 54, 65-68.

Chaudhary, M.A., and Ahmad, N. (1996). Sources and Impacts of Inflation in Pakistan. *Pakistan Economic and Social Review*, 34 (1), 21-39.

Cheem, N. (2003). Quarterly Growth Rates. *Statistics Singapore Newsletter*.

Cosimano, T., and Dennis, J. (1988). Estimation of the Variance of US Inflation based upon the ARCH Model. *Journal of Money, Credit, and Banking*, 20 (3), 409-423.

Crowford, A., and Kasumovich, M. (1996). *Does Inflation Uncertainty Vary with the Level Of Inflation?* Ottawa: Bank of Canada.

Engle, R. (1982). Autoregressive Conditional Heteroscedasticity with Estimates of United Kingdom Inflation. *Econometrica*, 987-1007.

Fountas, S. et al. (2000). A GARCH Model of Inflation and Inflation Uncertainty with Simultaneous Feedback. Working Paper.

Fountas, S. et al. (2006). Inflation Uncertainty, Output Growth Uncertainty and Macroeconomic Performance. *Oxford Bulletin of Economics and Statistics*, 68 (3).

Franses, P.H. (1990). *Testing for Seasonal Unit Roots in Monthly Data*. Econometric Institute Report No. 9032A. Rotterdam: Erasmus University.

Friedman, M. (1977). Nobel Lecture: Inflation and Unemployment. *Journal of Political Economy*, 85, 451-472.

Glosten, L. R., Jagannathan, R., and Runkle, D. (1993). On the Relations between the Expected Value and the Volatility of the Normal Excess Return on Stocks. *Journal of Finance*, 48, 1779-1801.

Golob, J.E. (1994). Does Inflation Uncertainty Increase with Inflation? *Federal Reserve Bank of Kansas City Economic Review*, Third Quarter.

Grier, K., and Perry, M. (2000). The Effects of Real and Nominal Uncertainty on Inflation and Output Growth: Some GARCH-M Evidence. *Journal of Applied Econometrics*, 15, 45-48.

Holland, A.S. (1984). Does Higher Inflation Lead to More Uncertain Inflation? *Federal Reserve Bank of St. Louis Review,* 66, 15-26.

Hafer, R.W. (1985). *Inflation Uncertainty and a Test of the Friedman Hypothesis*. Federal Reserve Bank of St. Louis Working Paper 1985-006A.

Hu, M.Y., Jiang, C.X., and Tsoukalas, C. (1997). The European Exchange Rates before and after the Establishment of the European Monetary System. *Journal of International Financial Markets, Institutions and Money*, 7, 235-253.

Khalid, A. M. (2005). Economic Growth, Inflation and Monetary Policy in Pakistan: Preliminary Empirical Estimates. *Pakistan Development Review*, 44 (4) Part II, 961-974.

Khan, M.S., and Senhadji, S.A. (2001). Threshold Effects in the Relationship between Inflation and Growth. *IMF Staff Papers* 48 (1).

Khan, A.H., and Qasim, M.A. (1996). Inflation in Pakistan Revisited. *Pakistan Development Review*, 35 (4), 747-759.

Khan, M.S., and Schimmelpfennig, A. (2006). Inflation in Pakistan: Money or Wheat? IMF Working Paper, wp/06/60.

Koutmos, G., and Booth, G.G. (1995). Asymmetric Volatility Transmission in International Stock Markets. *Journal of International Money and Finance*, 14, 747-762.

Malik, W.S., and Ahmad, A.M. (2007). The Taylor Rule and Macroeconomic Performance in Pakistan. *Pakistan Development Review*, 34.

Malik, W.S. (2006). Money, Output and Inflation: Evidence from Pakistan. *Pakistan Development Review*, 46 (4).

Nas, T.F., and Perry, M.J. (2000). Inflation, Inflation Uncertainty and Monetary Policy in Turkey. *Contemporary Economic Policy*, 18, 170-180.

Nelson, D.B. (1991). Conditional Heteroscedasticity in Asset Returns: A New Approach. *Econometrica*, 59, 347-370.

Price, S., and Nasim, A. (1999). Modeling Inflation and the Demand for Money in Pakistan: Cointegration and the Causal Structure. *Economic Modeling*, 16, 87-103.

Thornton, J. (2006). High and Variable Inflation: Further Evidence on the Friedman Hypothesis. *Southern African Journal of Economics*, 74, 167-171.

Tse, Y., & Booth, G.G. (1996). Common Volatility and Volatility Spillovers between US and Eurodollar Interest Rates: Evidence from the Features Market. *Journal of Economics and Business*, 48, 299-312.

Qayyum, A. (2006). Money, Inflation and Growth in Pakistan. *Pakistan Development Review*, 45 (2), 203-212.

Zivot, E. (2008). Practical Issues in the Analysis of Univariate GARCH Models. Unpublished Manuscript.

Appendix

Figure 6: Forecast of Conditional Variance (Inflation Uncertainty)

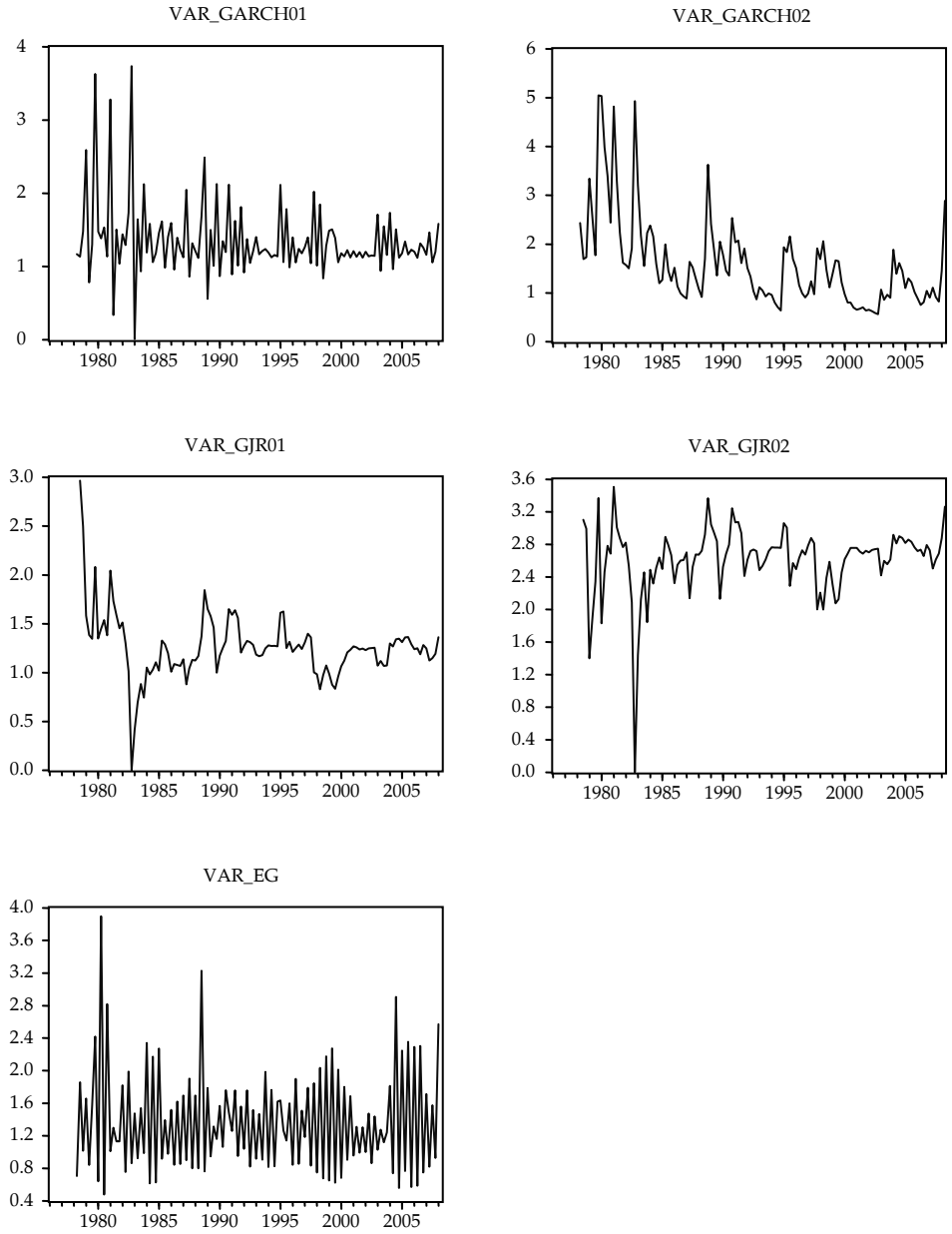
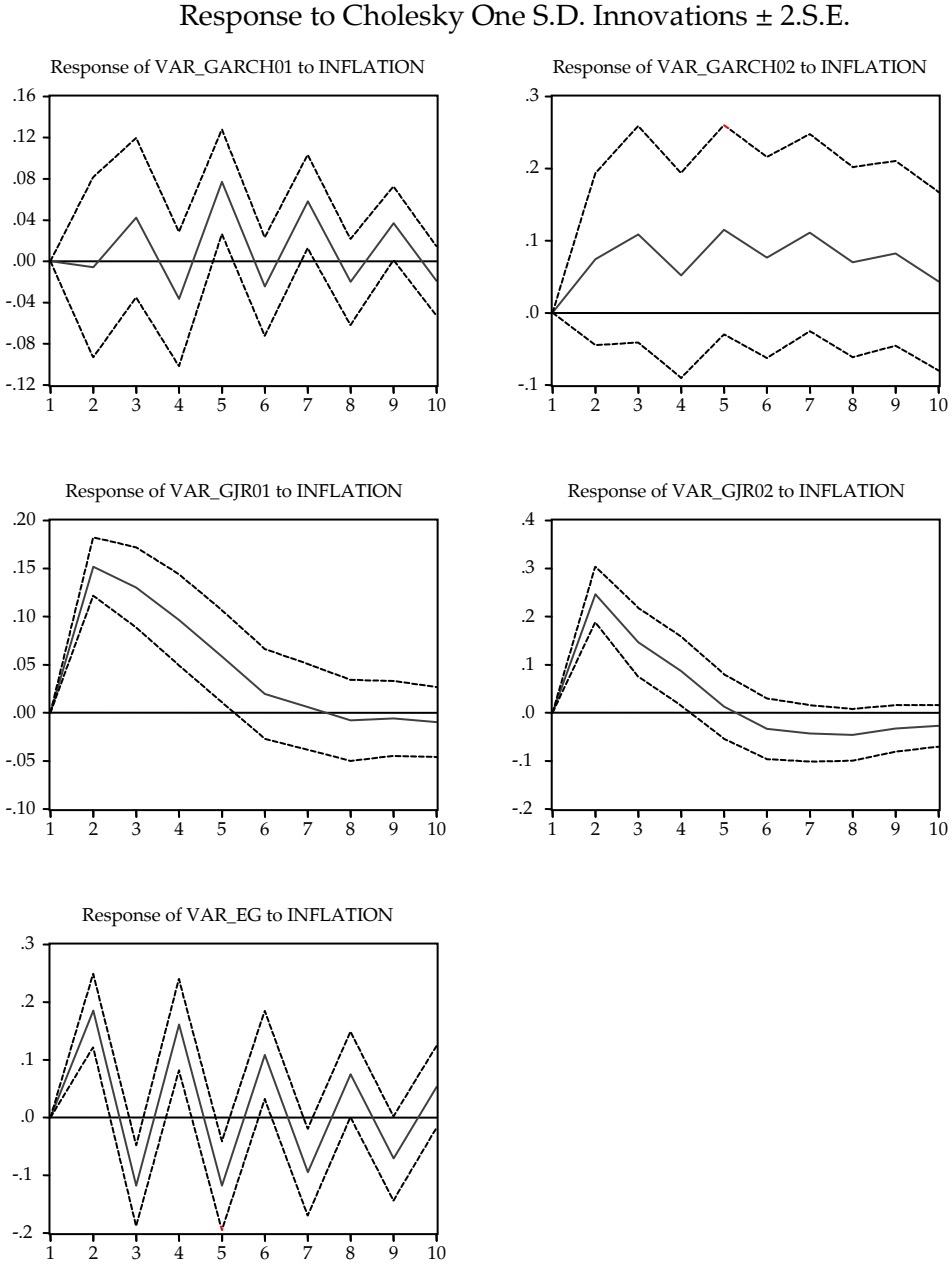


Figure 7: Impulse Response Functions of Uncertainty to Inflation



The Lahore Journal of Economics
15 : 2 (Winter 2010): pp. 35-50

Does Trade Openness Reduce Inflation? Empirical Evidence from Pakistan

Tahir Mukhtar[*]

Abstract:

One of the more celebrated propositions found in international trade is the case that trade liberalization is associated with declining prices, so that protectionism is inflationary. In line with this view, Romer (1993) postulates the hypothesis that inflation is lower in small and open economies. The objective of this study is to examine Romer's hypothesis in Pakistan. For this purpose, we have used multivariate cointegration and a vector error correction model. The study covers the period from 1960 to 2007. The empirical findings under the cointegration test show that there is a significant negative long-run relationship between inflation and trade openness, which confirms the existence of Romer's hypothesis in Pakistan.

Keywords: Trade openness, inflation, cointegration, vector error correction model, Pakistan.

JEL Classification: C22, F41, O53.

1. Introduction

One of the more celebrated propositions found in every international trade text is the case that trade liberalization is associated with declining prices, so that protectionism is inflationary. In today's world, no developing country can afford to isolate itself from the world economy. The benefits of outward-looking policies that help in taking advantage of the possibilities of international trade and capital flows are extensively discussed in the literature. Economic liberalization, globalization, and openness became buzzwords in the 1990s. There has been a distinct shift in favor of greater integration of the world economy. This trend has been toward greater opening up and most developing economies have moved away from the typical closed economy structure.

[*] Assistant Professor, Department of Economics, Fatima Jinnah Women's University, Rawalpindi.

Sustained low inflation has been a stylized fact of the late 1990s and early 2000s, both in advanced and increasingly in emerging markets. Some have argued that these developments could reflect stiffer global competition and the increased weight of developing countries in the global trading system (Rogoff, 2003). The relationship between inflation and openness has been the subject of research, theoretical as well as empirical. However, the literature on the subject is relatively scant. According to the 'new growth theory', openness is likely to affect inflation through its effect on output (Jin, 2000). This link could operate through: (i) increased efficiency, which is likely to reduce costs through changes in the composition of inputs procured domestically and internationally; (ii) better allocation of resources; (iii) increased capacity utilization; and (iv) a rise in foreign investment which could stimulate output growth and ease pressure on prices (Ashra, 2002).

When we review some of the existing empirical studies of the relationship between openness and inflation, we find inconclusive evidence suggesting that greater openness is associated with a lower trend in inflation. Romer (1993) finds that closed economies tend to have higher inflation. He argues that central banks in economies more open to trade find currency fluctuations caused by money surprises more painful and therefore exercise more restraint than their closed economy counterparts. Several studies have tested Romer's argument in different ways and have supported the conventional view of the negative relationship between trade openness and inflation. Thus empirical findings of Lane (1997), Ashra (2002), Sachsida *et al.* (2003), Yanikkaya (2003), Gruben and Mcleod (2004), Kim and Beladi (2004), Daniels et al. (2005), Razin and Loungani (2005), Aron and Muellbauer (2007), Badinger (2007), Bowdler and Nunziataz (2007) all validate Romer's argument. However, Terra (1998) only marginally supports Romer's argument by claiming that the negative correlation is only evident in severely indebted countries during the 1980s crisis period. Similarly, Batra (2001) argues that tariffs do not necessarily cause inflation, at least in the US. Gruben and Mcleod (2004) show that there does not exist any significant openness–inflation relationship among OECD economies. Kim and Beladi (2004) have estimated a positive relationship between price level and trade openness for some advanced economies, such as the US, Belgium, and Ireland, while for other countries, both developed and developing, their finding is in line with Romer's (1993) argument. Finally, it is interesting to note that Romer (1993) himself finds no significant openness–inflation relationship among OECD economies.

Most studies of the role of openness have focused on the estimation of cross-country averages of many different levels of economies. However, these studies cannot identify country-specific differences. Little work has been done on the dynamics of the impact of openness on inflation at a country level. The literature on the trade openness-inflation association in Pakistan is scarce. Ashra (2002), Kim and Beladi (2004) and Gruben and Mcleod (2004) have reported evidence of a negative relationship between trade openness and inflation for Pakistan using a panel data framework. However, we have come across only one study on Pakistan that uses time series data. Hanif and Batool (2006) have tested Romer's hypothesis for the Pakistan economy using annual time series data for the period 1973 to 2005. They find that, besides conventional explanatory variables like real gross domestic product (GDP) growth, monetary growth, the interest rate, and wheat support price, openness variables such as the ratio of growth in overall trade to GDP also has a significant negative impact on domestic price growth in Pakistan. However, this study suffers from one serious limitation: it uses a small number of observations (i.e., 32 in all) for carrying out the analysis using the heteroscedasticity and autocorrelation consistent (HAC) standards errors estimation technique. This technique is only valid for large samples and may not be appropriate for small samples (Gujarati, 2003). Thus, in the presence of relatively small data, the study is unable to provide conclusive results. Therefore, there is a need to reexamine the issue using a relatively larger data set and a more sophisticated estimation technique to obtain more reliable findings. This study is an attempt in that direction.

Until the mid-1980s, Pakistan pursued an economic policy that was strongly interventionist. During the late 1980s, Pakistan turned from inward-looking policies toward trade liberalization and export promotion strategies. From the late 1980s onwards, governments changed frequently but all of them liberalized the economy considerably. However, despite making the economy steadily more open, inflation has not been maintained within desirable limits in Pakistan. The objective of the study is to determine the nature of the relationship between inflation and trade openness in Pakistan.

The rest of the study is organized as follows: The theoretical model, sources of data and estimation technique are described in Section 2. Section 3 presents a discussion on the estimated results. Section 4 concludes the study.

2. Model, Data and Estimation

Inflation is a complex process and it is very difficult to construct an empirical model for a country. However, it is possible to find the key variables impacting the inflation process in a country like Pakistan. The most common empirical method of examining the trade openness-inflation relationship has been to employ a single equation model for inflation, treating trade openness as an exogenous variable among others. Solomon and de Wet (2004) use a four-variable single equation model where the budget deficit (BD), GDP, and the exchange rate (ER) are treated as exogenous variables, and inflation (CPI) as an endogenous variable. To this, we add trade openness (TO) as an exogenous variable.

$$LCPI_t = \alpha_1 + \alpha_2 LBD_t + \alpha_3 LER_t + \alpha_4 TO_t + \alpha_5 LGDP_t + u_t \qquad (1)$$

where $LCPI_t, LBD_t, LER_t, TO_t$ and $LGDP_t$ represent the consumer price index (CPI), budget deficit, exchange rate, trade openness, and GDP, respectively, expressed in natural logarithms except for trade openness at time t. u is a stochastic error term.

Now we present a brief discussion on the expected relationship between inflation and the explanatory variables in the above model. The influence of the budget deficit on inflation is positive: the higher the budget deficit, the greater the rate of inflation. The budget deficit affects inflation only if it is monetized, thus increasing the monetary base of the economy. According to Friedman's theory of money, inflation is a monetary phenomenon. Accordingly, if the budget deficit is monetized, it increases the money supply thereby increasing the price level. When the budget deficit is monetized, an extremely high correlation exists between the budget deficit and money supply. The problem of multicollinearity and reducibility precludes one from using both money supply and the budget deficit as explanatory variables in the regression analysis. Therefore, in order to estimate the effect of the budget deficit on inflation, the budget deficit is used as an explanatory variable instead of money supply. The exchange rate has a deterministic effect on the level of prices in underdeveloped economies. In countries like Pakistan, an exchange rate depreciation (appreciation) could increase (decrease) the price of imported commodities. Pakistan's markets are based significantly on imported commodities, implying that a depreciation of the exchange rate would be rapidly reflected in an increase in the price of the consumer's basket of commodities.

The expected impact of trade openness on inflation is negative because the direct and indirect price effects of cheaper imports of finished goods and intermediate inputs may net out to a decline in the overall price level. Additionally, opening up an economy to the rest of the world may alter the incentives to which central banks respond in determining a country's long-run inflation rate. Finally, openness could also lead indirectly to lower inflation by fostering faster domestic productivity growth as a result of increased competition. Because trade enables countries to specialize in activities in which they have a comparative advantage, sectors in which countries are relatively inefficient shrink, while sectors in which countries have a comparative advantage expand. Faster productivity growth allows firms to pay higher wages without necessarily passing these costs on in the form of higher prices. The fourth important explanatory variable is the level of GDP, which has an expected negative impact on the inflation rate as the availability of goods and services in the economy eases pressure on the domestic price growth.[1]

The time span covered in this study is from 1960 to 2007; we have used annual time series data. The inflation rate is proxied using the logarithm of the composite CPI. The control of inflation, measured as the annual growth rate of this variable, is the main goal of monetary policy and the State Bank of Pakistan (SBP) sets a target. In practice, the most commonly used measure of openness is the sum of imports and exports divided by GDP. This ratio generally reveals the degree of a country's openness to world trade: The more open a domestic economy, the less the restriction in world trade, and the higher the trade share in GDP. No doubt, there are various other possible measures that could be used as a proxy for openness but it is difficult to obtain long historical time series for most of these (Ashra, 2002). Thus, we restrict ourselves to the trade-to-GDP ratio, which indicates the overall openness of the economy. Other variables included in the analysis are the government budget deficit (BD), exchange rate (ER), and GDP. The data, seasonally unadjusted and expressed in nominal terms, has been obtained from various issues of the *Pakistan Economic Survey* and the IMF's International Financial Statistics.

2.1. Unit Root Test

Since macroeconomic time series data is usually nonstationary (Nelson & Plosser, 1982) and thus conducive to spurious regression, we test for the stationarity of a time series at the outset of our cointegration

[1] There is a vast literature on inflation and growth. I did not go into the details of it.

analysis. Testing for a unit root is an active research area, and several testing procedures have been developed over the years. Many of these tests are designed to overcome the difficulties encountered in practice. In this regard, the present study uses the augmented Dickey-Fuller (ADF) test, which is based on the t-ratio of the parameter in the following regression.

$$\Delta X_t = \kappa + \phi t + \Theta_i X_{t-i} + \sum_{i=1}^{n} \varphi_i \Delta X_{t-i} + \varepsilon_t \quad (2)$$

where X is the variable under consideration, Δ is the first difference operator, t captures any time trend, ε_t is a random error, and n is the maximum lag length. The optimal lag length is identified to ensure that the error term remains white noise, while κ, ϕ, Θ *and* φ are the parameters to be estimated. If we cannot reject the null hypothesis $\Theta = 0$, we can conclude that the series under consideration has a unit root and is therefore nonstationary.

However, the ADF unit root test is known to lose power dramatically against stationary alternatives with a low order MA process: a characterization that fits well with a number of macroeconomic time series. Consequently, along the lines of the ADF test, a more powerful variant is the Dicky-Fuller generalized least square (DFGLS) de-trending test proposed by Elliott, Rothenberg and Stock (1996). This test is similar to an ADF test, but has the best overall performance in terms of small sample size and power, dominating the ordinary Dickey-Fuller test. Therefore, to check the stationary of variables, we have also used the DFGLS test.

It is essential at the onset of cointegration analysis that we solve the problem of optimal lag length because multivariate cointegration analysis, which we are going to conduct in this study, is very sensitive to lag length selection. The two most commonly used lag length selection criteria are the Akaike information criterion (AIC) and the Schwarz Bayesian criterion (SBC).

2.2. *Cointegration Test*

The econometric framework used for analysis in this study is the Johansen (1998) and Johansen and Juselius (1990) maximum likelihood cointegration technique, which tests both the existence and number of cointegration vectors. This multivariate cointegration test can be expressed as:

$$Z_t = K_1 Z_{t-1} + K_2 Z_{t-2} + ... + K_{k-1} Z_{t-k} + \mu + \nu_t \quad (3)$$

where

$Z_t = (CPI, BD, ER, TO, GDP)$ i.e., a 5 x 1 vector of variables that are integrated of order one [i.e. *I* (1)], *CPI*, *BD, ER, TO* and *GDP* are the price level, budget deficit, exchange rate, trade openness, and GDP, respectively,

$\mu =$ a vector of constant and

$\nu_t =$ a vector of normally and independently distributed error term.

Equation (3) can be reformulated in a vector error correction model (VECM) as follows:

$$\Delta Z_t = \Gamma_1 \Delta Z_{t-1} + \Gamma_2 \Delta Z_{t-2} + \cdots\cdots + \Gamma_{k-1} \Delta Z_{t-k-1} + \Pi Z_{t-1} + \mu + \nu_t \quad (4)$$

where, $\Gamma_i = (I - A_1 - A_2 ..... - A_i)$, i = 1, 2, 3…..k – 1 and $\Pi = - (I - A_1 - A_2 - A_3 ..... - A_k)$. The coefficient matrix Π provides information about the long-run relationships among the variables in the data. Π can be factored into $\alpha\beta'$ where α will include the speed of adjustment to the equilibrium coefficients while the β' will be the long-run matrix of coefficients. The presence of r cointegrating vectors between the elements of Z implies that Π is of the rank r, $(0 < r < 5)$. To determine the number of cointegrating vectors, Johansen developed two likelihood ratio tests: the trace test (λ_{trace}) and the maximum eigenvalue test (λ_{max}). If there is any divergence of results between these two tests, it is advisable to rely on the evidence based on the λ_{max} test because it is more reliable in small samples (see Dutta & Ahmed, 1997, and Odhiambo, 2005).

3. Results and Discussion

The first step in cointegration analysis is to test the unit roots in each variable.[2] To this end, we apply the ADF stationary test to LCPI, LBD, LER, TO and LGDP.[3] From the results of the ADF test presented in

[2] Since the cointegration methodology involves finding a stationary linear combination of a set of variables, which are themselves nonstationary, a precondition for cointegration is that all variables should be nonstationary.

[3] All the variables are logarithmic except trade openness.

Table 1, it is evident that all the time series used in the study are stationary at first difference as expected. This implies that they are integrated of the order one, i.e., *I(1).* Similar results for all the macroeconomic variables are found under the DFGLS test.[4] To obtain the optimal lag length for cointegration analysis, we use two criteria, namely the AIC and the SBC. The SBC has a suggested a lag length of 1 as optimal, while the AIC indicates 3 as an optimal lag length (see Table A2 in the appendix). However, we have selected optimal lag length 1 as suggested by the SBC because when we use the lag length 3 for cointegration analysis, we find no cointegrating vector under both trace and maximum eigen statistics, while with lag length 1, we obtain one cointegrating vector under both these statistics.

Table-1: Augmented Dickey Fuller (ADF) Unit Root Tests

			Mackinnon Critical Values for Rejection of Hypothesis of a Unit Root				
Variables	Level	First Difference	1 %	5 %	10 %	Decision	Order of Integration
LCPI	6.791	-1.621	-2.58	-1.94	-1.62	Nonstationary at level but stationary at first difference	*I* (1)
LBD	-0.051	-10.439	-2.58	-1.94	-1.62	Nonstationary at level but stationary at first difference	*I* (1)
LEX	1.283	-7.089	-2.58	-1.94	-1.62	Nonstationary at level but stationary at first difference	*I* (1)
TO	-2.108	-3.744	-2.58	-1.94	-1.62	Nonstationary at level but stationary at first difference	*I* (1)
LGDP	4.909	-4.476	-2.58	-1.94	-1.62	Nonstationary at level but stationary at first difference	*I* (1)

The cointegration relationship among CPI, BD, ER, TO, and GDP has been investigated assuming a linear trend in the data, and both an intercept and a trend in the cointegrating equation using the Johansen technique. Table 2 reports our cointegration test results based on Johansen's maximum likelihood method. Both the trace statistic (λ_{trace})

[4] See Table A1 in the appendix.

and maximal eigenvalue (λ_{max}) statistic indicate that there is at least one cointegrating vector among the five time series. We can reject the null hypothesis of no cointegrating vector in favor of one cointegrating vector under both test statistics at a 5 percent level of significance. We cannot reject the null hypothesis of at most one cointegrating vector against the alternative hypothesis of two cointegrating vectors for both the trace and max-eigen test statistics. Consequently, we can conclude that there is only one cointegrating relationship among CPI, BD, ER, TO and GDP. This implies that the price level, budget deficit, exchange rate, trade openness, and GDP establish a long-run relationship in Pakistan.

Table-2.Cointegration Test Based on Johansen's Maximum Likelihood Method

Null Hypothesis	Alternative Hypothesis			Critical Values	
				95 %	P-values*
λ_{trace} rank tests		Eigen values	λ_{trace} rank value		
$H_0 : r = 0$	$H_1 : r = 1$	0.682	103.313***	76.973	0.0001
$H_0 : r = 1$	$H_1 : r = 2$	0.392	51.72	54.079	0.08
$H_0 : r = 2$	$H_1 : r = 3$	0.263	29.362	35.193	0.186
$\lambda_{\max}$ rank tests			$\lambda_{\max}$ rank value		
$H_0 : r = 0$	$H_1 : r > 0$	0.682	51.592***	34.806	0.0002
$H_0 : r \leq 1$	$H_1 : r > 1$	0.392	22.358	28.588	0.254
$H_0 : r \leq 2$	$H_1 : r > 2$	0.263	13.729	22.23	0.487

Normalized Cointegrating Equation:
LCPI=1.987 + 0.102*LBD + 0.388*LEX - 0.681*TO - 0.421*LGDP
(2.031)** (13.116)*** (2.514)** (-4.732)*** (-4.236)***

***denotes rejection of the null hypothesis at the 1 percent significance level.
** denotes rejection of the null hypothesis at the 5 percent significance level.
* MacKinnon-Haug-Michelis (1999) p-values.

Trace test indicates 1 cointegrating equation at 1 percent significance level.
Max-eigenvalue test indicates 1 cointegrating equation at 1 percent significance level.

The cointegrating equation, which is given at the bottom of Table 2, is normalized for LCPI to obtain meanings from the coefficients. All the

explanatory variables significantly affect the CPI. The coefficients of all the logarithmic variables may be interpreted in terms of elasticity. Thus, we can state that 1 percent increase in BD is associated with a 0.10 percent increase in CPI in Pakistan. Since the coefficient estimate for the budget deficit is significant, it implies that there is a significant long-run relationship between inflation and the budget deficit. This result is in accordance with the findings of Chaudhary and Ahmad (1995) and Agha and Khan (2006) that the budget deficit ultimately induces inflation in Pakistan. There exists a positive relationship between LCPI and LEX in such a way that a 1 percent increase in the nominal exchange rate results in a 0.38 percent increase in the inflation rate in the country. This implies that it is not advisable for policymakers to implement a flexible exchange rate system because that could lead to a major depreciation that would create inflationary problems. The coefficient of trade openness carries a negative sign, which shows that a 1 unit increase in trade openness brings about a 0.68 percent decrease in the inflation rate. This finding is consistent with the empirical findings of Romer (1993), Kim and Beladi (2004), Ashra (2002) and Gruben and Mcleod (2004), among others. Furthermore, it validates the results of Hanif and Batool (2006) that openness has a significant negative impact on the domestic price growth in Pakistan. This finding confirms the existence of Romer's hypothesis in Pakistan: inflation is lower in small and open economies. Furthermore, it indicates that the traditional closed economy explanation for the inflationary process remains valid, and adding the openness variable to the analysis is an important component to the empirical analysis of these macroeconomic phenomena. Finally, there is a significant negative relationship between the CPI and GDP such that a 0.42 percent decrease in the CPI is associated with a 1 percent increase in GDP.

A principal feature of cointegrated variables is that their time paths are influenced by the extent of any deviation from the long-run equilibrium (Anders, 2004). The error correction term (ECT) represents the percentage of correction to any deviation in the long-run equilibrium price in a single period and also represents how fast the deviations in the long-run equilibrium are corrected. The coefficient of the ECT of inflation variable carries the correct sign (negative) and statistically significant at a 10 percent level with the speed of convergence to equilibrium of 27 percent (Table 3). This means that, whenever there is any disturbance in the system in the long run, in every short-run period, a 27 percent correction to disequilibrium will take place. The overall restoration to equilibrium will happen in almost four years. This indicates the stability of the model. The coefficients of the ECTs of trade openness, exchange

rate, and GDP are statistically significant but they carry a positive sign. This means that, in case of any disturbance, divergence from the equilibrium path will take place and the whole system cannot be brought to equilibrium position in each case. The coefficient of the ECT of the budget deficit is not only insignificant but also carries the incorrect sign, i.e., positive. The insignificance of the ECT component for this variable indicates that this variable is weakly exogenous to the model. The diagnostic tests involve χ^2_tests for the hypothesis that there is no serial correlation, that the residual follows a normal distribution, that there is no heteroscedasticity, and lastly that there is no autoregressive conditional heteroscedasticity. In all equations, the diagnostics suggest that the residuals are Gaussian as the Johansen method presupposes.

Table-3.Summary Results from VECMs and Diagnostic Tests

	$\Delta L(CPI)$	$\Delta L(BD)$	$\Delta L(EX)$	$\Delta L(TO)$	$\Delta L(GDP)$
Constant	0.026	0.177	0.121	0.043	0.038
	(2.737)***	(0.880)	(3.667)**	(1.576)**	(1.857)**
ECT(-1)	- 0.275	1.761	0.417	0.853	0.102
	(1.898)*	(1.683)	(2.422)**	(5.887)***	(0.952)
R^2	0.684	0.277	0.548	0.604	0.391
Adjusted R^2	0.633	0.163	0.477	0.543	0.354
S.E. of Regression	0.032	0.669	0.111	0.093	0.068
Diagnostic Tests	χ^2 (p values are in the parenthesis)				
Serial Correlation (Breusch–Godfrey serial LM)	1.24(0.441)	0.791(0.557)	1.31(0.262)	2.15(0.156)	1.34(0.238)
Heteroscedasticity (White Heteroskedasticity Test)	0.04(0.982)	1.33(0.268)	1.351(0.252)	2.27(0.157)	0.084(0.897)
Normality (Jorque-Bera)	0.411(0.644)	0.774(0.361)	0.524(0.391)	2.3(0.194)	0.46(0.78)
AR.Cond. Heteroscedasticity (ARCH LM Test)	0.007(0.938)	1.344(0.261)	0.004(0.964)	1.247(0.285)	1.086(0.337)

Note: t-values given in parenthesis with,***, **, *, indicate significance at 1 percent, 5 percent and 10 percent probability level respectively.

4. Conclusion

Inflation has always been a concern for policymakers as it creates uncertainty in the economy that can adversely affect economic growth. Maintaining noninflationary stable economic growth has been at the core of macroeconomic policies in Pakistan as in many other developing countries. The concern with inflation stems not only from the need to maintain overall macroeconomic stability, but also from the fact that inflation hurts the poor in particular as they do not possess effective inflation hedges.

An important debate has centered on the effects of openness (in the trade-flow sense) on inflation. Theoretically, two alternative views have been espoused concerning the issue. One of these states that openness causes a slower rate of inflation, while the other states that openness causes a faster rate of inflation. Many empirical studies have been performed to test these hypotheses. However, there is inconclusive evidence in support of these two views.

The main objective of this paper was to apply the cointegration approach in order to reexamine whether the hypothesis proposed by Romer (1993), that there is a negative relationship between inflation and trade openness, holds for Pakistan. The study has used annual observations for the period 1960 to 2007. The results obtained corroborate Romer's proposition. This study further supports the results obtained by Romer (1993), demonstrating that there is a negative relationship between openness and inflation. Thus, whatever its cause, that greater openness to trade is associated with lower inflation should provide some comfort to those who fear that trade liberalization and flexible exchange rates will increase macroeconomic instability in Pakistan.

References

Agha, A.I., and Khan, M.S. (2006). An Empirical Analysis of Fiscal Imbalances and Inflation in Pakistan. *SBP Research Bulletin*, 2(2): 343-362.

Aron, J., and John, M. (2007). Inflation Dynamics and Trade Openness: With an Application to South Africa. Centre for the Study of African Economies Working Paper Series. Working Paper 270.

Ashra, S. (2002). Inflation and Openness: A Case Study of Selected Developing Economies. Working Paper 84. Indian Council of Research on International Economic Relations (ICRIER).

Badinger, H. (2007). Globalization, the Output-Inflation Tradeoff, and Inflation. FIW Working Paper 10, Austria.

Batra, R. (2001). Are Tariffs Inflationary? *Review of International Economics*, 9, 373-82.

Bowdler, C., and Nunziataz, L. (2007). Trade Union Density and Inflation Performance: Evidence from OECD Panel Data. *Economica*, 74 (293), 135-59.

Chaudhary, M.A., and Ahmad, N. (1995). Money Supply, Deficit and Inflation in Pakistan. *Pakistan Development Review*, 34, 945-56.

Daniels, J., Nourzad, F., and Van Hoose, D. (2005). Openness, Central Bank Independence, and the Sacrifice Ratio. *Journal of Money, Credit, and Banking*, 37, 371-379.

Dutta, D., and Ahmed, N. (1997). An Aggregate Import Demand Function for Bangladesh: A Cointegration Approach. Working Paper. University of Sydney.

Elliot, G., Rothenberg, T.J., and Stock, J.H. (1996). Efficient Tests for an Autoregressive Unit Root. *Econometrica*, 64, 813-36.

Enders, W. (1995). *Applied Econometric Time Series*. New York: John Wiley.

Engle, R.F., and Granger, C.W.J. (1987). Cointegration and Error Correction Representation, Estimation and Testing. *Econometrica*, 55, 251-76.

Government of Pakistan. (2008). *Pakistan Economic Survey*. Islamabad: Economic Advisory Wing, Finance Division.

Gruben, W.C., and McLeod, D. (2004). The Openness-Inflation Puzzle Revisited. *Applied Economics Letters*, 11, 465-468.

Gujarati, D. (2003). *Basic Econometrics*. New York: McGraw-Hill.

Jin, C.J. (2006). Can Openness be an Engine of Sustained High Growth Rates and Inflation? Evidence from Japan and Korea. *International Review of Economics and Finance*, 15, 228-240.

Johansen, S. (1988). Statistical Analysis of Cointegration Vectors. *Journal of Economic Dynamics and Control*, 12, 231-254.

Johansen, S., and Juselius, K. (1990). The Maximum Likelihood Estimation and Inference on Cointegration with Application to Demand for Money. *Oxford Bulletin of Economics and Statistics*, 52, 169-210.

Kim, M., and Beladi, H. (2005). Is Free Trade Deflationary? *Economic Letters*, 89, 343-349.

Lane, P.R. (1997). Inflation in Open Economies. *Journal of International Economics*, 42, 327-347.

Masih, A.M.M., and Masih, R. (1997). On the Temporal Causal Relationship between energy Consumption, Real Income, and Prices: Some New Evidence from Asian Energy Dependent NICs based on a Multivariate Cointegration/Vector Error Correction Approach. *Journal of Policy Modeling* 19 (4), 417-440.

Nelson, C., and Plosser, C. (1982). Trends and Random Walks in Macroeconomic Time Series: Some Evidence and Implications. *Journal of Monetary Economics*, 10, 130-162.

Odhiambo, N. M. (2005). Financial Liberalization and Financial Deepening: Evidence from Three Sub-Saharan African Countries. *African Review of Money, Finance and Banking (Savings and Development Supplement)*, 5-23.

Razin, A., and Loungani, P. (2005). Globalization and Equilibrium Output-Inflation Trade-Offs. NBER International Seminar on Macroeconomics (September).

Rogoff, K. (2003). Globalization and the Global Disinflation. Paper presented to the Federal Reserve Bank of Kansas, Jackson Hole Conference.

Romer D. (1993). Openness and Inflation: Theory and Evidence. *Quarterly Journal of Economics*, 108 (4), 869-903.

Sachsida, A., Galrao, F., and Loureiro, P.R.A. (2003). Does Greater Trade Openness Reduce Inflation? Further Evidence Using Panel Data Techniques. *Economic Letters*, 81, 315-319.

Solomon, M., and de Wet, W.A. (2004). The Effect of a Budget Deficit on Inflation: The Case of Tanzania. *South African Journal of Economic and Management Sciences*, 7 (1), 100-116.

Terra, C.T. (1998). Openness and Inflation: A New Assessment. *Quarterly Journal of Economics*, (113), 641-648.

Yanikkaya H. (2003). Trade Openness and Economic Growth: A Cross-Country Empirical Investigation. *Journal of Development Economics*, 72, 57-89.

Appendix

Table-A1: DF-GLS Unit Root Tests

Variables	Level	First Difference	Mackinnon Critical Values for Rejection of Hypothesis of a Unit Root			Decision	Order of Integration
			1 %	5 %	10 %		
LCPI	-0.438	-4.935	-3.77	-3.19	-2.89	Nonstationary at level but stationary at first difference	*I* (1)
TO	-1.955	-4.959	-3.77	-3.19	-2.89	Nonstationary at level but stationary at first difference	*I* (1)
LRGDP	-3.497	-6.375	-3.77	-3.19	-2.89	Nonstationary at level but stationary at first difference	*I* (1)
LEX	-2.151	-7.436	-3.77	-3.19	-2.89	Nonstationary at level but stationary at first difference	*I* (1)
LBD	-2.101	-7.523	-3.77	-3.19	-2.89	Nonstationary at level but stationary at first difference	*I* (1)

Table-A2: Lag Order Selection

Lag	AIC	SC
0	1.776864	1.981655
1	-7.158782	-5.930038*
2	-7.945100	-5.692402
3	-8.880952*	-5.604301
4	-8.698020	-4.397415

* indicates lag order selected by the criterion
AIC: Akaike information criterion
SC: Schwarz information criterion

The Lahore Journal of Economics
15 : 2 (Winter 2010): pp. 51-76

Adopting Inflation Targeting in Pakistan: An Empirical Analysis

Nadia Saleem*

Abstract

The objective of this paper is to assess the conditions for inflation targeting in Pakistan. The recent inflationary surge in Pakistan calls for rethinking monetary policy afresh. This paper argues the case for inflation targeting in Pakistan as a policy option to achieve price stability. The country experienced an inflation rate of just below 10 percent during 1970-2009, which makes it a potential candidate for inflation targeting. Applying the VAR technique to data for the same period, inflation is shown to be adaptive in nature, leading us to reject the accelerationist hypothesis. The Lucas critique holds as people are found to use forward-looking models in forming expectations about inflation. The paper also sheds some light on the State Bank of Pakistan's level of preparedness for the possibility of adopting inflation targeting, for which transparency and autonomy are prerequisites. The interest rate channel can play the role of a nominal anchor in the long run.

Keywords: Monetary policy, central bank, inflation targeting, Pakistan.

JEL Classification: C32, E31, E52.

1. Introduction

In recent years, the macroeconomic discourse has shifted from stability versus growth to stable growth because high inflation is a hindrance to sustained growth. The discussion then turned toward the effectiveness of monetary policy in controlling inflation. Money is not neutral, at least in the short to medium run, and it can generate inflation with lags; the central bank has no mechanism to exercise complete control over inflation. In the last two decades, countries have faced a contagion phenomenon and a worldwide liquidity crisis, raising the specter of another Great Depression. The experience points toward the miscalculations of monetary authorities in determining the role of money

* Associate Professor of Economics, FCC University, Lahore, Pakistan.

and its impact on the real economy. The question is, how does a country that is otherwise doing well land itself in a financial crisis? The answer lies in people's self-fulfilling expectations and the fallacy of composition on the part of policymakers. Expectations about the future play an important role in investment and gross domestic product (GDP) growth. Emerging economies face increased import bills due to liberalized trade and fluctuations in commodity prices and shortages in food grains. Declining productivity, an acute shortage of energy, imperfect markets, and poor fiscal management present another challenge to the central bank agenda of price stability.[1]

Broadly speaking, central bankers have three choices available for achieving a stable inflation rate which can contribute to economic growth. First, the central bank can adopt discretionary monetary policy without any framework—a policy which simply fails to answer the questions that a central bank has to confront in light of an unstable money demand function. Alternatively, the central bank can control the exchange rate—a policy that relies heavily on the policies of central banks in import-originating countries, besides requiring strong financial and economic conditions. Second, the central bank can opt for a rule-based monetary policy, which targets income instead of money or prices. Third, a central bank may choose to target inflation explicitly as "enemy number one"[2] by making a transparent conditional forecast to make it accountable. A single choice or even a blend of all three is not considered the best policy for all countries, all time periods, or all types of environment. There is no such thing as a single, ideal monetary policy. It varies from country to country and with changing conditions. Each country needs a monetary policy that is robust, along with a conducive set of institutions, and commitment to fiscal responsibility for achieving the objective of price stability.

The idea behind inflation targeting (IT) goes back to the early Keynesian-monetarist debate on rules versus discretion. The central bank announces one long-term target but not its technical or mechanical operating instructions. It requires structural and judgmental models of

[1] Price stability refers to a consistent increase in price level such that people can form their expectations: "A situation in which households and businesses in making their saving and investment decisions can safely ignore the possibility of sustained, generalized price increases or decreases" (Greenspan, 1988).

[2] The political priority for price stability can be traced back to US President Ford's campaign for combating inflation: "Whip Inflation Now" (WIN). In an address to Congress (Ford, 1974), he declared inflation enemy number one. After this, a controversy started with a counter movement, "Need Immediate Money" (NIM).

the economy, which help attain the inflation target. The central bank "looks at every other thing" but is focused on inflation (Svensson, 2000). In the words of Bernanke et al. (1999): "IT is constrained discretion which keeps the economic ship in the desired area in the long run, while permitting central bank to respond in the short run."

There are two important decisions involved in IT. The first is to choose an optimal horizon and the second is the choice of anchor. The central bank announces a target and then focuses on the expected inflation rate because of lags in the monetary transmission mechanism. In the case of open economies, an effective monetary policy works through the output gap channel instead of the exchange rate channel. Once a shock is generated, inflation deviates from the target, the central bank recognizes that inflation affects the real variables with a lag, and can use an instrument before the shock is fully absorbed by the economy to minimize loss of output. This is the look-at-everything approach mentioned earlier. The other approach, attributed to Batini and Haldane (1999) and McCallum and Nelson (1999) requires a policy rule for controlling inflation.[3]

This paper is concerned primarily with two aspects: (i) to examine the preconditions of IT as a policy choice in developing economies, and (ii) to assess the level of preparedness for the adoption of IT as a policy framework in Pakistan. Section 2 outlines and analyses the preconditions for IT and its success and failure in developing, transition, and developed economies. It accounts for the elements of success of IT in developing economies on the basis of empirical evidence and discusses issues related to the adoption of this policy in Pakistan. Informed by these conclusions, Section 3 outlines a VAR model applicable to conditions in Pakistan and presents the sources of data used. Section 4 gives detailed empirical results and compares them with earlier studies. The last section summarizes our findings and proposes a future course of action for the State Bank of Pakistan (SBP) to adopt IT.

2. Preconditions and Performance

IT as a monetary policy regime emerged at the time when the East Asian crisis threatened the world's financial stability. Ever since, the world has been divided between inflation targeters and nontargeters—a division reminiscent of the world when paper money was introduced, with arguments as to whether or not gold and silver standards could

[3] RT = Constant + $\phi(\pi_{t+1} - \pi_t)$, where Rt is the nominal interest rate, $RT > 1, \pi_{t+1}$ is the forecasted inflation rate and π_t is the targeted inflation.

work simultaneously. This section looks at the set of preconditions that has developed under IT regimes and the performance of these regimes compared to non-IT regimes. We focus specially on developing countries.

2.1. Preconditions

As a regime, the following set of conditions must be fulfilled before IT is introduced into an economy: (i) a strong commitment to price stability, (ii) a numerical target for inflation, (iii) a time horizon for achieving that target, and (iv) an autonomous, transparent, and accountable central bank to hold these factors together. The first order of business for the central bank is to opt to control price, not money or income, implying a reversal of causality from prices to money. Second, it has to decide what the desired level of inflation should be. The importance of price stability must always be paramount; higher inflation should invariably be a cause for serious concern for the central bank. IT thus requires a conservative central bank with a credible monetary policy.

IT varies from a strict, fully-fledged regime with a single anchor to a flexible regime with a floating exchange rate and an inflation target. If the commitment to price stability is high and it is the objective of monetary policy, then the central bank will select strict IT. High commitment translates into a shorter time horizon and the central bank stands ready to take action quickly; it will increase the sacrifice ratio and unemployment loss. The time horizon varies from 12 to 60 months.

With a view to announcing the target, IT needs a forward-looking model to forecast inflation. A nominal anchor must be chosen, which requires greater transparency and to which people can respond. Once the central bank announces IT as a policy regime, it has also to announce the target inflation rate and the nominal anchor that will pin down private expectations. This may be any instrument that is directly and monotonically related to the inflation rate. The choice of nominal anchor is important because it resolves the problems of time inconsistency and the disciplining of monetary policy (Mishkin, 1998). Policymakers may choose the interest rate, money supply, or exchange rate as an anchor. In most countries adopting IT, the nominal interest rate is considered an operational instrument. The short-run nominal interest rate is recommended as a targeting instrument for its negligible impact on the long-run real interest rate and if inflation deviates from the target, the nominal interest rate will be affected without adversely impacting output. Monetary policy is concerned not with the current level of output, but

with the future utilization of resources. Stable prices can contribute to achieving this objective (Gaiduch and Hunt, 2000).

IT requires the regular transmission of information to the public and private sectors about the affairs of the central bank. This transmission involves information related to the prediction of inflation, the path of the instrument, and a policy statement. This type of public statement limits discretion. It also demands close contact between monetary and fiscal policy without sacrificing the independence of the central bank. The next step is to determine how best to provide this information to the public. Various methods have been used to bridge the information gap between the central bank's decisions and the household and business sectors. The central bank can use an information flow chart, making a public announcement concerning inflation, and publishing the minutes of meetings, etc. This mechanism helps form expectations. In this way, the central bank helps people adopt a certain type of behavior. Most inflation targeters use fan charts to transmit the target and the path of the instrument, while New Zealand, Canada, Israel, Australia, Mexico, and Poland rely on making the central bank's minutes public. These public announcements make the central bank more answerable to the public. It is forced to adopt more transparent policies and account for instances where it fails to achieve the target. If the interest rate increases, private businesses know why and can learn about the future inflation rate. IT thus makes the central bank more objective in its actions; it brings about systematic changes in the policy rate.

The operational statement of IT can vary from strict to flexible and, on the basis of the target inflation rate, countries can be subdivided into maintainers, convergers, squeezers, and reversers. Maintainers are those who successfully maintain the stationary inflation rate at less than 5 percent. Convergers are those on the way to achieving a stationary inflation rate and their inflation rate is less than 10 percent. Squeezers are countries that have started to bring their inflation rate down to single-digit figures, and reversers are those who have achieved a zero inflation rate (Truman, 2005).

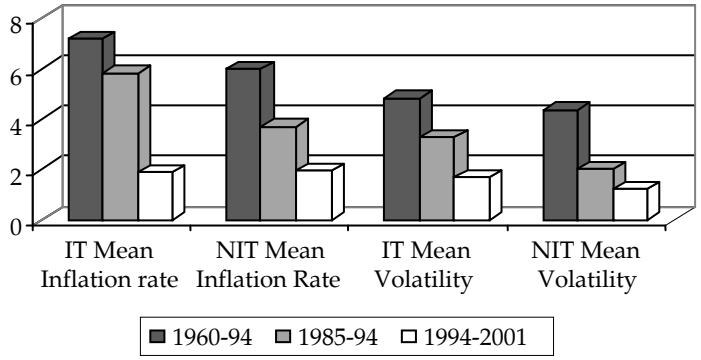
2.2. Successes and Failures

In the past two decades, 26 countries have embraced IT as a policy regime and many others are getting ready to adopt it. New Zealand (1990), the United Kingdom (1993), Australia (1994), Canada (1994), and Finland (1994) were the first to formally adopt IT. It was seen as a regime suitable for industrially developed countries. Evolved during financial

crises, the policy was considered the answer to the unusual shocks that monetary policy has to confront in the form of output variability and exchange rate fluctuations. However, inflation targeters also include emerging and transitional economies such as Brazil, Mexico, Colombia, Peru, the Republic of Korea, Thailand, Philippines, the Czech Republic, Hungary, Poland, and South Africa. The latest additions are Slovakia, Indonesia, Romania, Turkey, and Ghana. The variety of countries that have adopted IT shows that it is becoming an accepted policy choice in all kinds of economies, including emerging and developing economies.

Ball et al. (2003) find no evidence as to whether IT improves the economic performance of targeters compared to nontargeters. This is not because IT is unable to achieve macroeconomic stability along with price stability, but because both groups are using the same type of interest rate policy. Further, there is no evidence that if IT fails to deliver, it might harm a country's macroeconomic conditions. Further still, the authors conclude that IT might be desirable for political rather than economic reasons.

Figure-1: Average Annual Inflation Rate and Standard Deviation

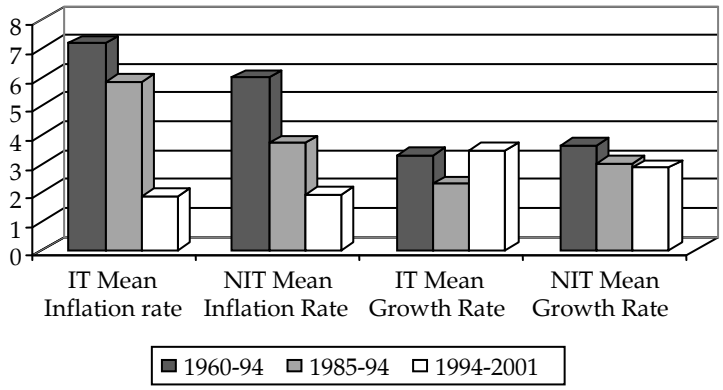


Source: Ball et al. (2003).

Figure-1 shows that noninflation targeters' (NITs) inflation rate (5.98 percent) was lower than that of inflation targeters (7.17 percent) during the period 1960-1994. NITs performed better than inflation targeters in controlling their inflation rate. Thus, it is the high inflation rate that leads inflation targeters to adopt IT. After adopting IT as a rule (1994-2001), inflation targeters were able to bring inflation down from 5.84 to 1.88 percent. This is not only a measure of success with respect to their previous record of inflation, but also with respect to NITs where the mean inflation rate was 1.95 percent during 1994-2001. IT not only enabled these countries to control inflation more successfully but also

reduced volatility of inflation which, measured by the standard deviation, is less in targeters than in NITs.

Figure-2: Growth Rate and Inflation Rate



Source: Ball et al. (2003).

Figure-2 shows that targeters initially have higher inflation rates than NITs. But inflation affects growth as countries experiencing high inflation tend to have lower growth rates. Although the inflation rate remains more or less the same for targeters and NITs after the central bank has adopted IT as a policy regime, the growth rate for inflation targeters accelerates. It seems that IT does not have any adverse impact on the growth rate. We can also conclude that adopting IT adoption reduces variability in the inflation rate and can facilitate growth.

2.3. IT in Developing Economies

Developing economies suffer from weak financial institutions, a lack of will to implement policies, and excess aggregate demand, all of which make it difficult to avoid inflationary pressures. The demand for money is not a stable function so the short-term interest rate can be considered an option to monitor the demand for liquidity.

The success story of Chile in controlling inflation started a debate among developing economies, as its experience indicated another path available to central banks. Most analysts maintain that Chile's success in adopting IT was attributable to the absence of a fiscal deficit. Further, the strict regulation and supervision of the financial system and substantial tightening of targets are also cited as reasons for success. The second example is that of Israel, which won credibility by preemptive actions

taken by the monetary authorities whenever there was a deviation from the target.

According to Masson et al. (1997), a program of fiscal consolidation, tight monetary policy, and institutional reform will be more effective in reducing the inflation rate in countries where it has been 30-40 percent annually and short lags exist in the implementation of monetary policy. Many economists recognize that developing economies have high *seigniorage*, which makes them unsuitable candidates for adopting IT. High *seigniorage* does not always lead to high inflation. The first necessary condition is political will and determination, while economic conditions come second. Boughrara (2004) concludes that a weak financial structure, fragile banking system, and incomplete knowledge of the monetary transmission mechanism—rather than fiscal dominance—are the main obstacles to adopting IT. Necessary and sufficient conditions apart, Angeriz and Arestis (2005) notice that administered prices and a high exchange rate pass-through regime play a crucial role. These two factors require effective coordination between fiscal and monetary policy with high vigilance. Arguably the greatest problem with IT, according to Svensson (1999), is the central banks' imperfect control of inflation due to the lags in and uncertainty about the transmission mechanism. Further, lack of accountability and transparency can reduce the potential benefits of IT.

The choice of IT is also influenced by "economic performance, conditions, structures and institutions" (Truman, 2005). A rapidly growing country satisfied with its performance is less likely to opt for IT as a monetary policy framework. Hu (2003) supports this view and explains that interest rates are negatively related and exchange rate pressures are positively related to the choice of switching to IT. Higher variability in growth, inflation, and interest rate sets the stage for IT in developing economies.

Kadioglu et al. (2000) concludes that many developing countries fail to satisfy the preconditions for IT and do not have powerful models to enable them to make successful inflation forecasts. Gottschalk and Moore (2001) show that exchange rates were effective in the case of Poland with respect to output and prices, and the direct linkages between interest rate and inflation did not appear to be very strong.

More recently, Ghana has formally adopted IT. It is only the second country after South Africa to announce a target of 5 percent for

inflation and the interest rate as the major anchor. Since adopting IT, interest rates have increased from 12.5 percent to 14.3 percent. Although a fiscal responsibility act had already been promulgated, inflation increased from the targeted 5 percent to 13.2 percent. This high rate of inflation was due to supply shocks and in this scenario, increasing the interest rate would be a drastic step. Severe supply shocks (rising oil and food prices) and falling exchange rates were real constraints on the success of IT in Ghana (Mckinley, 2007).

Table 1 explains how IT is adopted in transitional and developing economies. Chile, the Czech Republic, and Brazil suffered high to very high inflation rates at the time of adopting IT, while the Republic of Korea faced an economic downturn. Moreover, a high fiscal deficit prevailed in all these countries. They used monetary aggregates, or M2 growth, as a nominal anchor, effective and strong communication mechanisms, and the short- to long-term horizon for targeting inflation, and IT resulted in low inflation. These economies are transitional in nature, even if they are stable market economies because they are growing and working at a suboptimal level. To predict the future path of inflation and expectations in such countries is difficult, if not impossible. These are also those countries that have a long history of inflation and are even tolerant of a certain level of high inflation because it contributes to growth. Further, commitment and institutional support is often a problem in controlling inflation. Countries that have faced problems in implementing IT are Turkey and Ghana. They have opted for exchange rate management along with monetary aggregates, but there has been poor coordination with fiscal policy and a weak communication system.

Based on Table-1, we can conclude that strong commitment and effective communication, which helps people believe that the central bank will control inflation, is a real factor of success. The central bank should be capable of developing a forward-looking model of inflation based on an effective channel. IT has been successful in those countries where the central bank adopted a flexible exchange rate rather than floating or fixed exchange rate regimes.

Table-1 Assessing IT in Developing and Emerging Economies

Country	*Monetary Policy Regime*	*Problem*	*Communication Strategy*	*Autonomy*	*Fiscal Situation*	*Impact on Inflation*	*Horizon*
Chile	Pegged and monetary aggregates	High inflation with fear of floating	Effective and strong monthly inflation report	Full autonomy	High fiscal deficit	Low inflation	Long term horizon
Czech Republic	Pegged and monetary aggregates	High inflation	Problems in communication and reaction	No sovereignty	High fiscal deficit	Low inflation	Short term horizon
Brazil	Monetary aggregates and pegged exchange rate	Very high inflation rate	Quarterly report on inflation and minutes of meeting	High autonomy	High fiscal deficit	Low inflation	Short term horizon
Korea	Monetary target to an M2 Growth rate	Economic down- turn	Effective communication with the private sector	Autonomy in implementing monetary policy	No fiscal deficit	Lower inflation rate	Longer horizon
Turkey	Nominal floating Exchange rate	High inflation	Weak communication quarterly inflation reports	Coordination with fiscal policy	High fiscal deficit	Higher inflation	Longer horizon
Ghana	Exchange-rate management and monetary aggregates	Very high inflation rate	Weak communication annual inflation reports	Coordination with fiscal policy	High fiscal deficit	Higher inflation	Longer horizon

Sources: International Monetary Fund (2007a).
Data for Chile is taken from Hebbel and Tapia (2003).
Data for the Czech Republic is taken from Kotlán and Navrátil (2003); Czech (2001).
Data for Turkey is taken from Airaudo (2004), Ozatay (2004), Fkadioğlu, Ozdemir and Yilmaz (2000).
Data for Korea is taken from Hanson and Nam (2005), Kim and Park (2006), Hoffmaister (2001).
Data for Brazil is taken from the Research Department of the Central Bank, Brazil (2000).
Data for Ghana is taken from the Central Bank of Ghana, McKinley (2008) and Opoku-Afari (2008).

A number of points emerge in the case of developing economies. First, inflation is arguably an acceptable malaise in developing economies because of the high priority given to capital accumulation and the infant industry argument. Inflation generates capital gains and controlled interest rates boost investment incentives, which contribute to GDP growth. For this reason, developing countries generally emphasize increasing exports and controlling imports. Central banks try to manage the exchange rates and intervene in exchange rate markets. Second, in the absence of comprehensive analytical grounds for estimating inflation and output loss functions, the probability of the success of IT remains limited. Third, either central banks in developing economies believe in disequilibria in the money market as a cause of inflation or they consider the budget deficit as a reason for inflation. They might also believe in imported inflation and the exchange rate as a reason for wages to rise and trigger cost-push inflation as the first layer of inflation in the economy. The main argument in developing countries is that the interest rate has to be kept low for investment and inflation has to be tolerated in the interest of growth. There is less appreciation of the likelihood of uncertainty associated with inflation damaging expectations and hence affecting growth adversely.

2.4. Conditions for an IT Rule in Pakistan

The financial crises of the 1990s showed the need to adopt more market-oriented policies. An important element in the process of liberalization was the first steps taken in 1993 toward an autonomous State Bank of Pakistan (SBP), the central bank of the country. In 2001/02, the SBP adopted a free-floating exchange rate, reflecting its willingness to put its house in order by adopting a market-based monetary policy, a liberalized exchange rate regime, and an adjustment in T-bills' interest rate as an anchor for investment-friendly environment. It was against this backdrop that the debate on whether or not IT could be successfully implemented in Pakistan started. Gleaning from the experience of the IT countries outlined earlier, it can be said that adopting IT requires the existence of high inflation, sound financial markets, low fiscal dominance, an autonomous central bank that can independently choose a monetary policy stance, strong commitment and an effective and open channel of information with the public helping it form expectations about the future, and a nominal anchor that has a strong relationship with inflation. We now contextualize these conditions for Pakistan.

2.4.1 *Inflation Rate*

In Pakistan, the average annual inflation rate was 9.06 percent during 1970-2009, with a standard deviation of 5.61.[4] This is moderately high and volatile in nature. Inflation volatility and the associated uncertainty may generate a negative shock to output. Recently, the SBP took a tight monetary policy stance. The business sector raised a great hue and cry against higher interest rates, but it is not doing anything about the less concerned with the issue of productivity, which is important for increasing output when the economy is working below its potential level.

2.4.2 *Nominal Anchor*

The SBP has been using growth in broad money as an anchor to control inflation. There is discretion with a sense of safe limits, but this is not always the case in practice. Monetization of public debt is the main reason for monetary expansion in Pakistan. As a result, the SBP has lost control over broad money as an instrument to influence prices. M2 and inflation has two-way causation only with one lag but this bilateral causation fails with two lags. In the short run, M2 is not considered a reliable indicator of changes in monetary conditions and measurement of M2 as an indicator of demand for money is unstable. The recent liquidity crunch has made the situation worse.

The other variable that could lend itself as an anchor and is used in other developing economies is the exchange rate. Pakistan has already adopted a flexible exchange rate, which is in effect a dirty float. Evidence shows that there is very low exchange rate pass-through to inflation in the case of Pakistan. This is also due to the fact that net exports are not significant. Our results suggest that, whenever inflation increases, it affects the interest rate, and this results in the depreciation of the exchange rate. Pakistan has adopted a floating exchange rate regime but, as already noted, it intervenes whenever there is a crisis.

The third variable that could perform as a nominal anchor is the short-run interest rate. There exists a two-way causation between inflation and the call money rate in Pakistan. The anchor should have a long-run relationship with inflation and must be stable. In Pakistan, interest rates have been kept low most of the time and inflation has been high, which has had a negative effect on output. As the interest rate has a positive and significant relationship with the inflation rate, it can be used as an anchor. If inflation occurs in the economy, the interest rate will move to adjust. The

[4] For details see Saleem (2008).

real interest rate remains rigid, which shows that, due to the implications for debt and growth, the SBP has always been reluctant to allow changes to the real interest rate. The movement in the interest rate depends on the conditions prevailing in financial markets, not on policy. In Pakistan the M2/GDP ratio was almost constant throughout the 1990s and during 2000-05, the M2/GDP ratio increased drastically but was still low compared to other developing economies. Money supply increase shows financial deepening. Further, at an inflation rate of just under 10 percent, the interest rate is sensitive to inflation monitoring.

2.4.3 Conditions in the Financial Markets

Pakistan's financial markets are underdeveloped and comprise capital, money, and forex markets in the economy. The capital market consists of three stock markets in Karachi, Lahore, and Islamabad. It is highly volatile due to the narrow investor base. The money market comprises the banking sector, which had a total of 41 banks with 7,746 branches in June 2007. On average, one branch serves around 200,000 persons. Only 15 percent of the population has bank accounts. Most bank branches cluster together in urban areas. According to a recent study, 40 percent of the population has no access to financial services, formal or informal (Nenova et al., 2009).

The banking system has enjoyed rigid 'repo rates' and a controlled interest rate. Restructuring of the banking sector and overall financial sector reform started in the early 1990s under the umbrella of the International Monetary Fund (IMF) and World Bank. Two important objectives of the reforms were to reduce financial intermediation costs and government reliance on bank borrowing. Progress has been slow because of the increasing trend of *seigniorage*, the inflation rate, and interest rate spreads.

IT demands a vibrant financial sector, which can adjust itself according to market needs. Fragile, less integrated financial markets are the real hindrance in adopting IT. Markets give signals to individuals and rational economic agents respond to incentives. Distortions in markets impede these signals and create rigidities. Efforts to remove rigidities from the country's financial markets have met with partial success. The answer to how markets grow does not lie in a half-hearted reform agenda.

2.4.4 Autonomy of the SBP

The SBP has suffered from government influence like many other central banks, and it is not fully independent in the making of monetary

policy. Although a certain degree of coordination is recommended between monetary and fiscal policy for developing economies, a central bank cannot sacrifice the objective of price stability over the government's proclivity towards short-run inflationary growth. Autonomy was granted to the SBP in 1993, but the intrusive ministry of finance continues to effectively dilute it. The weak stance of monetary policy and lukewarm concern for controlling inflation reflect weak autonomy.

Several measures have been taken in the name of economic stability. The Fiscal Responsibility and Debt Limitation Act 2004 was passed with the objective of reducing the fiscal deficit and debt burden. However, it does not place any limit on the federal government's borrowing from the SBP.[5] A floating exchange rate regime was adopted for increasing export competitiveness and decreasing dependence on external inflows. In practice, however, the SBP has, more often than not, preferred short-run growth over long-run price stability. The government has a growth agenda for which the SBP invariably sacrifices price stability. Monetary policy is tightened only when the government fails to raise financing from foreign sources in the form of remittances and debt, forcing an arrangement with the IMF. The SBP has kept the interest rate low and financed the government to meet short-run obligations. Which has had adverse implications for the investment climate and for the availability of credit to the private sector. Furthermore, it has been slow in nurturing capital markets which function efficiently so that the government can rely on it to fulfill its financing needs.

The autonomy of a central bank can be measured by fiscal dominance. We measured *seigniorage* for Pakistan as a proxy for fiscal dominance, which turns out to be very high. With a maximum value of 26.89 percent and minimum value of 0.75 percent, its average lies at 7.32 percent. At 5.62 per cent during 1970-2005, the standard deviation is also very high. The absence of fiscal dominance is a prerequisite for pursuing IT. High *seigniorage* also suggests the existence of a fragile financial market, limiting the options available for nonbank borrowing.

2.4.5 Volatility of Growth and Inflation

Inflation volatility is a source of uncertainty in economic growth. Further, inflation volatility is significantly and positively related to the level of inflation. Put together, these conclusions support the widely held

[5] Recently, the National Assembly passed a bill to amend the State Bank Act to reduce fiscal dominance and place limits on bank borrowing; it awaits the approval of the Senate.

belief that inflation uncertainty adversely affects economic growth. This type of relationship between a volatile inflation rate and growth creates concern in the central bank and it makes the case for stabilization. In the case of Pakistan, inflation is volatile and our findings have shown that growth is inflationary. The SBP has preferred the growth objective to price stability. Inflation has never been high on the SBP's priority list, but this policy has failed to minimize the output gap.

The SBP has started using interest rate adjustment but it also has to finance the fiscal deficit. This lowers its commitment to controlling inflation and transparency in its operations. Its communication with the public is weak and there is no forward-looking behavioral model for the inflation rate and these are real obstacles to the success of IT in Pakistan. Again, the SBP has not played an active role in facilitating the public in forming expectations. Dealing with these issues may seem a daunting task, but by giving priority to the public and demonstrating a commitment to inflation control, reform through market signals can be started to put the economy on a sustainable path to stable growth.

3. The Model and its Data

We take Soderstorm's (1999) model and modify it on the basis of the literature on open economies and the response of the central bank to controlling inflation. Soderstorm criticized the Sevensson (1998) model for failing to incorporate an explicit interest rate equation and showed that this results in a more aggressive policy prescription. Our model introduces an explicit interest rate equation. Investment is crucial to growth in a developing economy. The central bank cannot afford to implement an aggressive policy to control inflation because of the inverse relationship between the interest rate and investment.

Formulated in this way, our model gives us the following relationship between the output gap, inflation rate, and interest rate.

$$y_{t+1} = \alpha(L)y_t + \beta(L)(i_t - \pi_t) + \varepsilon_{t+1} \tag{1}$$

This equation measures the aggregate demand type relationship between the output gap and its lag terms, where y_t is the gap between actual and potential GDP. A potential output series is generated using the Hodrick-Prescott filter to smooth the trend. It is widely used to obtain a smooth estimate of the long-term trend component of a series. Thus the output-inflation gap is measured on the basis of percentage deviation

from trend, the deviation between the interest rate and inflation rate. The term $(i_t - \pi_t)$ explains inflationary expectations and the interest rate path in the economy. This type of path helps in forming expectations. As we are following the rational expectations hypothesis, these expectations are measured in the form of an average relationship.

The inflation rate is measured by an aggregate supply type of equation:

$$\pi_{t+1} = \delta(L)\pi_t + \gamma(L)y_t + \mu_{t+1} \tag{2}$$

It relates the lead inflation rate to its current and lagged inflation rate, and output gap. It is assumed to follow an accelerationist type Philips curve relationship (Svensson, 1998).

This is a modified version of the parameter δ because it can assume any value different from 1 and is stochastic but not time varying. We were unable to use the time varying coefficient technique because of data limitations. In this paper, we have used annual data for the period 1970-2009.

A VAR representation explains that the central bank has to set the interest rate while adjusting output and inflation in the economy. This model tests whether the central bank's behavior is moderate or aggressive in controlling inflation.

$$y_{t+1} = \sum_{s=1}^{L} A_s^y y_{t-s} + \sum_{s=1}^{L} B_s^y \pi_{t-s} + \sum_{s=1}^{L} C_s^y i_{t-s} + \varepsilon_t^y \tag{3}$$

$$\pi_{t+1} = \sum_{s=1}^{L} A_s^\pi y_{t-s} + \sum_{s=1}^{L} B_s^\pi \pi_{t-s} + \sum_{S=1}^{L} C_s^\pi i_{t-s} + \varepsilon_t^\pi \tag{4}$$

$$i_{t+1} = \sum_{s=1}^{L} A_s^i y_{t-s} + \sum_{s=1}^{L} B_s^i \pi_{t-s} + \sum_{S=1}^{L} C_s^i i_{t-s} + \varepsilon_t^i \tag{5}$$

π_t is the annual CPI inflation rate, i_t is the call money rate, and y_t is the output gap. This model assumes that the central bank is not only responsible for price stability but also for maintaining financial stability and a congenial macroeconomic environment. It further assumes that shocks and changes in monetary and fiscal policy have no impact. In this way, the modified model deals with the supply side and demand side

equations in the open economy and explicitly recognizes interest rate and exchange rate adjustments in the open economy. An unrestricted VAR is used to estimate the model and forecast the future inflation rate (Soderstorm, 1999).

Our sources for the annual data series for the period 1970-2008 include *World Development Indicators* (World Bank, 2005), *International Financial Statistics* (IMF, 2007b), various issues of the *Pakistan Economic Survey*, and the website of the Federal Bureau of Statistics.

4. Empirical Results

Inflation Rate in a Closed Economy

Equation 1 explains the aggregate demand relationship in the economy for the study period. It relates the output gap to its own lag and lead relationships and the difference between the inflation rate and short-run interest rate, which is the call money rate in Pakistan. The results show that

$$\log y_{t+1} = 1.48 + 1.85 \log y_t - 1.14 \log y_{t-1} - 0.17(\pi^{\exp} - i^{\exp}) + \eta_t$$

S.E.	(2.04)	(0.62)	(0.44)	(0.26)
t - ratio	(0.725)	(2.98)	(-2.59)	(0.65)

$R^2 = 0.86$ D.W = 1.95 S.E. = 3.13

We use the OLS method for estimation. This equation confirms that in determining aggregate demand, the rational expectations hypothesis holds with particular force. We impose restrictions on the coefficients of the output gap and reject the null hypothesis to conclude that people show forward-looking behavior in forming their expectations.

Estimates of the aggregate supply equation show that the future rate of inflation depends on the lag series of the inflation rate, confirming that inflation is adaptive. All the coefficients are less than 1 so we reject the accelerationist hypothesis and confirm that no inflation-unemployment trade off existed in Pakistan during the study period. We can suggest the existence of a vertical type of Philips curve in Pakistan whereby individuals can synthesize information to offset policy effects. Inflation thus does not generate unemployment in Pakistan. These results are in line with the original empirical study of Rudebusch and Sevensson (1998).

$$\log \pi_{t+1} = 0.55 \log \pi_t - 0.013 \log y_t + 0.38 i_{t-1} - 0.077 \log xr_{t-1} + \varepsilon_t$$

S.E.	(0.20)	(0.077)	(0.27)	(0.16)
$t-ratio$	(2.75)	(−0.168)	(1.41)	(0.48)

$R^2 = 0.57$ D.W = 2.01 S.E. = 0.369

We impose linear restrictions to check that the sum of all autoregressive terms is equal to 1. The results of the Wald test show that the null hypothesis that inflation is adaptive in nature for the period 1970-2009 is not rejected. It also means that the SBP is using a backward-looking model rather than a forward-looking path to determine the inflation rate in the economy. We check the results for the stability test by examining the CUSUM and CUSUM square test, which confirms that the model is stable. Our model's results are comparable with other empirical findings of Soderstorm (1999) and Rudebusch and Sevensson (1998), which enhances the plausibility of our estimates. These results support the original empirical study of Rudebusch and Sevensson (1998).

4.1. VAR Results

To estimate the stability of the variables, we estimate an unrestricted vector autoregressive (VAR) model. This enables us to measure the sensitivity of the policy instrument, i.e., of the interest rate to the output gap and its impact on controlling inflation. Tests such as the augmented Dickey-Fuller (ADF) were applied to data on the inflation rate measured on the basis of the CPI (π_t), the lending rate measured on the basis of the average call money rate (i_t), and the output gap (y_t). The maximum lag length is 1, determined on the basis of the Akiake information criterion. Each column in the VAR summary table represents the equation in the system.

Table-2: VAR Results 1970-2009

	π_t	Y_t	i_t
π_{t-1}	0.734	-0.001	0.142
t- ratios	[4.93]*	[-0.17]	[3.12]*
Y_{t-1}	-0.404	0.98	-0.119
t- ratios	[-0.45]	[23.2]*	[-0.43]
i_{t-1}	-0.676	0.007	0.631
t- ratios	[-1.98]**	[0.45]	[6.05]*
Intercept	10.33	0.085	2.41
t- ratios	[1.695]	[0.296]	[1.292]
Adj. R-squared	0.375	0.94	0.65
Akaike Information Criterion	5.93	-0.196	3.56
Schwarz Information Criterion	6.1	-0.02	3.73
F-statistic	8.39	192.7	23.99
Log likelihood	-108.58	7.72	-63.56

* Indicates significance at 1 percent level ** Indicates significance at 5 percent level

The results of VAR inflation equation (4) (π_t) explain the relationship between inflation and its lag value, output gap, and short-run interest rate. It shows that the inflation rate is determined by the previous value of inflation and that it is significant. The output gap is negatively related to the inflation rate but is insignificant. The interest rate is negatively related and significant. We can conclude that the interest rate does affect the inflation rate.

Equation 3 measures the relationship between the output gap and the lag value of inflation rate and call money rate. The output gap is negatively related to the lagged value of the inflation rate, and positively related to the lagged value of the output gap and interest rate. However neither the inflation rate nor the interest rate is significant in explaining the output gap in the economy.

Equation 5 explains the interest rate and its responsiveness to inflation rate. The lagged value of the inflation rate affects the interest rate. This indicates the interest sensitivity of inflation.

V. Conclusions and Policy Implications

On the basis of empirical evidence, we can conclude that inflation is monetary and that the central bank can control inflation in Pakistan using the interest rate as a nominal anchor because there exists a negative relationship between the interest rate and inflation. This exercise also shows that prices have a long memory capable of impacting the interest rate and that the inflation rate is an indication for using IT as a policy instrument.

The SBP currently uses a backward-looking or adaptive form model to determine the path of the interest rate or inflation rate in the economy, while households and firms use rational expectations to indicate the path of inflation and stance of monetary policy in Pakistan. In this situation, IT could help stabilize the inflation-output relationship. There is no evidence for the accelerationist hypothesis in Pakistan. This means that we have a vertical type of Philips curve, which shows that policy behaviors are firm and not changing with respect to shocks in the economy.

The results confirm that the central bank has to pursue a more diversified objective while prioritizing the inflation rate via the interest rate. It needs to keep an eye on the output-inflation gap, exchange rate movements, and stability in the financial market. When a shock emerges in the economy, the nominal anchor moves to correct this disequilibrium, which results in loss of output and generates volatility in the system. These shocks are unpredictable and require a response from the central bank. This adds another dimension as to whether the policy response should be aggressive or conservative. The answer lies in the severity of shocks and uncertainty vis-a-vis the inflation-output tradeoff. If the inflation-output gap is volatile, then the central bank needs to adopt an aggressive stance. In this situation, IT would stabilize the inflation-output relationship.

We find that the interest rate channel exists for price stability in Pakistan. GDP growth and inflation during 1970-2009 are found to be negatively related, which makes the case for IT. We recommend that Pakistan should adopt flexible IT, which means that it can manage the exchange rate in addition to the interest rate, depending on the priorities emerging from inflation. To offset demand shocks in the economy, the SBP needs to win credibility by adopting aggressive monetary policy to monitor the future inflation rate.

The choice of IT, with all its limitations, is a market-based mechanism. Properly functioning markets do not exist as a prerequisite. Pakistan's situation, however, demands IT as a commitment of the SBP. By exerting pressure on markets, this commitment will allow markets to grow and respond. The fiscal burden is an indicator of an underdeveloped financial market and the fragility of the financial market means that it is prone to more financial crises. The increased intensity of financial crises demands transparent financial policies and commitment to the public interest. Fiscal pressure is negatively associated with the choice of adopting IT. Tahir (2004) suggests financial sector reforms to improve the market mechanism and he stresses the need for a legal framework for adopting IT in Pakistan.

We conclude that IT *per se* is not an objective, but is a means to achieving the objective of transparent market-oriented polices and to stabilize growth by providing a level playing field for investors and savers. It is a policy with certain limitations and, like any other good policy, its benefits depend on the quality of commitment.

References

Airaudo, M. (2004). Turkey Moves to Explicit Inflation Targeting? Some Lessons from a Simple Model of Policy Design With Imperfect Credibility. Paper presented at the LUISS Lab on European Economics, Rome, and Centre for European Policy Studies, Brussels.

Angeriz, A., and Arestis, P. (2005). *Inflation Targeting: Assessing the Evidence*. Cambridge: Centre for Economic and Public Policy, Department of Land Economy, University of Cambridge.

Ball, L., Mankiw, N.G., and Reis, R. (2003). Monetary Policy for Inattentive Economies. NBER Working Paper No. W9491.

Bank of Ghana. (2008). *Annual Report 2007*.

Bank of Ghana. (2001). *Monetary and Exchange Rate Management*.

Batini, N., and Haldane, A. (1999). Forward-Looking Rules for Monetary Policy. In John B. Taylor (ed.) *Monetary Policy Rules*. Chicago: Chicago University Press.

Bernanke, B.S., Laubach, T., Mishkin, F., and Posen, A. (1999). *Inflation Targeting: Lessons from the International Experience.* Princeton, N.J.: Princeton University Press.

Boughrara, A. (2004). Can Tunisia Move to Inflation Targeting? *Developing Economies*, 45 (1), 27-62.

Central Bank of Brazil. (2000). *Issues in the Adoption of an Inflation Targeting Framework in Brazil*. Research Department.

Czech National Bank. (2001). *The Setting of the Inflation Target for 2002-2005*. Retrieved from http://www.cnb.cz.

Ford, G. (1974). Whip inflation now. Retrieved from http://en.wikipedia.org/wiki/Whip_Inflation_Now.

Gaiduch, V., and Hunt, B. (2000). Inflation Targeting under Potential Output Uncertainty. Reserve Bank of New Zealand Working Paper No. DP2000/08.

Gottschalk, J., & Moore, D. (2001). Implementing Inflation Targeting Regimes: The Case of Poland. *Journal of Comparative Economics*, 29 (1), 24-39.

Government of Pakistan. *Pakistan Economic Survey.* Various Issues. Islamabad: Finance Division.

Government of Pakistan. (2009). www.statpak.gov.pk/depts/index.htm, Federal Bureau of Statistics.

Greenspan, A. (1988). Testimony before the Committee on Banking, Finance and Urban Affairs, US Senate, July 13.

Hanson, M. S., and Nam, K. (2005). Inflation Targeting in an Emerging Market: The Case of Korea. Wesleyan Economics Working Papers, No. 2005-007.

Hebbel, K. S., and Tapia, M. (2003). Toward Floating and Inflation Targeting in Chile. Paper prepared for the CEPT/Deutsche Bank Research Workshop, Kronberg, Germany.

Hoffmaister, A.W. (2001). Inflation Targeting in Korea: An Empirical Exploration. *IMF Staff Papers*, 48 (2), 317-343.

Hu, Y. (2003). Empirical Investigations of Inflation Targeting. IIE Working Papers Series, WP No. 03-6.

International Monetary Fund. (2007a). New Inflation-Targeting Countries. *Monetary Bulletin*, 2.

International Monetary Fund. (2007b). *International Financial Statistics*. [CD-ROM].

Kadioğlu, F., Özdemir, N., and Yilmaz, G. (2000). Inflation Targeting in Developing Countries. The Central Bank of the Republic of Turkey Discussion Paper.

Kim, S., and Park, Y. C. (2006). Inflation Targeting in Korea: A Model of Success? Department of Economics, Korea University, Seoul. BIS Paper No. 31.

Kotlan, V., and Navratil, D. (2003). Inflation Targeting as a Stabilization Rule: Its Design and Performance in the Czech Republic. *Czech Journal of Economics and Finance*, 53, 220-242.

Malik, W.S., and Ahmed, A.M. (2010). Taylor Rule and Macroeconomic Performance in Pakistan. *Pakistan Development Review*, 49 (1), 37-56.

Masson, P., Savastano, M.A., and Sharma, S. (1997). The Scope for Inflation Targeting in Developing Countries. IMF Working Paper 97/130.

McCallum, B.T., and Nelson, E. (1999). Nominal Income Targeting in an Open Economy Optimizing Model. *Journal of Monetary Economics*, 43 (3), 553-578.

McKinley, T. (2007). Why is Africa Constrained from Spending ODA? International Policy Centre for Inclusive Growth, Brasilia. One Pager No. 34.

Mishkin, F.S., and Posen, A.S. (1998). Inflation Targeting: Lessons from Four Countries. NBER Working Paper 6126.

Nenova, T., Niang, C., and Ahmad, A. (2009). *Bringing Finance to Pakistan's Poor: A study on Access to Finance for the Undersaved and Small Enterprises*. Washington, DC: The World Bank.

Opoku-Afari, M. (2008). *Inflation Targeting a Turning Point in Ghana*. Bank of Ghana.

Ozatay, F. (2004). High Public Debt, Multiple Equilibria and Inflation Targeting in Turkey. In *Globalization and Monetary Policy in Emerging Markets*. Bank of International Settlements Paper No. 23.

Saleem, N. (2008). *Dynamics of Inflation, Exchange Rates and Inflation Targeting in Pakistan*. Unpublished PhD Thesis, Government College University, Lahore.

Soderstorm, U. (1999). Should Central Bank be More Aggressive? Working Paper in Economics and Finance No. 309, Stockholm School of Economics.

Svensson, L.E.O., and Rudebusch, G.D. (1998). Policy rules for inflation targeting. *NBER Conference on Monetary Policy Rules*, 104, 125-145.

Svensson, L. E. O. (2000). Open Economy Inflation Targeting. *Journal of International Economics*, 50, 155-83.

Svensson, L. E. O. (1999). Inflation Targeting as a Monetary Policy Rule. *Journal of Monetary Economics*, 43, 607-654.

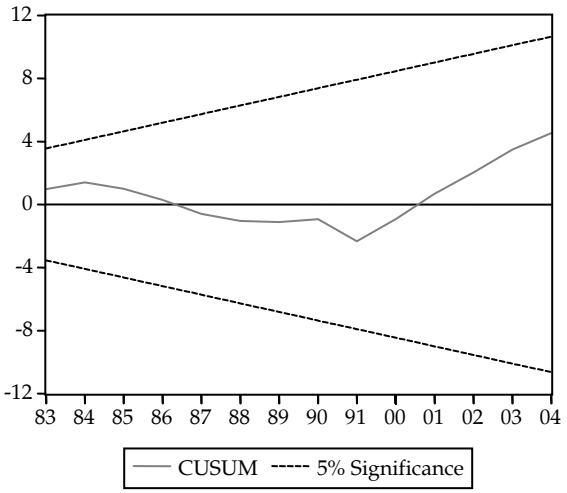
Tahir, P. (2004). Institutional Arrangements for Financial Sector Governance. *SBP Research Bulletin*, 2 (1), 283-310.

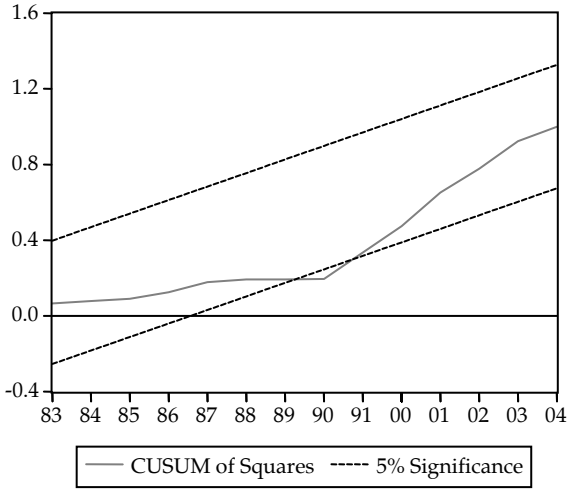
Truman, E.M. (2005). *Inflation Targeting in the World Economy.* New Delhi: Viva Books.

World Bank. (2005). *World Development Indicators*. [CD-ROM].

Appendix

Stability of the Model





The Lahore Journal of Economics
15 : 2 (Winter 2010): pp. 77-96

Evaluation of Rice Markets Integration in Bangladesh

Mohammad Ismail Hossain* **and Wim Verbeke****

Abstract

The liberalization of the agricultural sector in general and the rice subsector in particular has been a major component of Bangladesh's structural adjustment program initiated in 1992. However, the government has continued to intervene in the rice subsector. This paper examines whether the regional/divisional rice markets have become spatially integrated following the liberalization of the rice market. Wholesale weekly coarse rice prices at six divisional levels over the period of January 2004 to November 2006 were used to test the degree of market integration in Bangladesh using co-integration analysis and a vector error correction model (VECM). The Johansen co-integration test indicated that there are at least three co-integrating vectors implying that rice markets in Bangladesh during the study period are moderately linked together and therefore the long-run equilibrium is stable. The short-run market integration as measured by the magnitude of market interdependence and the speed of price transmission between the divisional markets has been weak.

Keywords: Market liberalization, integration; vector error correction model, rice, price transmission, Bangladesh.

JEL Classification: D 40, Q 13.

1. Introduction

While globalization and liberalization has opened up new avenues of international and regional trade, the gains of liberalization, accrue to the producers-sellers and consumers only if agriculture and food supply chains become efficient, competitive, and innovative not only in production but also in marketing. In the past 20 years, a number of Asian countries including Bangladesh have adopted market-oriented policies resulting in the reduction of government intervention in agricultural markets. The general consensus among economists and

* PhD Candidate, Department of Agricultural Economics, Faculty of Agriculture, Aristotle University of Thessaloniki, Greece.
** Professor, Department of Agricultural Economics, Faculty of Bioscience Engineering, Ghent University, Belgium.

policymakers is that market liberalization enhances economic growth whereas intervention policies inhibit it (FAO, 1987; Onafowora and Owoye, 1998). Unless agricultural markets are integrated, producers and consumers will not realize the gains from liberalization, since the correct price signals will not be transmitted through the marketing channels and as a result farmers will not be able to specialize according to long-term competitive advantages. Finally, the potential gains from trade will not be realized in full (Ravallion, 1986). Therefore, in the past years a number of developing countries have adopted market-oriented policies, characterized by a reduction and/or complete elimination of the main market distortions. Within agriculture, particularly the food grains subsector, these have included the removal of restrictions on inter-regional trade of food grains by traders; elimination of regional and seasonal pricing; and reform or even complete abolition of government parastatal marketing organizations for allowing greater private sector participation. Rice markets in Bangladesh underwent major liberalization during the late 1980s and early 1990s.

Market integration is a central issue in many contemporary debates concerning market liberalization. It is perceived as a precondition for effective market reform in developing countries: "Without spatial integration of markets, price signals will not be transmitted from urban food deficit to rural food surplus areas, prices will be more volatile, agricultural producers will fail to specialize according to long term comparative advantage and gains from trade will not be realized" (Baulch, 1997, p. 477).

An indirect method of analyzing market efficiency is to test for market integration (Hopcraft, 1987). A basic issue preoccupying many researchers is whether market liberalization enhances the integration of spatial markets (Silumbu, 1992; Goletti and Babu, 1994; Goletti et al., 1995; Barrett, 1996; Dercon, 1995, Getnet et al.; 2005). Silumbu (1992) used monthly wholesale prices to test for the spatial and inter-temporal market integration of maize markets in Malawi and found that the integration of urban markets had increased slightly even under partial liberalization. Goletti and Babu (1994) used different measures of integration and monthly retail maize prices for eight regional markets in Malawi. They concluded that the liberalization of the maize market had increased market integration. Goletti et al. (1995) used weekly wholesale prices of rice to test the structural determinants of market integration in the rice market in Bangladesh and concluded that the degree of rice market integration in Bangladesh is moderate. Baulch et al. (1998) studied the spatial integration

and pricing efficiency of the private sector grain trade in Bangladesh and provided econometric evidence suggesting that wholesale markets for rice are in fact well integrated, except for periods of major shortages in domestic production (such as those just after the 1997/98 and 1998/99 *Aman* harvests). Finally, Getnet et al. (2005) studied the spatial equilibrium of grain markets (white teff) in Ethiopia by using the co-integration technique and provided evidence of domestic market integration.

For spatially dispersed regional food markets, as exist in many Asian countries, the nature and extent of market integration in the context of food market liberalization is of vital importance, since many of the regional food markets are characterized by periodic food shortages which have the potential to generate transient food insecurity and sometimes even chronic food security problems. Merely knowing that markets are integrated is not enough. It is necessary to know the extent of spatial market integration within the context of market integration. This paper uses cointegration analysis to formally test whether rice markets in Bangladesh have become integrated.

2. Methodology

The model of spatial integration predicts that, under competitive conditions, price differences between two regions in the same economic market for a homogeneous commodity will approximately equal the inter-regional transportation costs. Market integration thus involves a test of price efficiency by examining how food markets in different regions respond jointly to supply and demand forces. If price movements in different parts of the country tend to behave similarly, reflecting the cost of transferring the product between two regions, then markets are said to be integrated.

Several studies on market liberalization have tested for food market integration (Gupta and Mueller, 1982; Hytens, 1986; Ravallion, 1986; Silumbu, 1992; Alexander and Wyeth; 1994; Goletti and Babu, 1994; Dercon, 1995; and Goletti et al., 1995; Goletti et al., 1994). Early empirical studies of market integration used static price correlations to test for spatial market integration in agricultural markets (Jones, 1968; 1972; Farruk, 1970; and Lele, 1972). This involves the estimation of bivariate correlation or regression coefficients between the time series of spot prices for an identical good at different market places. In these analyses, a statistically significant coefficient implies that the two markets are integrated. This kind of modeling of spatial market integration has been criticized for masking other

effects like inflation and seasonality. Price correlation assumes instantaneous price adjustment and cannot capture the dynamic nature of a marketing system (Heytens, 1986; Ravallion, 1986 and Sexton et al., 1991). It is possible that price correlation might suggest be the result of spurious market integration, like common trends, common seasonality, monopoly price fixing, etc. (Harriss, 1979; Delgado, 1986; and Heytens, 1986). Price correlation tests may also overestimate a lack of market integration if a lag in market information produces a lag in the price response between markets (Barrett, 1996). Finally, price correlation tests only a pair of markets at a time and cannot be used to evaluate the marketing system as a whole (Delgado, 1986). In order to overcome the weaknesses of price correlation tests, various alternative methods have been developed (Delgado, 1986; Ravallion, 1986; Engle and Granger, 1987 and Johansen, 1988).

Time series methods have been introduced in the study of market integration to overcome the problems of common trends and nonstationarity of food prices inherent in bivariate price correlation models. Studies employing time series methods also formally modeled issues pertaining to short-run and long-run integration, seasonality, and the degree of market integration (Boyd and Brosern, 1986; Delgado, 1986; and Ravallion, 1986).

The Granger causality method employs an error correction mechanism to determine the extent to which current and past price changes in one market explain price changes in another. The error correction model (ECM) (Engle and Granger, 1987) holds that if the price of a local market and the price of the central market are co-integrated, then the error term from the co-integrating equation should be included, otherwise a first differencing regression between the two prices will be mis-specified and cannot be used to test for market integration (Palaskas and Harriss, 1993; Dercon, 1995). The advantage of the ECM is that not only can short-run and long-run information be conveyed between markets, but the relevant direction of the flow of price information can also be determined. Another advantage of the ECM is that it helps to alleviate the problems of auto-correlation and multicollinearity of most food price series (Baulch, 1997). The shortcoming of Granger co-integration analysis is that it does not allow for the investigation of all possible co-integrating vectors in a multivariate system (Myers, 1994; Fackler, 1996).

Johansen (1988) developed a multivariate method of co-integration analysis which is a more recent development in this field. The

method uses a maximum likelihood methodology to test the hypothesis of co-integrating relationships among several economic time series. The use of multivariate analysis is the most suitable approach to use if prices are endogenously determined, which is usually the case for food markets, and in which prices are simultaneously determined. The multivariate approach was used by Silvapulle and Jayasuriya (1994) in their study of Philippine rice markets to study the co-integration of markets; they found that rice markets were co-integrated. Chang and Griffith (1998) applied the multivariate approach to Australian monthly beef prices at the farm, wholesale, and retail levels and found all three prices to be co-integrated.

For the present study, there is some validity in the above mentioned criticisms especially as far as non-stationary transfer costs are concerned. Nonetheless, time series analysis can provide useful insights into the issue of market integration if an appropriate testing framework is employed and the results are interpreted correctly. Co-integration tests and ECMs provide an analytical tool that can focus beyond the case of market integration in testing notions such as completeness, speed, and asymmetry of the relationship between prices.

In analyzing spatial integration, data on daily prices or average weekly prices are preferable. Like other developing countries, in Bangladesh, daily prices are available for only a few central markets and only for a short period of time. For the purpose of this study, data pertaining to weekly wholesale rice prices were collected from different marketing intelligence centers (MICs) as assigned by the Department of Agricultural Marketing, Government of the People's Republic of Bangladesh, for the period January 2004 to November 2006. Data on prices pertain to Friday of each week for twelve months. The prices were reported in Tk/quintal. The selected six MICs for this study were Dhaka, Chittagong, Rajshahi, Khulna, Barisal, and Sylhet.

The individual price series are tested for the order of integration to determine whether or not they are stationary. A number of tests for stationarity are available in the literature; these include the Dickey-Fuller (DF) test (Dickey and Fuller, 1979), the Augmented Dickey-Fuller (ADF) test (Dickey and Fuller, 1981) and the Philips-Perron (PP) test (Perron, 1988). Having established that the variables are nonstationary a maximum likelihood approach based on a finite vector autoregression (VAR) model as developed by Johansen (1991) can be specified to determine whether the system of equations are co-integrated. The model is:

$$X_t = A_0 + A_1 X_{t-1} + \ ... + A_p X_{t-p} + v_t; \mathrm{t} = 1,2, \ldots \mathrm{T}, \quad (1)$$

where p = lag length; X_t = a (n×1) vector of endogenous variables; A's are matrices of unknown parameters; and υ_t is an independently and identically distributed n dimensional vector with zero mean and variance matrix ε_t. The next step is specifying a VAR model in an error correction form. Following Johansen (1988) and Johansen and Juselius (1990), a general system of regression equations is stipulated as:

$$\Delta X_t = \tau_0 + \tau_1 \Delta X_{t\text{-}1} + \quad ... \quad + \tau_{p\text{-}1} \Delta X_{t\text{-}(p\text{-}1)} + \Pi X_{t\text{-}p} + \upsilon_t$$

or

$$\Delta X_t = \tau_0 + \sum_{j=1}^{p-1} \tau_j \Delta X_{t\text{-}1} + \Pi X_{t\text{-}p} + \upsilon_t \quad (2)$$

Where $\tau_0 = A_0$;

$$\tau_j = -\left(I - \sum_{j=1}^{p-1} A_j \right); \mathrm{j} = 1, 2 \ldots\ldots, \mathrm{p\text{-}1}$$

$$\Pi = -\left(I - \sum_{i=1}^{p} A_i \right)$$

and $\Delta X_{t\text{-}j}$ is an (n×1) vector of $X_{t\text{-}j}$ in first differences, and Π and τ_j (j = 1, 2, ……, k) are n by n matrices of parameters and V_t is an n-vector of residuals which are assumed to be normally distributed with mean zero and have a contemporaneous covariance matrix ε_t. The long-run information in X_t is summarized by the long-run impact matrix Π. Π is the rank of the matrix of the VECM that determines the number of independent co-integrating vectors. If the matrix Π has a rank, r, greater than 0, then co-integration exists. If the rank of Π is 0, then the variables are segmented and the model translates into a standard VAR model in differences.

3. Results and Discussion

The original data for the six selected divisional markets are shown in Figure 1 while the logarithm of the six divisional market price series and their first difference series are presented in Figures 2 and 3. It can be

seen from the figures that there are some spatial variations between the divisional markets as well as some seasonal variations.

Figure 1: Nominal wholesale rice prices of six regional divisions in Bangladesh (weekly data from January 7, 2004 to November 29, 2006)

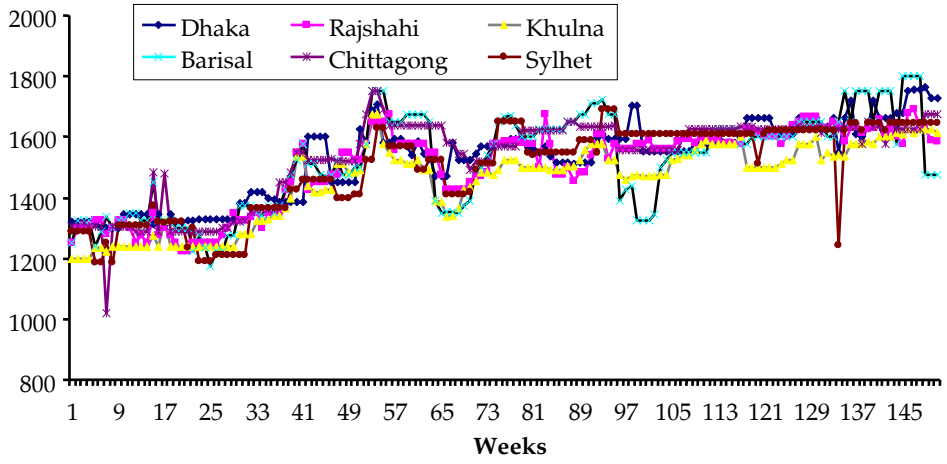


Figure 2: Weekly Log Wholesale Divisional Rice Prices in Levels

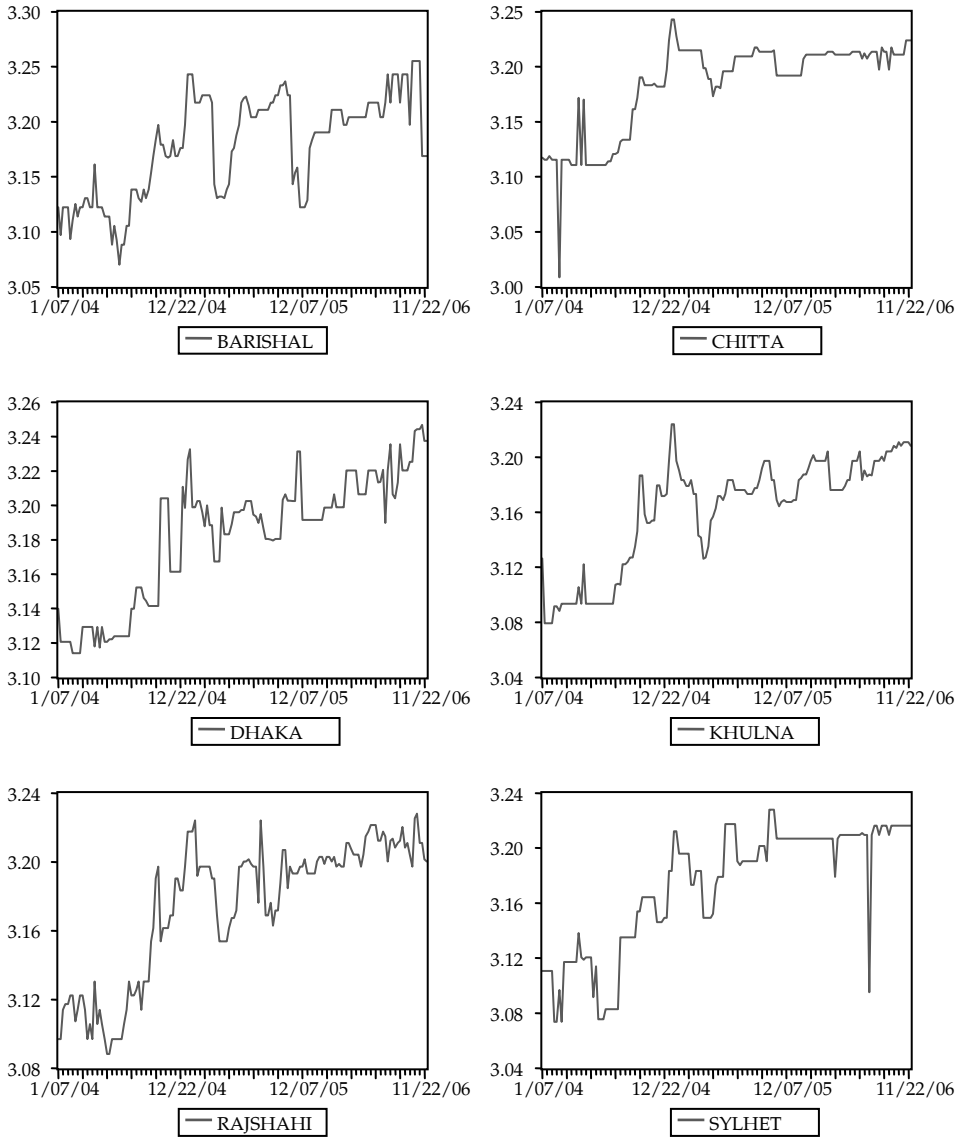
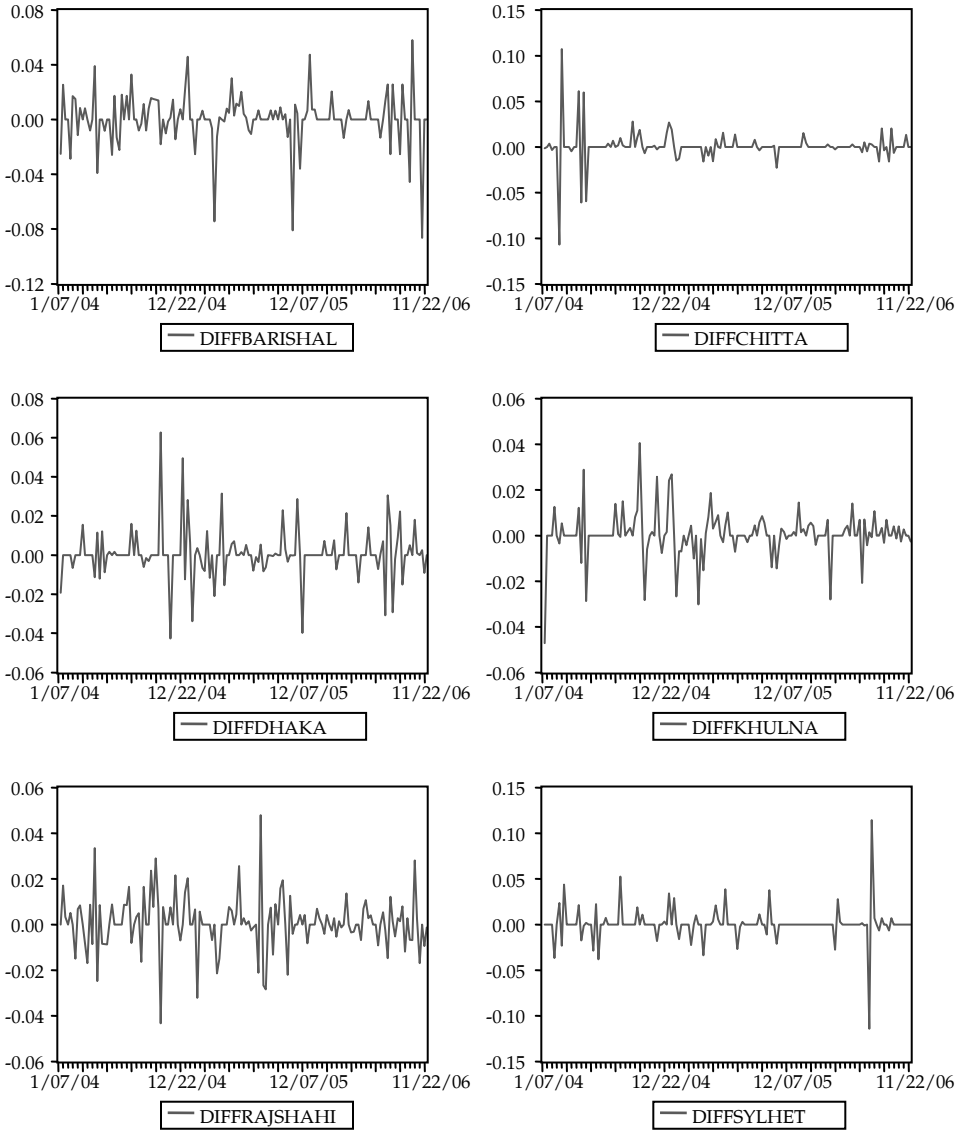


Figure 3: Weekly Log Wholesale Divisional Rice Prices in First Difference



3.1. Co-Integration Analysis Results

For the multivariable model, co-integration is tested using Johansen's maximum likelihood procedure using two test statistics, namely the trace and eigenvalue. The maximum lag was 2, based on the Akaike Information Criterion (AIC) and Schwartz Criterion (SC). The test results are presented in Table-1.

The results of λ_{trace} using the Johansen co-integration test indicate that the rank of Π can reach 3 (at 95% level of significance) which means that there are at least three co-integrating equations in our estimation. If we select r = 4 then the λ_{trace} value is smaller than the critical value. The results from these trace statistics indicate that there are three co-integrating vectors and three common trends which suggest that rice markets are stationary in three directions and nonstationary in three directions. This indicates that the rice markets in Bangladesh during the study period are moderately linked together and that therefore the long-run equilibrium is stable. This finding is supported by the earlier studies carried out Goletti et al. (1995) and Baulch et al. (1998) who also concluded that the degree of market integration in Bangladesh was moderate.

3.2. Causality and Integration of Rice Markets

Before the Granger causality test was carried out, the VECM was tested for the presence of any diagnostic problems to check the adequacy of the model. The model was found to have no major diagnostic problems, i.e., the variables were found to be nonstationary in levels and stationary in differences.

The results for causality tests are inferred from the F statistic shown in Table-2. The results indicate the strength of causality from regional market C to regional market L and vice versa. A Granger causality test to establish the appropriate direction of the flow of price information is implied if the null hypothesis that there is no causality from C to L or L to C is rejected.

Table-1: Results of Co-Integration Analysis

Null hypothesis	Maximum eigenvalue (λ_{max})	Trace statistic (V_{trace})	95% critical value
r = 0	0.286	131.455***	102.14
r = 1	0.172	81.271**	76.07
r = 2	0.124	53.179**	53.12
r = 3	0.116	33.514	34.91
r = 4	0.070	15.194	19.96
r = 5	0.029	4.321	9.24

Note: ** (***) denotes rejection of the hypothesis at 5% (1%) significance level.

If λ_{trace} value exceeds the critical value, the null hypothesis is rejected.

Source: Weekly rice price series 7, 2004 to November 29, 2006 collected from DAM.

Table-2: Granger Causality Test Results

From market C	To market L					
	Dhaka	**Chittagong**	**Rajshahi**	**Khulna**	**Barisal**	**Sylhet**
Dhaka		4.492**	5.57***	2.05	1.53	7.69***
Chittagong	5.94***		1.22	1.57	2.55*	8.27***
Rajshahi	10.92***	4.89***		0.34	3.92**	9.78***
Khulna	12.95***	9.13***	10.01***		6.21*	15.12***
Barisal	8.57***	4.53**	3.48**	0.62		7.70***
Sylhet	1.16	2.84*	2.73*	0.87	1.49	

Note: The figures indicate the calculated F values associated with the hypothesis that there is no Granger causality from market C to L and vice versa and from appendix Table-3.

* Significance at the 10% level ** Significance at the 5% level *** Significance at the 1% level.

Source: Weekly rice price series from January 7, 2004 to November 29, 2006 collected from DAM.

The results suggest that price changes in Dhaka "Granger-cause" price changes in Rajshahi and Sylhet at a 1% level of significance and those in Chittagong at 5%. Price changes in Dhaka are however Granger-caused by those in Chittagong and Rajshahi at 1%. This indicates a two-way causation of prices between Dhaka and Chittagong and Dhaka and Rajshahi. The results for Rajshahi and Chittagong are as expected since Rajshasi is a major surplus region and Chittagong is a deficit region and also an importing region of rice. No causality was found from Dhaka to Khulna and Barisal, and from Sylhet to Dhaka. This implies that Dhaka to Khulna and Barisal and Sylhet to Dhaka; Dhaka leads the price formation process for only Sylhet. However, there was bi-directional causality between Dhaka and Chittagong, and Dhaka and Rajshahi. Thus, Dhaka cannot be considered a central market.

Chittagong is an urban deficit region and situated in the southern part of Bangladesh. The results reveal bi-directional causality with Dhaka, Barisal and Sylhet; and unidirectional causality from Khulna to Chittagong and from Rajshahi to Chittagong. It is said that Chittagong is not a major central market for the other regional centers. Rajshahi is a major surplus region and has unidirectional Granger causality with Chittagong, insignificant causality with Khulna, and bi-directional causality with Dhaka, Barisal, and Sylhet. Khulna is another surplus region and has significant unidirectional causality with all five regions. The Khulna region is a price leader for all other regions, which is unexpected.

On the basis of the Granger causality results, we conclude that there is no dominant market whose price changes influence all other markets. The bivariate model reveals that price changes in Bangladesh appear to be organized around more than one market. These results are in line with the nature of markets in developing countries, in that those markets are usually more complex than is portrayed by the Ravallion radial configuration of markets. These results are similar to what Silvapulle and Jayasuriya (1994) found in their analysis of rice markets in the Philippines.

3.3. Dynamic Analysis of Rice Market Integration

It is not sufficient to know that markets are integrated. It is also important to know the extent to which markets are integrated. This requires distinguishing between the short- and long-run impacts of price changes emanating from one region to another. The speed of adjustment, the length of time needed for prices to be transmitted from one market to another, can be studied by dynamic adjustments.

A vector autoregression model was first estimated with four lags, the number of lags chosen based on the AIC and SC criteria. Beginning with four lags, the lagged variables were tested for the significance and only the variables that were significant were included in the final VECM. This yielded a VECM with two lags (determined by the smallest values of AIC and SC). The finding of three co-integrating vectors and three common trends means that three prices can be expressed in terms of the other three prices. For example, if we normalize the long-run relationship by the price changes in Rajshahi the result can be interpreted as the long-run price response function for the other three prices.

The long-run co-integration of price series can be seen by analyzing the normalized co-integrating coefficients (β). To estimate co-integrating coefficients (β), we used the Johansen co-integration test. If we normalize the long run relationships by the price changes in Rajshahi, Sylhet, and Khulna, respectively, the three normalized co-integrating equations are as follows:

RAJSHAHI = 1.044 DHAKA – 0.201 CHITTAGONG + 0.256 BARISAL – 0.322 (1)

(-5.218)*** (0.895) (-1.756)* (-1.539)

SYLHET = 0.991 DHAKA + 0.323 CHITTAGONG – 0.170 BARISAL – 0.468 (2)

(-3.346)*** (-0.968) (0.786) (1.512)

KHULNA = 0.486 DHAKA + 0.522 CHITTAGONG + 0.033 BARISAL – 0.154 (3)

(-3.660)*** (-3.495)*** (-0.338) (1.112)

Note: All figures in parentheses indicates t values.

*** Significant at 1% and *Significant at 10%.

Equation (1) indicates that a 1% increase in prices in Dhaka results in a 1.04% increase in prices in Rajshahi whereas a 1% increase in prices in Chittagong decreases prices in Rajshahi by 0.2%. This implies that, as Chittagong is a rice-importing region and Rajshahi a rice-producing region, the gains of price increases do not transfer from Chittagong to Rajshahi. The gains are captured by marketing agencies, not by farmers. Due to the longer distance between Chittagong and Rajshahi, price signals were not transmitted accurately and correctly. Prices in Rajshahi increase by 0.26% if prices in Barisal increase by 1%. Equation (2) and (3) contain a similar interpretation.

The short-run dynamics among these variables can be evaluated by examining the significance and signs of the estimated lagged coefficients which are presented in Table-3. The short-run results from the VECM revealed that all the estimated short run coefficients except for four are statistically insignificant at the 5% level. The coefficients' values range between 0.004 and 0.40. This suggests that the transmission of price changes from one market to another during the same week is weak. The speed of adjustment is given by the size of the adjustment coefficient. In co-integration equation 1, price changes in Rajshahi and Barisal during the studied period were transmitted to other markets at a rate of 22% and 24%, respectively, within a week. On the other hand, adjustment toward the long run is especially slower in the case of price changes in Sylhet (0.6%), Khulna (5%), Dhaka (21%), and Chittagong (13%). In the case of

equation 2, only Sylhet (36%) showed faster transmission and in equation 3, Chittagong (43%) showed faster adjustment.

4. Conclusions and Implications

Using weekly market price data for the period 2004-2006 from six regional markets in Bangladesh, this study has investigated the nature and extent of market integration after rice market liberalization. The overall results of the market integration analysis in Bangladesh indicate that, although the six regional markets in Bangladesh are co-integrated—meaning that they have a stable long run relationship—these markets are only weakly integrated in the short run. The results from trace statistics show that there are three co-integrating vectors and three common trends, which suggest that rice markets are stationary in three directions and nonstationary in three directions. Granger-causality results indicated that there was unidirectional causality originating from Dhaka to Khulna and Barisal, and from Sylhet to Dhaka, while Dhaka leads the price formation process only for Sylhet. There was also bi-directional causality between Dhaka and Chittagong, and Dhaka and Rajshahi. The short-run results indicate that these rice markets are not well integrated while long-run integration is evident, suggesting that the markets do eventually move together in the long term. The spread of adjustment appears to be the inverse of distance and directly related with ease of transport. The policy implications of these results is that structural rigidity resulting from poor infrastructure and insufficient transportation networks hampers the easy flow of information between markets and therefore the integration of markets in the short run. Thus, in order for rice surplus regional markets to be better integrated with deficit regions, the government should invest in better transportation and infrastructure facilities.

Table-3: Long-Run and Short-Run Integration Estimates from the Vector Error Correction Estimates Model

	D(RAJSHAHI)	D(SYLHET)	D(KHULNA)	D(DHAKA)	D(CHITTA)	D(BARISAL)
CointEq1	-0.221	0.005	-0.045	0.214	-0.133	0.236
	(0.067)	(0.095)	(0.058)	(0.067)	(0.089)	(0.111)
	(-3.256)	(0.060)	(-0.773)	(3.160)	(-1.503)	(2.120)
CointEq2	-0.009	-0.359	-0.026	-0.017	-0.061	-0.183
	(0.060)	(0.084)	(0.051)	(0.060)	(0.078)	(0.098)
	(-0.154)	(-4.237)	(-0.506)	(-0.290)	(-0.778)	(-1.854)

CointEq3	0.113	0.332	-0.132	0.324	0.425	0.022
	(0.095)	(0.134)	(0.081)	(0.095)	(0.124)	(0.156)
	(1.188)	(2.482)	(-1.616)	(3.401)	(3.405)	(0.145)
D(RAJSHAHI (-1))	-0.187	-0.116	0.026	-0.177	-0.060	-0.032
	(0.098)	(0.139)	(0.085)	(0.099)	(0.129)	(0.162)
	(-1.892)	(-0.836)	(0.310)	(-1.792)	(-0.463)	(-0.202)
D(RAJSHAHI (-2))	-0.121	-0.015	0.088	-0.126	0.088	0.135
	(0.091)	(0.128)	(0.078)	(0.091)	(0.119)	(0.149)
	(-1.336)	(-0.123)	(1.128)	(-1.383)	(0.739)	(0.907)
D(SYLHET (-1))	0.019	-0.271	0.042	-0.051	0.063	0.004
	(0.068)	(0.096)	(0.058)	(0.068)	(0.089)	(0.112)
	(0.282)	(-2.812)	(0.717)	(-0.753)	(0.707)	(0.038)
D(SYLHET (-2))	0.024	-0.080	0.006	-0.117	0.114	0.106
	(0.059)	(0.084)	(0.051)	(0.059)	(0.078)	(0.098)
	(0.406)	(-0.960)	(0.125)	(-1.957)	(1.458)	(1.077)
D(KHULNA (-1))	0.145	-0.224	0.073	-0.195	-0.123	0.295
	(0.129)	(0.181)	(0.111)	(0.129)	(0.169)	(0.212)
	(1.129)	(-1.234)	(0.661)	(-1.513)	(-0.728)	(1.390)
D(KHULNA (-2))	0.055	-0.021	-0.019	-0.091	-0.347	0.124
	(0.114)	(0.161)	(0.098)	(0.114)	(0.150)	(0.188)
	(0.481)	(-0.134)	(-0.197)	(-0.791)	(-2.310)	(0.658)
D(DHAKA (-1))	-0.033	-0.074	-0.080	0.044	0.046	0.104
	(0.092)	(0.129)	(0.079)	(0.092)	(0.121)	(0.151)
	(-0.361)	(-0.577)	(-1.017)	(0.480)	(0.382)	(0.690)
D(DHAKA (-2))	-0.091	-0.019	-0.008	0.069	-0.039	0.222
	(0.083)	(0.117)	(0.071)	(0.083)	(0.109)	(0.137)
	(-1.098)	(-0.168)	(-0.119)	(0.825)	(-0.358)	(1.615)
D(CHITTA (-1))	0.070	0.285	-0.071	0.130	-0.396	-0.101
	(0.074)	(0.105)	(0.064)	(0.074)	(0.098)	(0.122)
	(0.941)	(2.715)	(-1.105)	(1.741)	(-4.042)	(-0.819)
D(CHITTA (-2))	0.052	0.076	0.026	0.069	-0.030	-0.013
	(0.069)	(0.097)	(0.059)	(0.069)	(0.091)	(0.114)
	(0.748)	(0.779)	(0.447)	(0.997)	(-0.329)	(-0.119)
D(BARISAL (-1))	0.088	0.151	0.057	0.181	-0.032	-0.105
	(0.054)	(0.076)	(0.046)	(0.054)	(0.070)	(0.088)
	(1.627)	(1.986)	(1.241)	(3.359)	(-0.456)	(-1.181)
D(BARISAL (-2))	0.030	0.239	0.084	-0.014	0.184	-0.050
	(0.056)	(0.079)	(0.048)	(0.056)	(0.074)	(0.093)
	(0.536)	(3.007)	(1.728)	(-0.251)	(2.485)	(-0.547)

R-squared	0.215	0.361	0.098	0.302	0.397	0.147
Adj. R-squared	0.133	0.295	0.004	0.230	0.334	0.058
Sum sq. resids	0.015	0.030	0.011	0.015	0.026	0.041
S.E. equation	0.010	0.015	0.009	0.010	0.014	0.017
F-statistic	2.627	5.429	1.046	4.159	6.311	1.661
Log likelihood	471.687	420.752	494.240	471.522	431.316	397.599
Akaike AIC	-6.130	-5.446	-6.432	-6.127	-5.588	-5.135
Schwarz SC	-5.827	-5.143	-6.130	-5.825	-5.285	-4.833
Mean dependent	0.0005	0.0007	0.0008	0.0007	0.0007	0.0003
S.D. dependent	0.011	0.018	0.009	0.012	0.017	0.018
Determinant Residual Covariance		4.27E-24				
Log Likelihood		2740.307				
Akaike Information Criterion		-35.292				
Schwarz Criterion		-33.054				

Note: Included observations 149, 3 after adjusting endpoints.
Standard errors and t -statistics in parentheses and the numbers in parentheses in the first column refers to the lag order.

References

Alexander, C. and Wyeth, J. (1994). Co-Integration and Market Integration: Application to the Indonesian Rice Market. *Journal of Development Studies*, 30(2), 303-328.

Barrett, C.B. (1996). Market Analysis Methods: Are our Enriched Toolkits Well Suited to Enlivened Markets? *American Journal of Agricultural Economics*, 78(3), 825-829.

Baulch, B. (1997). Transfer Costs, Spatial Arbitrage and Testing Food Market Integration. *American Journal of Agricultural Economics*, 79(2), 477-487.

Baulch, R., Das, J., Jain, W. M. H., Farid, N. and, Zohir S. (1998). The Spatial Integration and Pricing Efficiency of the Private Sector Grain Trade in Bangladesh. Phase I and II report. Bangladesh Institute of Development Studies. Bangladesh Agricultural University and University of Sussex.

Boyd, M., and Brorsen, B.W. (1986). Dynamic Price Relationships for US and EC Corn Glutten Feed and Related Markets. *European Review of Agricultural Economics*, 13, 199-215.

Chang, H.S., and Griffith G. (1998). Examining Long-run Relationships between Australia Beef Prices. *Australian Journal of Agricultural and Resource Economics*, 42(4), 369-387.

Delgado, C.L. (1986). A Variance-Components Approach to Food Grain Market Integration in Northern Nigeria. *American Journal of Agricultural Economics*, 68(4), 970-979.

Dercon, S. (1995). On Market Integration and Liberalization: Method and Application to Ethiopia. *Journal of Development Studies*, 32(1), 112-143.

Dickey, D.A., and Fuller, W.A. (1979). Distribution of the Estimators for Autoregressive Time Series with a Unit Root. *Journal of the American Statistical Association*, 74(366), 427-431.

Dickey, D.A., and Fuller, W.A. (1981). Likelihood Ratio Statistics for Autoregressive Time Series with a Unit Root. *Econometrica*, 49(4), 1057-1072.

Engle, R.A., and Granger, C.W.J. (1987). Cointegration and Error Correction: Representation, Estimation and Testing. *Econometrica*, 55(2), 251-76.

Fackler, P. (1996). *Spatial Price Analysis: A Methodological Review*. Mimeo, North Carolina State University.

Food and Agriculture Organization (FAO) (1987). *Agricultural Price Policies: Issues and Proposals*. FAO Economic and Social Development Series No. 40. Rome.

Farruk, M.O. (1970). The Structure and Performance of the Rice Marketing System in East Pakistan. Occasional Paper No. 31. Department of Agricultural Economics. Cornell University Press, Ithaca, NY.

Getnet, K., Verbeke, W., and Viaene, J. (2005). Modeling Spatial Price Transmission in the Grain Markets of Ethiopia with an application of ARDL approach to White Teff. *Agricultural Economics.* 33(3), 491-502.

Goletti, F., and Babu, S. (1994). Market Liberalization and Integration of Maize Markets in Malawi. *Agricultural Economics*, 11 (2/3), 311-24.

Goletti, F., Ahmed, R., and Farid, N. (1995). Structural Determinants of Market Integration: The Case of Rice Markets in Bangladesh. *The Developing Economics*, 33(2), 185-202.

Gupta, S., and Mueller, R. (1982). Analyzing the Price Efficiency in Spatial Markets: Concept and Application. *European Review of Agricultural Economics*, 9, 24-40.

Harriss, B. (1979). There is Method in my Madness: Or is it Vice Versa? Measuring Agricultural Market Performance. *Food Research Institute Studies*, 17, 197-218.

Heytens, P. (1986). Testing Market Integration. *Food Research Institute Studies*, 20 (1), 25-41.

Hopcraft, P. (1987). Grain Marketing Policies and Institutions in Africa. *Finance and Development*, 24 (1), 37.

Johansen, S.K., and Juselius, K. (1990). Maximum Likelihood Estimation and Inference on Cointegration with Application to the Demand for Money. *Oxford Bulletin of Economics and Statistics*, 52, 169-210.

Johansen, S.K. (1988). Statistical Analysis of Cointegration Vectors. *Journal of Economic Dynamics and Control*, 12, 231-254.

Johansen, S.K. (1991). Estimation and Hypothesis Testing of Cointegration Vectors in the Presence of Linear Trend. *Econometrica*, 59, 151-58.

Jones, W.O. (1968). The Structure of Food Marketing in Nigeria as Revealed by Price Analysis. *Food Research Institute Studies*, 8 (2), 95-124.

Jones, W.O. (1972). *Marketing Staple Food Crops in Tropical Africa*. Cornell University Press: Ithaca, NY.

Lele, U. (1972). *Food Marketing in India: Private Performance and Public Policy*. Cornell University Press: Ithaca, NY.

Myers, R.J. (1994). Time Series Econometrics and Commodity Price Analysis: A Review. *Review of Marketing and Agricultural Economics*. 62, 167-181.

Onafowora, O.E., and Owoye, O. (1998). Can Trade Liberalization Stimulate Economic Growth in Africa? *World Development*, 26(3), 497-506.

Palaskas, T., and Harriss, W.B. (1993). Testing Market Integration: New Approaches, with Case Material for the West Bengal Economy. *Journal of Development Studies*, 13 (1), 1-57.

Perron, P. (1988). Trends and Random Walks in Macroeconomic Time Series. *Journal of Economic Dynamics and Control*, 12, 297-332.

Ravallion, M. (1986). Testing Market Integration. *American Journal of Agricultural Economics*, 68, 102-109.

Sexton, R., Kling, C., and Carman, H. (1991). Market Integration, Efficiency of Arbitrage and Imperfect Competition: Methodology and Application to U.S. Celery. *American Journal of Agricultural Economics*, 7, 568-580.

Silumbu, A. (1992). Changing Marketing Environment, Emerging Pricing Issues and Policy in Malawi, in J.B. Wyckoff and Mandivamba Rukuni (eds.) *Food Security Research in Southern Africa: Policy Implications*. University of Zimbabwe/Michigan State University. Food Security Research in South Africa Project. Department of Agricultural Economics and Extension. Harare.

Silvapulle, P., and Jayasuriya, S. (1994). Testing for Philippines Rice Market Integration: A Multiple Co-Integration Approach. *Journal of Agricultural Economics*, 45(3), 369-380.

The Lahore Journal of Economics
15 : 2 (Winter 2010): pp. 97-112

Measurement and Decomposition of Consumption Inequality in Pakistan

Muhammad Idrees* **and Eatzaz Ahmad****

Abstract

This paper shows that inequality in consumption expenditure in Pakistan improved slightly between 1992/93 and 2004/05, and that the extent of inequality in food consumption has remained substantially lower than in nonfood consumption. An important result is that household expenditure on education has been more unequally distributed than overall consumption expenditures. In contrast, healthcare expenditure in urban areas has been distributed relatively more evenly in recent years, while the level of inequality in healthcare expenditures in rural areas has remained persistent and somewhat higher.

Keywords: Consumption inequality, decomposition, Gini coefficient, Pakistan.

JEL Classification: D6, I3, D63, D31.

1. Introduction

Income inequality is one of the major economic problems that Pakistan faces. Despite the reasonable economic growth that Pakistan has achieved since its independence in 1947, poverty remains widespread, which is often attributed to the unequal distribution of income. Many studies have analyzed income inequality in Pakistan but only a few have focused on the decomposition of income inequality by household, sources of income, and other relevant attributes. Some significant contributions in this regard are Kurijk et al. (1985, 1986, and 1987), who carry out the decomposition of income inequality with respect to various factors such as regions, number of earners, labor and nonlabor income, and income sources. Adams (1993) analyzes the contribution of different sources of rural income to total income inequality in rural Pakistan. Nasir and Mahmood (1998) decompose inequalities of personal earnings with respect to the age of earners.

* Assistant Professor, Department of Economics, Quaid-i-Azam University, Islamabad, Pakistan.
** Professor, Department of Economics, Quaid-i-Azam University, Islamabad, Pakistan.

However, hardly any study focuses on the measurement of consumption inequality and its decomposition into various components to see how overall inequality translates into inequality within each consumption component. It would be useful to compare inequality in consumption with the inequality within each subcategory of consumption, such as food, housing, and health, among others. Such an analysis would indicate the extent to which the overall inequality in consumption translates into inequality in essential indicators of well-being such as food consumption, housing expenditure, expenditure on health, expenditure on education, and others. This information would in turn be useful in understanding the various implications of inequality, such as the impact on investment in human capital through education and health. Another reason for undertaking this study is that inequality measures based on income alone are more likely to be biased due to business cycles and the misreporting of income as compared to income inequality measures that also consider consumption expenditure.

In addition, consumption is generally considered a more appropriate measure of well-being than income, especially in poor countries where the main concern is the fulfillment of basic needs. In this context, it is important to measure inequality in the distribution of disaggregated consumption including food, housing, and health.

The present study attempts to accomplish this task. The study is based on household-level consumption expenditure data for the survey years 1992/93, 1998/99, and 2004/05 taken from various issues of the Household Integrated Economic Survey (HIES). The analysis is carried out for Pakistan and its rural and urban areas. The measurement of inequality used is the Gini index and the unit of analysis is adult-equivalent.[1]

The remaining paper is organized as follows: Section 2 describes the measurement of inequality and decomposition techniques. Sections 3 and 4 discuss the data used and results reported, respectively, and Section 5 concludes the study.

[1] Adult-equivalent works out the number of male adult-equivalents in a household. Each household member is expressed as a fraction of an adult male. Many adult-equivalent scales are proposed in the literature (see Elteto & Havasi, 2002; Jafri, 2002; and Demoussis & Mihalopoulos, 2001). The present study is based on the adult-equivalent scale proposed by Jafri (1995, 1999).

2. Measurement and Decomposition of Inequality

The literature on techniques of measuring inequality has produced a wide variety of inequality measures. Obviously, not all measures are equally good in theory and practice. An inequality measure that is regarded as a good inequality measure usually has the following properties: (i) the Pigou-Dalton transfer principle, (ii) income scale independence, (iii) the population principle, (iv) decomposability, (v) well defined and interpretable limits, and (vi) symmetry.[2]

The Gini coefficient is one measure that fulfills all these conditions and is the most widely used measure of inequality. In our analysis, we use the Gini coefficient as a measure of inequality because it is source-decomposable and provides a neat interpretation. It lies between 0 and 1, 0 representing perfect equality and 1 representing perfect inequality, and these well defined limits make it a relative measure, so that the values of the Gini coefficient for two different populations can also be compared. However, a problem associated with the Gini coefficient is that it gives more weight to income transfers affecting middle-income classes and not much weight to income transfers within extreme income classes.[3]

There are many approaches to defining the Gini coefficient, the most common being 'geometric approach,' in which the Gini coefficient is the ratio of the area between the line of absolute equality and the Lorenz curve to the total area below the line of absolute equality. Rao (1969) provides the following formula based on a geometric approach to calculating the Gini coefficient, which can also be used to measure inequality in consumption.

$$G = \sum_{i=1}^{n-1} \left(P_i q_{i+1} - P_{i+1} q_i \right) \tag{1}$$

Where P_i is the cumulative population share and q_i is the cumulative consumption share corresponding to the *ith* household when all households are arranged in ascending order of consumption.

---

[2] For more detail, see Idrees (2007) and Litchfield (1997).

[3] The Gini coefficient is income scale-independent but changes if a constant is added to all observations. This may turn out to be a problem if equality of life expectancy over time between geographical areas is to be measured. In this case, if the baseline increases in life expectancy of the overall population (it is, in effect, adding a constant), there can be a change in the Gini coefficient over time even if the absolute differences in life expectancy between the areas remains constant.

Shorrocks (1982) provides the following source-decomposition of the Gini coefficient of income. The same procedure can be adopted for the allocation-wise decomposition of consumption inequality.

$$G = \sum_{k=1}^{K} [s_k (C_k)] \tag{2}$$

Here s_k is the consumption share of the component k in total consumption and C_k is the concentration ratio of the *kth* consumption component. The concentration ratio is the same as that of the Gini coefficient except that the ranking of households is by total consumption and not the *kth* consumption component. This is given as:

$$C_k = \sum_{i=1}^{n-1} \left(P_i q_{i+1}^k - P_{i+1} q_i^k \right) \tag{3}$$

Where P_i is the *ith* household's cumulative population share and q_i^k is its cumulative share of the consumption component k. The concentration ratio of a particular consumption component measures how evenly or unevenly it is distributed as compared to the distribution of total consumption. If C_k is greater (smaller) than the Gini coefficient, it implies that the consumption of kth component is distributed more (less) unevenly than total consumption expenditure.

3. Data Source and Period of Analysis

The main source of data on household economic activity in Pakistan is the HIES, compiled and published by the Federal Bureau of Statistics, Government of Pakistan. It is a countrywide survey based on more than 14,000 households and provides fairly detailed information on consumption expenditures. HIES data is available in two formats, i.e. as aggregated data and disaggregated data. Information provided as aggregated data is with respect to entire groups of households classified as various income groups, e.g., the number of households in a group, average number of persons per household in a group, average monthly consumption per household in a group, and so on. This grouping suppresses important information and makes it impossible to explore consumption inequalities within households in the same group. Due to these limitations, the present study is based on disaggregated micro-level data, which provides detailed grassroots-level information on each

household and its members. The study covers the survey years 1992/93, 1998/99 and 2004/05.[4]

For the decomposition of consumption inequality, two classifications of total household consumption are considered:

1. Decomposition of household consumption inequality into food and nonfood consumption components.

2. Decomposition of household consumption inequality into the following expenditure groups:

   Group 1: Cereals and grains (all cereal products and food grains).

   Group 2: Other food items (baked and fried products, milk and milk products, edible oils and fats, meat and fish, poultry, fresh and dry fruits, vegetables, condiments and spices, sugar, honey, tea and coffee, beverages, tobacco, chewing products, readymade food and other food items).

   Group 3: Apparel textile, footwear and personal effects (clothing, footwear and items such as umbrellas, walking sticks, watches, etc, including repair and service charges of such articles).

   Group 4: Household textiles (items such as pillow covers, bed sheets, quilts, blankets, curtains, table cloths, etc.).

   Group 5: Fuel and lightning (electricity, gas, kerosene oil, firewood, coal, matchboxes, candles, etc.).

   Group 6: House rent and housing expenses (rent paid by the household or rental value of owner-occupied house and expenses incurred by minor repairs and redecoration, etc.).

   Group 7: Fixture and furniture and other durable household items (furniture, sanitary fittings, carpets, rugs, air conditioners, geysers, and knitting machines, etc.).

[4] Survey data is also available for 1996/97 and 2001/02, but these two years are not included in our analysis. Data for the survey year 2001/02 has been excluded from the analysis because it was made public after much controversy regarding the government's claims of the extent of poverty. Data for the year 1996/97 is also excluded from the analysis to create an equal time gap between the years of analysis. Apart from the above mentioned controversy, HIES data is considered fairly comprehensive and reliable in academic research. This is indicated by academic papers published around the world (see Kakwani, 2003, and Deaton, 1997).

Group 8: Transport, travel, and communication (noncommercial transport, telephone, telegraph, postal charges, registration fee, driving license fee, and maintenance costs, etc.).

Group 9: Recreation and entertainment (tickets for cinemas, musical concerts, camera film, magazines, novels, storybooks, membership fees of social and recreational societies, license fee of noncommercial television, expenditure on hobbies, etc.).

Group 10: Education and professional expenditures (fees of educational institutions, private tuition fees, hostel living charges, expenditure on educational books, stationary, electronic equipment such as personal computers, membership fees of professional societies, etc.).

Group 11: Medical expenses (expenditure on medicines, contact lenses, hospitalization, doctor consultancy fees, etc.).

Group 12: Cleaning laundry and personal appearance (laundry, laundry articles, personal care articles and services, toilet rolls, soap, toothpaste, shampoo, hair cutting, dyeing, cosmetics, etc.).

Group 13: Miscellaneous (all remaining expenditure items such as legal expenses, locker charges, pocket money to children, fines, wages paid to household servants, religious and other occasional functions such as birthdays, marriages, etc.).

4. Results and Discussion

Estimates of overall household consumption inequality along with the decomposition results of consumption inequality in terms of food and nonfood consumption are shown in Table 1. The table shows that the extent of inequality has declined moderately over the 12-year period considered and that this decline has been slightly greater in urban Pakistan than in rural Pakistan. Furthermore, the rate of decrease in the Gini coefficient during the last six years of analysis was greater than that during the initial six years. In rural Pakistan the extent of inequality increased slightly during the first six years. The period 1992/93 to 1989/99 is typically regarded as a period of structural adjustment and economic squeeze in Pakistan. Thus, the slight increase in rural inequality can likely be attributed to cuts in subsidies on agricultural inputs and decreases in government development expenditure.

We now consider the results of the decomposition of consumption inequality into food and nonfood components. This decomposition provides a broad picture of the incidence of inequality in terms of food and nonfood expenditure. For a more detailed analysis, we shall then decompose consumption inequality into 13 categories of food and nonfood consumption.

Table-1 also reports the decomposition of overall household consumption inequality into inequality in food and nonfood consumption. The results show that the concentration ratio in food is consistently lower than the corresponding Gini coefficient, while the concentration ratio in nonfood consumption expenditure is greater. This indicates that consumption inequality within food expenditures is lower than the inequality in nonfood expenditures. This expected result complies with the well-known Engle law that the share of food in total expenditure is greater among poor households than rich households, i.e., food is a relative necessity compared to nonfood consumption. The results show that the concentration ratio of nonfood consumption is nearly twice as large as that of food in urban Pakistan and more than 1.5 times as large in rural Pakistan, indicating that the incidence of inequality is mainly in nonfood consumption. This result also has important implications for poverty research. The typical practice in Pakistan is to compute food expenditure to meet the subsistence calorie requirement and divide the resulting figure by the share of food in income among those households that fall below the food poverty line (see Havinga et al. 1989). Since the share of food among poor households is relatively high, the poverty line of income is underestimated. This, in turn, underestimates various measures of poverty.

As far as contribution to overall consumption inequality is concerned, in all the three periods of analysis, nonfood consumption contributed more than 65% to overall consumption inequality in Pakistan, more than 71% in urban Pakistan, and more than 52% in rural Pakistan. An interesting finding is that the share of food consumption in overall consumption expenditures has increased over time in both rural and urban Pakistan. This result is somewhat surprising, given that living standards, as measured by per capita consumption, have on average improved over the years both in rural and urban Pakistan. A possible reason is the popularity of more expensive foods in the form of packed products, imported and western-style foods that use expensive ingredients, such as fast food. Another reason could be the relatively higher rate of food inflation.

Table-1: Decomposition of Overall Household Consumption Inequality into Food and Nonfood Categories

Consumption Groups & Inequality	1992-93			1998-99			2004-05		
	Overall	Rural	Urban	Overall	Rural	Urban	Overall	Rural	Urban
Gini Index of Consumption	0.390	0.322	0.426	0.376	0.323	0.404	0.344	0.289	0.367
Concentration Ratio	0.276	0.274	0.268	0.279	0.286	0.270	0.254	0.251	0.261
Contribution to Consumption Expenditure (%)	44.10	50.55	37.78	46.47	53.80	38.76	47.10	54.32	40.00
Contribution to Gini Coefficient (%)	31.19	42.95	23.75	34.46	47.46	25.89	34.84	47.24	28.48
Nonfood									
Concentration Ratio	0.480	0.372	0.522	0.461	0.366	0.488	0.423	0.333	0.437
Contribution to Consumption Expenditure (%)	55.90	49.45	62.22	53.53	46.20	61.24	52.90	45.68	60.00
Contribution to Gini Coefficient (%)	68.81	57.05	76.25	65.54	52.54	74.11	65.16	52.76	71.52

We now split inequality in consumption expenditure into the major components of food and especially nonfood consumption. For this, we divide food consumption into two categories and nonfood consumption into 11 categories. The results of decomposition are shown in Table-2. The table also reports the share of each consumption category in total household consumption expenditure. According to the results, more than 58% of total consumption expenditure is incurred by two food groups and the category 'house rent and housing expenses.' These three categories obviously represent the most important consumption requirements of households.

The decomposition results in the table show that, throughout the period of analysis, the concentration ratios of four groups (cereals and grains; other food items; apparel textile, footwear, and personal effects; and fuel and lightning have remained lower than the overall Gini coefficients of household consumption. This implies that the effect of inequality in consumption is disproportionately less in these consumption categories. Therefore, the consumption share of these

categories among poor households remained greater than the consumption share among rich households. It also follows, therefore, that these consumption components are classified as relative necessities.

Table-2: Decomposition of Overall Household Consumption Inequality into Major Consumption Groups

Consumption Components and Inequality	1992-93			1998-99			2004-05		
	Overall	Rural	Urban	Overall	Rural	Urban	Overall	Rural	Urban
Cereals and grains									
Concentration Ratio	0.184	0.213	0.155	0.199	0.249	0.157	0.151	0.193	0.120
Contribution to Consumption Expenditure (%)	10.48	13.22	7.83	11.08	14.68	7.31	10.46	13.41	7.56
Contribution to Gini Coefficient (%)	4.94	8.73	2.85	5.86	11.32	2.85	4.59	8.97	2.47
Other food items									
Concentration Ratio	0.305	0.296	0.297	0.304	0.300	0.296	0.284	0.270	0.294
Contribution to Consumption Expenditure (%)	33.58	37.33	29.95	35.38	39.12	31.45	36.64	40.91	32.44
Contribution to Gini Coefficient (%)	26.25	34.24	20.91	28.62	36.33	23.05	30.26	38.27	26.02
Apparel textile, footwear, and personal effects									
Concentration Ratio	0.335	0.286	0.375	0.307	0.292	0.329	0.298	0.268	0.317
Contribution to Consumption Expenditure (%)	7.82	8.43	7.24	7.30	8.26	6.28	5.91	6.41	5.41
Contribution to Gini Coefficient (%)	6.72	7.48	6.37	5.96	7.46	5.12	5.11	5.95	4.69
Household textiles									
Concentration Ratio	0.475	0.408	0.511	0.383	0.377	0.400	0.369	0.323	0.423
Contribution to Consumption Expenditure (%)	0.76	0.75	0.77	0.41	0.47	0.35	0.45	0.49	0.41
Contribution to Gini Coefficient (%)	0.93	0.95	0.92	0.42	0.55	0.35	0.48	0.55	0.47
Fuel and lightning									
Concentration Ratio	0.276	0.267	0.248	0.311	0.286	0.301	0.281	0.237	0.291
Contribution to Consumption Expenditure (%)	5.15	5.47	4.84	6.14	6.26	6.01	7.63	7.76	7.51

Contribution to Gini Coefficient (%)	3.64	4.53	2.82	5.07	5.54	4.49	6.23	6.37	5.96
House rent and housing expenses									
Concentration Ratio	0.481	0.288	0.533	0.522	0.331	0.526	0.486	0.293	0.466
Contribution to Consumption Expenditure (%)	16.64	12.40	20.73	14.63	8.77	20.78	14.18	8.04	20.22
Contribution to Gini Coefficient (%)	20.51	11.07	25.93	20.31	9.00	27.10	20.05	8.16	25.73
Fixture and furniture									
Concentration Ratio	0.637	0.557	0.655	0.503	0.466	0.535	0.532	0.479	0.540
Contribution to Consumption Expenditure (%)	1.42	1.19	1.65	0.77	0.78	0.77	0.51	0.47	0.55
Contribution to Gini Coefficient (%)	2.32	2.05	2.53	1.03	1.12	1.02	0.79	0.77	0.82
Transport traveling and communication									
Concentration Ratio	0.636	0.481	0.685	0.614	0.538	0.637	0.575	0.481	0.588
Contribution to Consumption Expenditure (%)	5.03	3.65	6.37	3.66	3.05	4.30	7.29	5.81	8.75
Contribution to Gini Coefficient (%)	8.19	5.44	10.23	5.97	5.08	6.79	12.19	9.68	14.04
Recreation and entertainment									
Concentration Ratio	0.712	0.620	0.664	0.784	0.732	0.720	0.350	0.259	0.372
Contribution to Consumption Expenditure (%)	0.91	0.49	1.32	1.54	0.61	2.52	1.70	1.56	1.85
Contribution to Gini Coefficient (%)	1.66	0.94	2.06	3.21	1.39	4.50	1.74	1.40	1.88
Education and professional expenditures									
Concentration Ratio	0.728	0.653	0.677	0.612	0.527	0.566	0.622	0.561	0.567
Contribution to Consumption Expenditure (%)	2.23	1.16	3.26	3.69	2.19	5.26	2.95	1.87	4.01
Contribution to Gini Coefficient (%)	4.16	2.36	5.18	6.00	3.57	7.38	5.33	3.63	6.20
Medical expenses									
Concentration Ratio	0.399	0.354	0.457	0.370	0.368	0.388	0.318	0.333	0.294
Contribution to Consumption Expenditure (%)	2.98	3.33	2.63	4.07	4.73	3.37	3.68	4.20	3.16

Contribution to Gini Coefficient (%)	3.04	3.66	2.83	4.00	5.39	3.24	3.41	4.86	2.54
Cleaning, laundry, and personal appearance									
Concentration Ratio	0.336	0.263	0.350	0.297	0.254	0.311	0.356	0.270	0.374
Contribution to Consumption Expenditure (%)	4.17	4.05	4.29	3.75	3.87	3.61	2.37	2.16	2.58
Contribution to Gini Coefficient (%)	3.59	3.31	3.52	2.96	3.05	2.79	2.46	2.02	2.64
Miscellaneous									
Concentration Ratio	0.621	0.576	0.647	0.526	0.458	0.574	0.406	0.391	0.433
Contribution to Consumption Expenditure (%)	8.83	8.52	9.12	7.58	7.21	7.96	6.22	6.91	5.55
Contribution to Gini Coefficient (%)	14.04	15.23	13.85	10.60	10.21	11.32	7.36	9.37	6.56
Overall Gini Index of Consumption Inequality	**0.390**	**0.322**	**0.426**	**0.376**	**0.323**	**0.404**	**0.344**	**0.289**	**0.367**

House rent and housing expenses; fixtures and furniture; transport, travel, and communication; education and professional expenditures; and miscellaneous expenditure are the consumption groups whose concentration ratios have been greater than the overall Gini coefficients of household consumption throughout the period of analysis. This implies that rich households spend a relatively greater proportion of their expenditures on these consumption groups, so in general these can be treated as relative luxuries. The fact that the concentration ratio of educational and professional expenditures remained significantly greater than the Gini coefficients of aggregate consumption implies that inequality has a disproportionately adverse effect on expenditure on education among the poor. In other words, existing inequality has undesirable consequences on human capital formation among the poor. If all other things remain constant, this result implies that poverty is likely to be perpetuated among poor families.

In contrast to education, expenditure on healthcare is distributed more evenly compared to overall consumption expenditure, except for the first year of analysis, and the extent of inequality has declined over the years. This result is encouraging as it indicates that poor households are becoming more conscious of the health of their members and tend to consider healthcare a necessity relative to rest of the consumption basket. The results

further show that expenditure on household textiles has been distributed more unequally than overall household consumption expenditure.

We now look at the consumption share of various consumption components in Pakistan overall. The statistics in Table 2 indicate that the combined share of the five consumption categories with a concentration ratio greater than the overall Gini coefficient of consumption fluctuated between approximately 22% and 41%. These consumption categories make up the main incidence of inequality in consumption, while the remaining eight categories comprising 59% to 78% of consumption expenditure are somewhat insulated from the incidence of consumption inequality.

Not all categories of household consumption have experienced the same magnitude or even the same direction of change in inequality. The main reasons for the changing patterns of inequality in various consumption categories include the government's evolving economic stabilization policies, especially transfer payments (such as the people's work program and different employment schemes) and the changing nature of developmental expenditures. Inequality in food items, for example, is likely to have increased mainly due to higher indirect taxes relative to direct taxes, higher food inflation, and inconsistent economic growth. Likewise, the increase in inequality in fuel and lighting and transport can be attributed to substantial increases in the price of fuel items that are generally found to be necessities with low income elasticities.

On the other hand, the decrease in the concentration ratio of apparel could be because of a decrease in the relative prices of clothing items (that is, the prices of clothing items have grown less than the overall inflation rate during the period of analysis).

We now analyze the results of decomposition for urban and rural Pakistan. The first interesting observation is that the relative position of eight of the thirteen consumption categories in terms of their concentration ratios relative to the Gini coefficient of household consumption in urban and rural Pakistan is the same as that of Pakistan overall. Specifically the concentration ratios of cereals and grains; other food items; apparel textile, footwear and personal effects; and fuel and lighting have remained lower than the overall Gini coefficients of household consumption. On the other hand, fixtures and furniture; transport, travel, and communication; education and professional expenditures; and miscellaneous expenditure are consumption groups whose concentration ratios are greater than the overall Gini coefficients of household consumption.

A major difference in results across rural and urban Pakistan occurs with respect to house rent and housing expenses. As in the case of overall Pakistan overall, house rent and housing expenses in urban Pakistan have also remained more unequally distributed than aggregate consumption expenditure. In rural Pakistan, on the other hand, house rent and housing expenses have remained more equally distributed in the first year of analysis. However, with the development of the rural economy over time, housing costs in rural areas have also increased, especially because rural households by and large also look for the same kind of durability, comforts and amenities (such as formal construction, modern kitchen, laundry washrooms, cooling, heating, etc.) in their houses as are available in urban localities. This may have made housing a luxury consumption category in the rural community. Thus, the difference in the position of house rent and housing expenses with respect to its concentration ratio between urban and rural Pakistan has diminished over time.

Another difference between urban and rural Pakistan is in terms of healthcare expenses. Contrary to the pattern for Pakistan overall, expenditure on healthcare in rural Pakistan has been more unequally distributed than overall consumption expenditure throughout the period of analysis. This indicates adverse consequences for inequality in terms of the healthcare of household members in rural areas. On the other hand, the pattern observed for urban Pakistan is the same as that for Pakistan overall, i.e., a decline in inequality in healthcare expenditure relative to the inequality in overall consumption expenditure. This convergence can be attributed to the development of the economy and increasing awareness of the importance of healthcare as urban households gain better access to global media.

5. Summary

This paper shows that income distribution in Pakistan, as revealed by the Gini index of household consumption, has improved moderately over the 12-year period 1992/93 to 2004/05, especially during the last six years and in urban regions. The extent of inequality in food consumption has remained substantially less than that of nonfood consumption. An important implication of this expected result is that the practice of estimating the poverty line in Pakistan by dividing the food poverty line by food consumption share among households below the food poverty line tends to underestimate the extent of poverty.

A decomposition analysis of consumption inequality shows that, at the country level, the concentration ratios of cereals and grains, other food items, apparel textile, footwear and personal effects, and fuel and lighting have remained lower than the overall Gini index of household consumption, indicating that these consumption components are classified as relative necessities. On the other hand, the concentration ratios of house rent and housing expenses, fixtures and furniture, transport, travel, and communication, education and professional expenditures, and miscellaneous expenditure have remained greater than the overall Gini index household consumption, implying that these consumption groups can be treated as relative luxuries.

The existing pattern of inequality in education expenditure indicates that poverty may be perpetuated among poor families both in rural and urban areas. In contrast, healthcare expenditure in urban areas has been distributed relatively more evenly in the most recent year considered with a sharp decline in the concentration ratio in 2004/05, implying that poor households are becoming more conscious of the health of their members. However, the level of inequality in health care expenditures in rural areas has remained persistent and somewhat higher than the level of inequality in overall consumption expenditure.

Another difference in results across rural and urban Pakistan is with respect to housing expenditure (house rent and housing expenses). While in urban areas housing expenditures have remained more unequally distributed compared to aggregate consumption expenditure, in rural areas housing expenditures were more equally distributed in the first year of analysis. However, with the development of the rural economy and blurring of the rural-urban divide over time, housing costs in rural areas have increased and rural households have also started looking for durability and comfort in the same way that urban households do, thereby making housing a luxury consumption category in the rural community as well.

References

Adams, J. R. (1993). Non-Farm Income and Inequality in Rural Pakistan. *Pakistan Development Review*, 32, 1187-1198.

Deaton, A. (1997). *The Analysis of Household Surveys: A Microeconometric Approach to Development Policy*. World Bank, Washington DC.

Demoussis, M., and Mihalopoulos. (2001). Adult Equivalence Scales Revisited. *Journal of Agricultural and Applied Economics*, 33(1), 135-146.

Elteto and Havasi. (2002). Effects of Observation Unit and Scale of Equivalence on Income Inequality and Poverty. *Szocioplogia Szemle*, 4, 157-170.

Havinga, I. C. et al. (1989). Poverty in Pakistan: 1984-85. *Pakistan Development Review*, 28, 851-867.

Idrees, M. (2007). *An Analysis of Income and Consumption Inequalities in Pakistan*. (Doctoral Dissertation). Department of Economics, Quaid-i-Azam University, Islamabad.

Jafri, S. M. Y. (2002). *Issues in Measuring Poverty.* Center for Research and Poverty Reduction and Income Distribution: Islamabad.

Kakwani, N. (2003). Issues in Setting Absolute Poverty Lines. *Poverty and Social Development Papers*.

Kruijk, H. et al. (1985). Changes in Poverty and Income Inequality in Pakistan during the 1970s. *Pakistan Development Review*, 24, 407-422.

Kruijk, H. et al. (1986). Inequality in Four Provinces of Pakistan. *Pakistan Development Review*, 25, 685-706.

Kruijk, H. et al. (1987). Sources of Income Inequality in Pakistan. *Pakistan Development Review*, 26, 659-672.

Lichfield, J. A. (1999). *Inequality Methods and Tools*. World Bank, Washington DC.

Nasir, Z. M., & Mahmood, R. (1998). Personal Earning Inequalities in Pakistan: Findings from HIES 1993-9, *Pakistan Development Review*, 37, 781-792.

Rao, V. M. (1969). Two Decompositions of Concentration Ratio. *Journal of the Royal Statistical Society*, 132, 418-425.

Shorrocks, A. F. (1982). Inequality Decomposition by Factor Components. *Econometrica*, 50, 193-211.

The Lahore Journal of Economics
15 : 2 (Winter 2010): pp. 113-133

Fiscal Marksmanship in Pakistan

Muhammad Zakaria* **and Shujat Ali****

Abstract

Using Theil's inequality coefficient based on the mean square prediction error, this paper evaluates the forecasting efficiency of the central government budget and revised budget estimates in Pakistan for the period 1987/88 to 2007/08 and decomposes the errors into biasedness, unequal variation and random components to analyze the source of error. The results reveal that budgetary forecasting is inefficient in Pakistan and the error is due mainly to exogenous variables (random factors). We also find that neither the budget nor revised budget estimates of revenue and expenditure satisfy the criteria of rational expectations of forecasting. Further, there is very little evidence of improvement in the efficiency of budgetary forecasts over time.

Keywords: Budget, Forecast errors, Theil's inequality coefficient, rational expectations, Pakistan.

JEL Classifications: C53, E62, H68.

1. Introduction

"... the, general principle that no government can hope to execute its economic policies successfully if its budgetary forecasting is wildly inaccurate seems clear enough".

Prest (1975)

The government spends a great deal of time, money and effort in preparing the annual budget. Each department is asked to prepare its budget, which goes through several layers of bureaucracy before it is finally approved. Midway through the year, each department is asked to revise its estimates based on the budget in the first part of the year. Thus, correcting budget estimates is a substantial project. Despite all this, if gross under/over estimates in revenue/spending occur, it reflects a

* Assistant Professor, Pakistan Institute of Development Economics, Islamabad, Pakistan.
** Joint Secretary, Ministry of Finance, Islamabad, Pakistan.

failure in budget planning and its implementation, which is termed a failure in fiscal marksmanship by the government. It indicates that the government is not formulating budget estimates efficiently on the basis of all the available information. In other words, the government is not making budget estimates on the basis of rational expectations.

In an efficient market, economic agents make predictions on the basis of rational expectations. The rational expectations hypothesis stipulates that economic agents use all available information efficiently to form expectations about future economic conditions. In the literature, the rational expectations hypothesis has been used to form predictions about various macroeconomic indicators, such as gross domestic product (GDP), inflation, and unemployment, etc. However, little effort has been devoted to efficient forecasts of the budget and its components (revenue and expenditure) using rational expectations, particularly, in developing countries,[1] where the wide variations in budgetary forecast errors have significant macroeconomic implications. First, significant variations between actual revenue and expenditure from the predicted budgetary magnitudes can indicate the nonoptimization or nonattainment of the set objectives of fiscal policy. Second, excessive financing of deficits occurs if actual expenditure exceeds forecasted expenditure and cutbacks in crucial public expenditure result when actual revenue falls short of budgeted. Third, a budget represents a key link between the formulation and implementation of five-year plans; without sound budgetary forecasts, a satisfactory integration between plan formulation and implementation cannot be achieved. Fourth, persistently larger-than-budgeted expenditures, a good proportion of which are unplanned, result in the poor integration of plans with budgetary policy, which creates distortions in the implementation of government plans. Fifth, large errors in forecasting fiscal variables weaken the credibility of the central government and fiscal discipline in the country. Without strong fiscal discipline, it is difficult to see how discipline in other areas, so vital for development, can be instilled.

Errors in budgetary forecasting can occur due to endogenous and exogenous factors. Errors due to endogenous factors can arise because of the use of incorrect parameters, especially with respect to prices, incomes, and elasticities of demand and supply of products and factors in the case of the forecasting authorities' failure to take into account the two-way

[1] Fiscal marksmanship studies for developed countries are relatively few and on the whole are not very recent.

relationship between the government budget and national income, etc. Exogenous factors are those that are beyond the control of the forecasting authorities, e.g., a sudden change in the terms of trade, unavailability of external loans and grants, an outbreak of international conflict, unforeseen climatic conditions, international developments such as the quadrupling of oil prices after 9/11, a sudden shift in the internal political situation in the country, etc.[2]

Previously, Prest (1961), Allan (1965), and Davis (1980) studied the accuracy of budget forecasts in the context of the UK and concluded that accurate budget forecasts are needed if fiscal policy is to be used to move the economy toward full employment without engendering excessive inflation. Similarly, Auld (1970) has investigated forecasting errors in budgetary estimates in the context of Canada, Bird (1970) for Colombia, Rabushka (1976) for Hong Kong, Asher (1977) for Singapore, Morrison (1986) for the US, and Bagdigen (2005) for Turkey. More recently, Chakraborty and Sinha (2008) have tested budgetary forecasts and their efficiency for India for the period 1990/91 to 2003/04.[3] The study concludes that neither revenue nor expenditure forecasts in India are rational. The present paper examines the accuracy of the Government of Pakistan's budgetary forecasts for the period 1987/88 to 2007/08. The evaluation is done in terms of errors and their decomposition, unbiasedness, rational expectations, and improvement/deterioration in forecasting efficiency over time. The importance of good fiscal marksmanship makes it all the more surprising that no work has been done on the Pakistan experience. There have been a few discussions on the significance of budget errors, but no study has been made of the discrepancies between budget estimates and outturns as such. Thus, this study fills the gap in the literature on the subject in Pakistan.

The rest of the paper is organized as follows: Section 2 provides an analytical framework. Section 3 presents an overview of the data and discusses empirical results. Section 4 concludes the paper and discusses policy implications.

---

[2] Because of the interdependence of endogenous and exogenous sources of error, it is difficult to systematically isolate the influence of each of these sources of error and no such attempt is made in this paper. Instead, the paper focuses on examining the direction and magnitude of errors in forecasting the components of the budget.

[3] Earlier studies on fiscal marksmanship in India include Chand (1962), Asher (1978), Chakrabarty and Varghese (1982), and Bhattacharya and Kumari (1988).

2. Analytical Framework

Budget estimates of government revenue and expenditure can be regarded as budget forecasts of actual government revenue and expenditure, respectively. If A_t is the actual value and P_t the predicted value in year *t* then the forecasting error (E_t) in percentage form can be calculated as

$$E_t = \left[\left(P_t - A_t\right)/A_t\right]100 \tag{1}$$

E_t can be positive, negative, or 0 depending on whether the forecast is overpredicted, underpredicted, or perfect. Apart from such percentage errors, several other statistics such as mean errors and root mean square errors (RMSEs) are frequently used to evaluate prediction performance. The problem with mean errors is that they may be close to 0 if large positive errors cancel out large negative errors. Although mean absolute errors can be used to avoid the problem of positive and negative errors canceling each other out, RMSEs are used more often in practice, since they penalize large individual errors more heavily.[4] The RMSE and root mean square percentage error (RMSPE) for a sample period of n years are calculated with the help of the following formulas, respectively.

$$RMSE = \sqrt{1/n\sum(P_t - A_t)^2} \tag{2}$$

$$RMSPE = \sqrt{1/n\sum\left[(P_t - A_t)/A_t\right]^2} \tag{3}$$

The RMSE will be zero when the forecast is absolutely perfect for all years, i.e., when the predicted value is equal to the actual value for all *t*. A more rigorous measure for analyzing the accuracy of budget forecasts is Theil's (1958) inequality coefficient (U), which is defined as

$$U_1 = \frac{\sqrt{1/n\sum(P_t - A_t)^2}}{\sqrt{1/n\sum P_t^2} + \sqrt{1/n\sum A_t^2}} \tag{4}$$

[4] The RMSE has two limitations. It does not distinguish between under- and overpredictions. Also, there is no theoretical upper bound for the RMSE, and consequently it cannot be used for statistical inference.

The numerical value of U_1 falls between 0 and 1. If U_1 is close to 0, it means that there is a perfect fit (in this case $P_t = A_t$ for all observations). If U_1 is close to unity, it means that there is nonpositive proportionality between P_t and A_t (in this case $P_t \neq A_t$ for all observations). Alternatively, Theil's (1966, 1971) revised measure of inequality is defined as

$$U_2 = \frac{\sqrt{1/n \sum (P_t - A_t)^2}}{\sqrt{1/n \sum A_t^2}} \tag{5}$$

This measure has the advantage that the inequality coefficient does not depend on the forecast as the denominator does not contain P_t. If the forecast is perfect, then U_2 equals 0. However, there is no upper bound value for U_2. If P_t and A_t are defined in terms of changes, then no change forecast ($P_t = 0$ for all t) would lead to a value of 1. When U_2 equals unity, the forecast has the same accuracy as would have been achieved by means of a "naïve no change extrapolation" (Theil, 1971). A more precise measure of Theil's inequality statistic is also used by incorporating the lags in the actuals and the difference of predicted value from the lag of the actuals to capture the magnitude of error. Mathematically,

$$U_3 = \frac{\sqrt{1/n \sum [p(t) - a(t)]^2}}{\sqrt{1/n \sum [p(t)]^2} + \sqrt{1/n \sum [a(t)]^2}} \tag{6}$$

where $a(t) = A(t) - A(t-1)$ and $p(t) = P(t) - A(t-1)$. The upper value of U_3 would depend on whether or not the direction of change is predicted correctly. If the direction of change is predicted correctly, on average, i.e., when $\sum [p(t).a(t)] > 0$, then U_3 will be less than unity. If, on the other hand, the direction of change is predicted wrongly, i.e., when $\sum [p(t).a(t)] < 0$, then U_3 will be greater in unity. U_3 will be exactly equal to unity when the forecast implies no change, i.e., when $p(t) = 0$ for all *t* or $\sum [p(t).a(t)] = 0$.[5]

[5] There is no specific probability distribution of Theil's inequality coefficient and consequently it cannot be used for statistical inference except as a broad measure of prediction. In addition, like the RMSE, it cannot distinguish between under- or overprediction.

Furthermore, we also analyze the partitioned forecast error of budgetary estimates. For this purpose, the mean square prediction error is decomposed to obtain systematic and random sources of error. The systematic portion is further separated into the proportion of the total forecast error due to bias and the proportion of total forecast error due to unequal variation (Morrison, 1986). It is pertinent to mention that both systematic and random sources of error add up to unity. Mathematically,

$$\frac{(\overline{P_t} - \overline{A_t})^2}{1/n\sum(P_t - A_t)^2} + \frac{(S_p - S_a)^2}{1/n\sum(P_t - A_t)^2} + \frac{2(1-r)S_p.S_a}{1/n\sum(P_t - A_t)^2} = 1 \qquad (7)$$

where $\overline{P_t}$ and $\overline{A_t}$ are mean predicted and mean actual changes, respectively, S_p and S_a are the standard deviations of predicted and actual values, respectively, and *r* is the coefficient of correlation between predicted and actual values. The first expression on the left hand side of equation (7) is the proportion of the total forecast error due to bias. It represents a measure of proportion of error due to the over/underprediction of the average value. The second expression on the left hand side of equation (7) is the proportion of total forecast error attributable to unequal variation. In other words, it measures the proportion of error due to the over/underprediction of the variance of the values. The third expression on the left hand side of equation (7) measures the proportion of forecast error due to random variation. The first two sources of error are systematic. Presumably, they can be reduced by improved forecasting techniques, while the random component is beyond the control of the forecaster (Theil, 1966; Pindyck and Rubenfield, 1998).

Budget estimates can be viewed as government expectations of revenue, expenditure, and deficit. Expectations are derived both endogenously and rationally. If expectations are derived endogenously then the forecast is based on univariate autoregressive behavior. In this case P_t becomes some function of A_{t-1}, A_{t-2} and so on. If expectations are rational, then forecasts of government revenue, expenditure, etc., will depend on prior information on all variables such as national income, price level, etc., which have functional relationships with government revenues and expenditures.[6]

[6] In practice, budget estimates may be based on both endogenous and rational expectations because estimates are made partly on the basis of past trends of revenues and expenditures and partly on the basis of expected national income, imports, inflation rate, etc.

This paper also tests the rational expectation hypothesis for fiscal variables in Pakistan. For this, a necessary condition is that the forecast should be an unbiased predictor of the actual (Muth, 1961). The sufficient condition is that the forecast error is uncorrelated with the predicted value, which implies that the correlation coefficient (ρ) between the forecast error and predicted value should be 0, i.e. $\rho = 0$ (Muth, 1961). In other words, the sufficient condition is that the predicted error must be uncorrelated with historical information, which can be tested in terms of whether or not the lagged value of the actuals is related to the present value of actuals (Lovell, 1986). Thus, the rational expectations hypothesis can be tested with the help of the following equation.

$$A_t = \beta_1 + \beta_2 P_t + \beta_3 A_{t-1} + \upsilon_t \tag{8}$$

As defined previously, A_t is the actual value and P_t is the predicted value. The condition for rational expectations is satisfied if $\beta_1 = 0$, $\beta_2 = 1$, $\beta_3 = 0$ and $\rho = 0$.

We also examine whether or not the efficiency of budgetary forecasts improves over time. This can be examined by estimating the following function.

$$E_t = \alpha_1 + \alpha_2 T_t + \nu_t \tag{9}$$

As defined previously $E_t = \left[\left(P_t - A_t\right)/A_t\right]100$ and T is the linear time trend. The efficiency of forecasting improves if $\alpha_2 < 0$. In turn, $0 < \alpha_2$ would imply deterioration in forecasting efficiency over time.

3. Data and Budgetary Forecasts

Budgetary data in Pakistan is published in three stages: (i) as budget estimates, (ii) as revised estimates, and (iii) as actuals. The difference between budget estimates and revised estimates is that, while the former represents estimates of revenue and expenditure for the next fiscal year, the latter refers to estimates for the current fiscal year. In fact, revised estimates incorporate all modifications in budget estimates and utilize actual figures for part of the financial year, usually eight or nine months. Revised estimates are therefore partly actual and partly forecasted. Both budget and revised estimates are categorized into revenue and capital accounts. The final estimates, given as actuals, are

published a year after the completion of the financial year for which it was prepared. The fiscal year in Pakistan is from 1 July to 30 June, and the budget is presented in early June.

For this study, annual time series data was collected for revenue and expenditure for Pakistan for the period 1987/88 to 2007/08. While 2007/08 represents the latest year for which relevant data is available, due to several changes in accounting classifications, mergers, and regroupings of items, consistent data for the years before 1987/88 could not be obtained. Thus, the choice of time period was governed by the availability of consistent time series data. Due to the unavailability of budget documents, we relied primarily on the Budget Wing of the Ministry of Finance, Islamabad.[7]

Some summary statistics regarding forecasting accuracy for revenues and expenditures are presented in Table-1 and Table-2, respectively. The tables present the actual values of both revenue and expenditure along with the forecasting errors for the sample period. The results reveal that both revenue and expenditure components of the budget have errors in forecast. The analysis shows that revenue receipts were broadly overestimated during the 1990s both for budget and revised estimates. This indicates that the government had given high targets of revenue collection to the Federal Board of Revenue (FBR),[8] which the FBR was unable to collect due to shortfalls in revenues from income tax and import and excise duties. This shortfall was mainly due to recessionary conditions in the industrial sector and the changing composition of imports toward lower or no duty imports. Further, many of the factors affecting revenues from customs duties (world prices of imported goods, availability of external assistance.) are notoriously difficult to predict. The forecasting errors seem to be large. Revenue receipts were grossly underestimated during the 2000s both for budget and revised estimates, mainly due to uncertainty in obtaining foreign aid and assistance to fight terrorism and the shortfall of revenues from earthquake-affected areas in 2005. In turn, errors in capital receipts have shown a somewhat mixed trend during the 1990s and 2000s both in budget and revised estimates. Errors in capital receipts were mainly errors in forecasting defense expenditures, interest payments, and grants/aid. On the expenditure side, errors in revenue expenditures showed a varied tendency during the 1990s both in budget

[7] Appendix Table 1 presents data on revenue and capital receipts in the revenue account, while Appendix Table 2 explains data on revenue and capital receipts in the expenditure account.

[8] Formerly the Central Board of Revenue.

and revised estimates, but during the 2000s revenue expenditures were grossly underestimated with respect to budget estimates (due mainly to low expected expenditures on the reconstruction and rehabilitation of earthquake-affected areas) and were grossly overestimated in the case of revised estimates (due to high expectations of obtaining assistance from donors to be used for the uplift of earthquake-hit territories). Like capital receipt errors, errors in capital expenditures also showed a slightly mixed trend during the 1990s and 2000s both in budget and revised estimates. The errors in capital expenditures were due mainly to errors in forecasting loans and advances.

Table 1: Errors in Forecasting Revenue

(Rs. Billion)

	Revenue Receipts			Capital Receipts		
Years	Actual	% Error (BE)	% Error (RE)	Actual	% Error (BE)	% Error (RE)
1987-88	119.60	-0.57	1.37	642.44	-8.99	-5.41
1988-89	143.08	2.14	0.30	729.86	-11.58	1.97
1989-90	163.53	-2.50	-1.48	811.63	-5.90	-0.64
1990-91	170.34	8.79	8.18	914.17	6.18	-6.75
1991-92	216.59	6.46	2.90	864.44	-16.61	-12.28
1992-93	242.62	7.58	2.98	947.00	5.94	0.94
1993-94	273.24	5.66	6.92	1071.51	1.29	2.98
1994-95	321.32	12.71	0.95	1171.12	-3.45	-0.98
1995-96	370.51	3.26	3.08	1371.44	-6.94	-3.26
1996-97	384.26	18.17	1.16	1505.84	-1.18	-1.01
1997-98	433.64	6.08	3.58	1653.07	3.50	2.08
1998-99	464.37	11.65	8.07	1888.77	1.63	2.47
1999-00	531.30	5.58	-2.24	2136.14	-14.57	0.18
2000-01	535.09	11.12	4.27	2572.58	-8.05	-1.97
2001-02	619.07	4.00	2.22	2733.45	4.38	1.16
2002-03	720.70	-6.36	-2.65	2304.84	2.35	-1.40
2003-04	794.13	-8.28	-4.17	2071.16	-5.54	-1.59
2004-05	900.04	-11.52	-2.75	3115.29	-26.33	-1.08
2005-06	1076.63	-13.86	-5.01	3228.64	3.03	-1.06
2006-07	1297.96	-16.58	-6.47	3764.30	-17.62	-0.93
2007-08	1499.38	-8.75	-6.70	3897.15	-4.66	-0.92

Note: BE (RE) is Budget Estimates (Revised Estimates).

Overall, errors in budget estimates both in revenue and capital receipts are far greater then errors in revised estimates. This indicates that the government made errors at the time of budget formulation but there was ample opportunity to correct these errors when the budget estimates were revised. Thus, the errors grew smaller in revised estimates. Further, in relative terms, errors in budget forecasting were greater during the 2000s than during the 1990s both in revenue and capital receipts, particularly in relation to budget estimates. A similar interpretation holds for errors in forecasting expenditures. The disaggregated level of analysis also indicates that the degree of error in forecasting receipts is more or less the same as errors in forecasting expenditures during the sample period. Thus, we can conclude that the forecasting record of both revenue and expenditure accounts with respect to both budget and revised estimates are far from satisfactory. However, errors are not systematic, which indicates that revenue and expenditure forecasts in Pakistan are not based on adaptive expectations.

Table 2: Errors in Forecasting Expenditures

(Rs. Billion)

	Revenue Expenditures			Capital Expenditures		
Years	Actual	% Error (BE)	% Error (RE)	Actual	% Error (BE)	% Error (RE)
1987-88	147.54	-8.75	-0.89	51.15	12.26	6.08
1988-89	163.09	-0.02	-2.21	47.03	-10.89	2.06
1989-90	165.24	0.52	5.31	57.18	4.69	1.05
1990-91	189.28	-2.00	-2.77	70.86	-22.30	-15.52
1991-92	211.69	-3.88	0.64	114.40	-20.78	-11.19
1992-93	248.54	-5.70	0.31	86.14	9.20	-2.29
1993-94	268.03	1.65	6.72	96.30	-7.66	3.23
1994-95	315.71	0.14	0.48	106.05	2.15	0.74
1995-96	382.67	-4.76	-0.79	124.20	-7.29	-10.89
1996-97	414.45	1.20	0.27	135.38	2.36	-0.57
1997-98	466.50	2.24	0.80	125.90	0.56	3.20
1998-99	529.03	-2.47	-6.58	156.98	2.50	-4.64
1999-00	604.37	-8.35	-3.18	137.07	10.53	10.70
2000-01	612.68	-1.41	-1.79	95.38	-5.30	0.79
2001-02	694.45	-4.59	0.46	254.28	-31.78	1.94
2002-03	705.84	-8.29	0.47	155.41	-21.85	-2.20
2003-04	769.70	-8.47	0.45	122.99	0.22	1.92
2004-05	833.82	-5.71	0.43	150.65	-18.93	-1.08
2005-06	1068.50	-10.05	0.35	123.01	7.75	0.92
2006-07	1230.28	-9.29	0.31	131.11	5.12	-0.59
2007-08	1767.56	-23.42	0.23	148.59	4.56	0.36

Note: BE (RE) is Budget Estimates (Revised Estimates).

The RMSE and RMSPE of revenues and expenditures are given in Table-3. As expected, both the RMSE and RMSPE turn out to be lower for revised budget estimates in comparison to budget estimates. RMSEs indicate that, in relative terms, the capital budget reveals more forecasting errors than the revenue budget. In other words, capital receipts and capital expenditures showed relatively more forecasting errors than revenue receipts and revenue expenditures during the sample period. However, capital expenditures have shown less errors then revenue expenditures in the budget and revised estimates in the case of the RMSE alone. This result shows that the efficiency of budgetary estimates for revenue receipts and expenditures has improved over time, because it might show an improvement in the budget estimation process, especially since revenue receipts and expenditures far outweigh capital receipts and expenditures. The results also indicate that more emphasis needs to be placed on predicting the budget's capital account. The RMSPEs for budget estimates and actuals are higher than those for revised estimates and actuals, which again indicates that budget forecasts in Pakistan are less efficient. Although the size of the errors is small, even relatively small errors in forecasting revenue and expenditure can cause large errors in estimates of the budget deficit and as a result in the government's borrowing requirements.

Table 3: Root Mean Square Errors for Federal Budget Forecasting

	RMSE (BE, Actual)	RMSPE (BE, Actual)	RMSE (RE, Actual)	RMSPE (RE, Actual)
Revenue Receipts	75.38	0.09	34.80	0.04
Capital Receipts	256.40	0.10	40.17	0.04
Revenue Expenditures	100.14	0.07	10.39	0.03
Capital Expenditures	21.86	0.13	6.27	0.06

Note: RMSE (RMSPE) is Root Mean Square Error (Root Mean Square Percentage Error) and BE (RE) is Budget Estimates (Revised Estimates).

Based on RMSEs, we calculate Theil's inequality coefficient (U). Like RMSEs, Theil's inequality coefficient cannot distinguish between under- or overprediction. However, the magnitude of errors can be assessed from the inequality coefficients (Us). The three inequality coefficients, estimated using variants of Theils' U, are given in Table-4. The table reveals that Theil's inequality coefficients for budget estimates and actuals are higher than those for revised estimates and actuals. Even the value of Theil's

inequality coefficient (U_3) goes up to 0.503 in relation to budget estimates and actuals for capital receipts, which supports our previous finding that forecasts of budget estimates are inefficient in Pakistan and more emphasis should be placed on predicting the budget's capital account.

Table 4: Theil's Inequality Statistic (U) for Federal Budget Forecasting

	Theil's U (BE, Actual)			**Theil's U (RE, Actual)**		
	U_1	U_2	U_3	U_1	U_2	U_3
Revenue Receipts	0.059	0.115	0.217	0.027	0.053	0.118
Capital Receipts	0.062	0.121	0.503	0.009	0.019	0.071
Revenue Expenditure	0.077	0.145	0.311	0.008	0.015	0.043
Capital Expenditure	0.090	0.172	0.343	0.025	0.049	0.094

Note: BE (RE) is Budget Estimates (Revised Estimates).

Until now we have seen that there are errors in budget forecasting in Pakistan. An important question is, what accounts for errors in budget forecasting in Pakistan. To answer this question, we decompose errors into two components: errors on account of miscalculation and wrong judgment (bias and variance errors), and errors on account of unanticipated and exogenous shocks (random errors). The former can occur partly because of incorrect judgment of key economic variables such as national income, investment, savings, inflation, which influences government revenues and expenditures; and partly because of improper estimation of key parameters of budgeting, such as tax and expenditure elasticities. The latter is beyond the control of the government. Table-5 provides estimates of these error components.

The decomposition of error reveals that, in relative terms, the proportion of error due to random variations has been significantly higher, leaving less scope for the elimination of error. However, the role of errors due to bias and variance proportion cannot be ignored in budget estimates (compared to revised estimates). Although the proportion of error in the forecast due to bias and unequal variation is relatively low, better forecasts based on the buoyancy estimates of revenue and expenditure as well as periodic assessment of the stochastic errors of the budgetary forecast might improve the efficiency and reliability of budgetary forecasting. The analysis has shown that there are errors in budget forecasts in Pakistan but that this is mainly due to random variations, which is beyond the control of the government. These figures

are not standardized and hence no rigorous inference can be drawn from them. Therefore, the efficiency and accuracy of budget forecasts is tested using the rational expectations hypothesis.

Table 5: Partitioning Error Components

	Decomposition of Forecasting Errors					
	Budget Estimates			Revised Estimates		
	Bias	Variance	Random	Bias	Variance	Random
Revenue Receipts	0.044	0.561	0.395	0.056	0.665	0.279
Capital Receipts	0.141	0.121	0.738	0.144	0.003	0.853
Revenue Expenditure	0.203	0.552	0.245	0.007	0.007	0.986
Capital Expenditure	0.100	0.113	0.787	0.015	0.035	0.950

Table-6 presents the estimated results of the rational expectation hypothesis.[9] The results reveal that coefficients of β_1 are not significant in most cases and β_2 is not significantly different from 1. It also reveals that revenue expenditure seems to be overestimated by a constant amount every year in budget estimates and actuals, which is reflected in $\beta_1 < 0$. Similarly, revenue receipts in revised estimates and actuals seem to be overestimated by a fixed rate, as $\beta_1 < 0$. In relation to budget estimates, capital receipts are overestimated (as $\beta_2 < 1$), while both revenue and capital expenditures seem to be underestimated (as $\beta_2 > 1$). Revised estimates systematically overestimate both revenue and capital receipts as well as revenue and capital expenditures (as $\beta_2 < 1$). These results suggest that neither budget estimates nor revised budget estimates are the product of rational expectations of actual government receipts and expenditures.

It is also worth noting that the coefficients of β_3 are not insignificant in all cases. Similarly, the high values of ρ signify that the forecast errors of receipts and expenditures are correlated with the

[9] The stationary properties of the variables are not checked because the purpose is not to find a cointegrated relationship among the variables.

respective budget forecasts. Thus, the coefficients in Table-6 suggest that the rational expectations hypothesis is not valid in the case of fiscal variables in Pakistan during the sample period as neither the necessary condition for rational expectations (i.e., that the forecast should be an unbiased predictor of actuals) nor the sufficient condition for rational expectations (i.e., that the predicted error must be uncorrelated with the historical information) are fulfilled.

The overall goodness of fit of both budget estimates and revised estimates predictions, as indicated by R^2, is quite satisfactory. The values of Durbin *h* statistics are less than $|1.96|$, which indicates that least square estimations lead to errors that are serially correlated. This suggests that (strong) rationality can be rejected, because information that was available when the prediction was made (the previous forecast error) was not being taken into account. Therefore, in the presence of an autocorrelation error, inferences based on the least square estimation should be viewed with caution. We do not regard these results as evidence that econometric forecasting methods are useless. It could be that government in Pakistan implements these methods poorly, and/or that the results are ignored by political decision makers, and/or that for reasons fiscal variables have become intrinsically more difficult to forecast, so that in the absence of econometric methods, the results would have been worse. Still, on the basis of these results, one would have to be cautious in urging the government to replace old hands with computers.

Table 6: Testing Rational Expectations

Variables	β_1	β_2	β_3	R^2	Adj. R^2	Durbin *h*	ρ
			(Budget Estimates, Actuals)				
Revenue Receipts	-6.987	-0.159	1.331	0.995	0.994	-1.050	-0.734
	(-0.406)	(-0.761)	(6.450)*				
Capital Receipts	-7.245	0.897	0.173	0.947	0.940	NA	-0.266
	(-0.058)	(2.998)*	(0.589)				
Revenue Expenditure	-76.874	1.672	-0.472	0.984	0.982	NA	-0.801
	(-3.197)*	(4.757)*	(-1.266)				
Capital Expenditure	0.609	1.124	-0.062	0.770	0.743	1.900	-0.172
	(0.034)	(6.548)*	(-0.469)				
			(Revised Estimates, Actuals)				
Revenue Receipts	-35.540	0.959	0.136	0.998	0.997	NA	-0.834
	(-3.932)*	(4.628)*	(0.606)				
Capital Receipts	9.098	0.979	0.027	0.999	0.998	1.021	-0.043
	(0.469)	(31.712)*	(0.819)				
Revenue Expenditure	-0.220	0.971	0.036	0.999	0.999	1.334	0.092
	(-0.042)	(30.840)*	(0.861)				
Capital Expenditure	7.257	0.964	-0.016	0.981	0.979	-0.435	0.248
	(1.538)	(26.566)*	(-0.457)				

Note: Values in parentheses denote underlying student-*t* values. The *t* statistics significant at 5 % level of significance are indicated by *.

Table 7 provides the results of the efficiency of budget forecasts. The results suggest that not all the variables have improved significantly over time. Only the forecasts of revenue receipts and expenditures in budget estimates and revenue receipts in revised estimates have shown a significant improvement over time. These results support the hypothesis that the efficiency of budgetary forecasts seems to have remained unchanged during the sample period in Pakistan.

Table 7: Efficiency of Budgetary Forecasts

	α_1	α_2	R^2	Adj. R^2	DW
		(Budget Estimates, Actuals)			
Revenue Receipts	10.159	-0.850	0.311	0.274	0.825
	(2.990)*	(-2.925)*			
Capital Receipts	-3.190	-0.172	0.015	-0.037	2.471
	(-0.848)	(-0.535)			
Revenue Expenditure	0.645	-0.547	0.340	0.306	1.233
	(0.316)	(-3.131)*			
Capital Expenditure	-4.082	0.004	0.000	-0.053	1.781
	(-0.749)	(0.008)			
		(Revised Estimates, Actuals)			
Revenue Receipts	4.970	-0.428	0.363	0.330	1.604
	(3.273)*	(-3.294)*			
Capital Receipts	-2.708	0.140	0.063	0.013	1.639
	(-1.866)	1.126			
Revenue Expenditure	0.305	-0.035	0.007	-0.046	2.004
	(0.262)	(-0.353)			
Capital Expenditure	-2.478	0.172	0.033	-0.018	1.688
	(-0.991)	(0.802)			

Note: Values in parentheses denote underlying student-*t* values. The *t* statistics significant at 5% level of significance are indicated by *.

4. Conclusion

This paper attempts to examine the magnitude of error in the budget estimates and revised estimates of the Government of Pakistan's revenues and expenditures for the period 1987/88 to 2007/08. For this purpose, we have calculated simple percentage errors, RMSEs, and Theil's inequality coefficient. To analyze the source of errors, errors have been decomposed into biasedness, unequal variation, and random components. Further, to test rationality in the budget forecasts, we also present a rational expectations hypothesis.

The results show that the degree of error in forecasting revenues is more or less the same as errors in forecasting expenditures, and that the capital budget reveals more forecasting errors than the revenue budget.

However, there is no specific trend in forecasting errors, which reveals that budgetary estimates in Pakistan are not made based on adaptive expectations. In other words, the results indicate that there is no simple way to characterize the nature of the bias. Forecasters do not always under/overforecast by the same number of percentage points; nor do they under/overforecast by a constant proportion of the correct forecast. Hence, there does not appear to be a simple rule of thumb producing the discrepancy between actual and predicted forecasts. Values of Theil's inequality coefficients also show unfairness in budget forecasts in Pakistan. The proportion of error due to random variations is relatively higher, which is beyond the control of the forecaster, while errors due to bias and variance are low, which again shows inefficiency in budget forecasting in Pakistan. The test of rational expectations is not validated, thereby discouraging the applicability of the rational expectations hypothesis in fiscal estimates in Pakistan. The efficiency of forecasts has also not shown a general improvement in budgeting over time.

The analysis in this paper indicates that there is a great deal of room for improvement in the Government of Pakistan's fiscal marksmanship. There are two ways of improving the efficiency and reliability of budget estimates of government revenue and expenditure: (i) having better forecasts of basic macro variables, such as national income, price level, etc., and (ii) having better estimates of key parameters such as tax and expenditure elasticities. Both these require an increase in the technical sophistication of the forecasting process. Additionally, the government should focus on those areas of its revenues and expenditures which it can forecast most accurately. The areas of greatest predictability on the revenue side, for instance, are income tax, excise duty, and general sales tax; on the expenditure side, are, for instance, civil and defense expenditures. Further, to reduce errors in budget forecasts, forecasting authorities should be linked to movements in exogenous variables in the economy. Moreover, the government should avoid making any deliberate effort to under/overestimate revenues/expenditures (i) to give themselves enough room to maneuver with regard to unanticipated shortages/excess, or (ii) to prevent potential public reactions before the operation of the budget provided they were informed earlier about the potential budget deficit, tax increase, etc.

References

Allan, C.M. (1965). Fiscal Marksmanship, 1951-63. *Oxford Economic Papers*, 17(2), 317-327.

Asher, M.G. (1977). Fiscal Marksmanship in Singapore, 1966 to 1974-75. *Suara Ekono'd*, 14, 11-22.

Asher, M.G. (1978). Accuracy of Budgetary Forecasts of Central Government, 1967-68 to 1975-76. *Economic and Political Weekly,* 13(8), 423-432.

Auld, D.A.L. (1970). Fiscal Marksmanship in Canada. *Canadian Journal of Economics*, 3(3), 507-511.

Bagdigen, M. (2005). An Empirical Analysis of accurate budget Forecasting in Turkey. *Dogus Universitesi Dergisi,* 6(2), 190-201.

Bhattacharya, B.B., and Kumari, A. (1988). Budget Forecasts of Central Government Revenue and Expenditure: A Test of Rational Expectation. *Economic and Political Weekly*, 23(26), 1323-1327

Bird, R.M. (1970). *Taxation and Development*. Cambridge, MA: Harvard University Press.

Chakrabarty, T.K., and Varghese, W. (1982). The Government of India's Budget Estimation: An Analysis of the Error Components. *Reserve Bank of India Occasional Papers,* 3(2).

Chakraborty, L.S., and Sinha, D. (2008). Budgetary forecasting in India: Portioning Errors and Testing for Rational Expectations. Working Paper No. 2008(7538), MPRA.

Chand, M. (1962). A Note on Under-Estimation in the Indian Central Budget. *Indian Journal of Economics,* 43.

Davis, J. M. (1980). Fiscal Marksmanship in the United Kingdom, 1951-78. *Manchester School of Economics & Social Studies,* 48(2), 187-202.

Lovell, M.C. (1986). Tests of the Rational Expectations Hypothesis. *American Economic Review,* 76(1), 110-124.

Morrison, R.J. (1986). Fiscal Marksmanship in the United States: 1950-83. *Manchester School of Economic and Social Studies,* 54(3), 322-333.

Muth, J.F. (1961). Rational Expectations and the Theory of Price Movements. *Econometrica,* 29, 315-335.

Pindyck, R.S., and Rubenfield, D.L. (1998). *Economic Models and Economic Forecasts*. 4th ed., McGraw-Hill.

Prest, A.R. (1961). Errors in Budgeting in the UK. *British Tax Review,* 30-43.

Prest, A.R. (1975). *Public Finance in Developing Countries*. London: Weidenfeld and Nicolson.

Rabushka, A. (1976). *Value for Money: The Hong Kong Budgetary Process*. Stanford: Hoover Institution Press.

Theil, H. (1958). *Economic Forecasts and Policy*. Amsterdam: North Holland.

Theil, H. (1966). *Applied Economic Forecasting*. Amsterdam: North Holland.

Appendix

Table 1: Revenue and Capital Receipts in Revenue Account

Rs. Billion

	Revenues					
	Revenue Receipts [a]			Capital Receipts [b]		
Years	Actual	Budget Estimates	Revised Estimates	Actual	Budget Estimates	Revised Estimates
1987-88	119.60	118.92	121.24	642.44	584.68	607.69
1988-89	143.08	146.14	143.51	729.86	645.33	744.24
1989-90	163.53	159.43	161.10	811.63	763.70	806.47
1990-91	170.34	185.32	184.27	914.17	970.67	852.43
1991-92	216.59	230.57	222.87	864.44	720.86	758.24
1992-93	242.62	261.00	249.85	947.00	1003.29	955.89
1993-94	273.24	288.69	292.14	1071.51	1085.33	1103.46
1994-95	321.32	362.16	324.37	1171.12	1130.67	1159.64
1995-96	370.51	382.59	381.92	1371.44	1276.20	1326.73
1996-97	384.26	454.07	388.70	1505.84	1488.00	1490.61
1997-98	433.64	460.01	449.17	1653.07	1711.01	1687.41
1998-99	464.37	518.46	501.86	1888.77	1919.61	1935.37
1999-00	531.30	560.95	519.40	2136.14	1824.89	2139.88
2000-01	535.09	594.60	557.95	2572.58	2365.43	2521.85
2001-02	619.07	643.80	632.80	2733.45	2853.07	2765.08
2002-03	720.70	674.89	701.58	2304.84	2359.11	2272.55
2003-04	794.13	728.37	760.98	2071.16	1956.33	2038.21
2004-05	900.04	796.32	875.31	3115.29	2295.01	3081.65
2005-06	1076.63	927.40	1022.70	3228.64	3326.61	3194.31
2006-07	1297.96	1082.81	1214.04	3764.30	3101.18	3729.25
2007-08	1499.38	1368.14	1398.92	3897.15	3715.73	3861.37

[a] It includes tax and non-tax revenues.

[b] It includes total federal internal gross receipts and loans.

Table 2: Revenue and Capital Receipts in Expenditure Account

Rs. Billions

	Expenditures					
	Revenue Expenditures [a]			Capital Expenditures [b]		
Years	Actual	Budget Estimates	Revised Estimates	Actual	Budget Estimates	Revised Estimates
1987-88	147.54	134.63	146.23	51.15	57.42	54.25
1988-89	163.09	163.06	159.48	47.03	41.90	47.99
1989-90	165.24	166.10	174.02	57.18	59.86	57.78
1990-91	189.28	185.48	184.03	70.86	55.06	59.86
1991-92	211.69	203.49	213.04	114.40	90.62	101.60
1992-93	248.54	234.37	249.30	86.14	94.07	84.17
1993-94	268.03	272.46	286.03	96.30	88.92	99.40
1994-95	315.71	316.14	317.23	106.05	108.32	106.83
1995-96	382.67	364.47	379.66	124.20	115.14	110.68
1996-97	414.45	419.42	415.56	135.38	138.57	134.60
1997-98	466.50	476.93	470.23	125.90	126.61	129.93
1998-99	529.03	515.96	494.23	156.98	160.91	149.70
1999-00	604.37	553.91	585.12	137.07	151.51	151.74
2000-01	612.68	604.02	601.71	95.38	90.32	96.13
2001-02	694.45	662.61	697.68	254.28	173.47	259.22
2002-03	705.84	647.33	709.18	155.41	121.45	152.00
2003-04	769.70	704.48	773.17	122.99	123.25	125.35
2004-05	833.82	786.25	837.42	150.65	122.13	149.02
2005-06	1068.50	961.10	1072.22	123.01	132.55	124.14
2006-07	1230.28	1115.94	1234.15	131.11	137.82	130.33
2007-08	1767.56	1353.66	1771.56	148.59	155.37	149.13

[a] This includes current expenditure and development expenditure on revenue account.

[b] This includes current expenditure and development expenditure on capital account.

The Lahore Journal of Economics
15 : 2 (Winter 2010): pp. 135-147

A Note on the Pricing of Liquidity in Stock Returns

Nawazish Mirza*

1. Introduction

Keynes (1930) proposed that an asset is more liquid than another "if it is more certainly realisable at short notice without loss" (vol. II, p. 67). This definition suggests that the liquidity of an asset is twofold. First, an asset should have a market that can readily absorb the sale, and second, do so without risk to its final value. This suggests that investors should be rewarded for both the level of liquidity and liquidity risk. The standard form of asset pricing models assumes financial markets to be perfectly liquid. In a perfectly liquid market, there are no arbitrage possibilities. Therefore, the under traditional asset pricing approach, all assets that have similar expected cash flows must have the same price. This phenomenon of frictionless markets ignores the impact of liquidity of financial assets on their respective prices and consequently on returns. The relation between liquidity and expected returns has been statistically observed and explains certain market anomalies such as the small firm effect, equity premium, and risk-free rate puzzle.

In a market with frictions, one source of illiquidity is transaction costs, which are ignored in the traditional asset pricing framework. Such costs might include brokerage fees, order processing costs, etc. Whenever a security is traded, the buyer and seller incur transaction costs. Moreover, the buyer will bear additional transaction costs whenever the security is further sold in the market. Apart from transaction costs, other sources of liquidity could be demand pressure and inventory risk. Demand pressure can be created in a market where buyers are not available, and to liquidate the position, the seller might have to settle for a much lower price. The factor of demand pressure might be worsened in the presence of circuit breakers in a continuously bearish market. If the prices hit the lower circuit, sellers will not be able to lay off their positions and this phenomenon will continue if, on the following days, prices continue to open on their lower

* PhD Candidate at University of Paris Dauphine, Assistant Professor (on leave) Finance, Center for Research in Economics and Business, Lahore School of Economics.

circuits.[1] In the presence of such demand pressure, buyers will enter and transact at a much lower price, causing a significant loss for sellers. However, buyers who buy in anticipation of an increase in prices will later be exposed to the risk of price changes while holding the asset in inventory. The buyer must be compensated for this risk—a compensation that imposes a cost on the seller in the form of a lower price.

Insider information can also be a source of illiquidity and can cause market friction. Buyers might fear that sellers have insider information (negative profits to be declared) and sellers might fear the opposite (high profits). Thus, trading with an informed counter party will end up with a loss. In over-the-counter (OTC) markets, another source of illiquidity can occur when it becomes difficult to locate a counter party who is willing to trade a particular security or a large quantity of a given security. This search friction is more likely to exist in OTC markets because of the nonavailability of a central marketplace. A searching trader will incur financing costs or opportunity costs as long as his trade is delayed and may need to settle the deal at a low price. Alternatively, the trader might choose to trade quickly by bearing the illiquidity cost.

Illiquidity costs should affect security prices because investors incorporate them in their required rate of return. Moreover, since liquidity varies over time, every risk-averse investor may require compensation for being exposed to liquidity risk. This compensation is more relevant to countering inventory risk. The effects of liquidity on asset prices are important. Investors must incorporate them in designing their investment strategies. The impact of liquidity, if incorporated into the required rate of return for investors, will ultimately affect corporations' cost of capital and hence the allocation of the economy's real resources.

2.1. Liquidity and Asset Pricing

Several asset pricing models have been introduced in the literature to explain how investors measure risk and value risky assets.[2] At the forefront are the capital asset pricing model (CAPM) and subsequent extensions of the CAPM, as well as the arbitrage pricing theory (APT).

[1] This phenomenon was observed in the Pakistan stock market (Karachi Stock Exchange) in March 2005, when prices continuously opened at lower circuits for a week. Consequently, sellers were unable to square their positions.

[2] For more on asset pricing models and their origin, see Bachelier (1900), Markowitz (1952), Tobin (1958), Sharpe (1964), Mossin (1966), Litner (1965), Ross (1976), and Fama and French (1992).

According to these models, expected returns can be predicted given specific related variables. Empirical tests of the CAPM use the risk of the market as measured by beta—a measure of the relative variability of a security's return compared to the variability of the entire market's return. The CAPM uses the beta of a security in conjunction with the risk premium on the market to account for the expected risk premium on a specific security, where it attempts to account for the market's perception of risk and return. However, critics of the CAPM point out that beta does not accurately capture the risk that investors face. In general, studies have shown that the beta of a security is an incomplete measure of risk. For example, Hansen and Jagannathan (1997) show that there are portfolios comprising stocks with small capitalization that earn higher returns on average than those predicted by the CAPM. This implies that there may be something missing from the model, namely some component of risk. Due to such shortcomings, extensions of the CAPM and APT have evolved to bridge this gap and try to account for the missing risk. Most recent models either remove beta from the model and replace it with a more complete proxy of risk faced by investors or add other variables that may aid beta in capturing the true risk an investor encounters.

Recent studies have tried to identify factors that accurately predict returns. Studies by Banz (1981), Rosenberg, Reid, and Lanstein (1985), and Fama and French (1992) show that factors other than a stock's beta can predict returns. One such factor is liquidity, which is the risk that investors face for not being able to readily transfer ownership of a security. Therefore, the returns earned on the small capitalization stock portfolio of Hansen and Jagannathan (1997) above that of the CAPM may be explained by a missing risk measure. In recent years, increasing attention has been given to liquidity as an explanatory factor of asset pricing (Chordia, Roll, and Subrahmanyam, 2002).

As mentioned earlier, standard asset pricing models (CAPM, APT, etc.) assume markets to be frictionless, where securities can be traded without transaction costs. The fair value of a security is the present value of all its future cash flows. This rationale implies that every security with a similar stream of cash flows must yield the same price in the market. Surprisingly, in the real world, securities with similar cash flows can yield a different price. This price differential is based on investors' expectations, which are different from their equilibrium state. This deviation can be attributed to various factors, including the liquidity or illiquidity of a particular security. Although intrinsic value logic prevails, in long-term securities, an important consideration for investors is that ownership of the

securities will change hands over time. Therefore, their beliefs concerning the potential of future trading will affect investors' current demand for these securities. The future trading potential depends solely on the counterparty's preferences concerning that security. Ultimately, these factors are reflected in investors' required rate of return, causing the deviation from the equilibrium returns of standard asset pricing.

Equilibrium-based standard asset pricing models assume investors to be price takers. This assumption might not hold in certain circumstances and therefore advocates of liquidity-based asset pricing relax this assumption. If trading activity is going to affect the price level of a security, investors must take this into account. If an investor is going to place a significantly large "buy" order, prices in the market will ultimately increase. This effect must be incorporated in the pricing by the investor. Moreover, liquidity-based asset pricing assumes that not necessarily all investors have the same information. The existence of insider trading will affect stock prices in markets with friction. Apart from insider information about the fundamentals of a security, some market participants might have private information about the order flow. Brokers acting for hedge funds might know that the fund needs to liquidate a large position that will result in a decline in prices. Brokers can short sell at this point and buy later at lower price levels.

The importance of liquidity comes from investors' desire to reap greater rewards for the larger risk they incur. Investors require a certain level of liquidity to be able to move in and out of securities without being subject to losses. Given this desire, investors require a risk premium for securities that do not meet their liquidity needs. Specifically, liquidity and asset returns have an inverse relationship, where investors are willing to accept a lower return from securities with a higher level of liquidity.

2.2. *Measures of Liquidity*

One problem in empirical literature is determining the measure of liquidity, as there is hardly any single measure that can capture all its aspects. Moreover, these measures are sometimes constrained by their nonavailability. The data required is high-frequency, which is not normally available for every security. The use of ex-post data further complicates the situation as their variance from expected returns is normally high. These problems in measurement ultimately reduce the power of tests of the effects of liquidity on securities' pricing. There can be two possible problems that face every test of liquidity with respect to asset pricing.

i) Since a single measure cannot capture every aspect of liquidity, there will be an obvious bias in the result.

ii) There could be a large variance between ex-post and ex ante returns.

The list of liquidity measures is exhaustive; however, the following are the most widely used liquidity measures in empirical research.

a) Bid-Ask Spread

The bid-ask spread is normally calculated as the difference between the bid price by the bid-ask midpoint. This will directly calculate the cost of executing a small trade. There are two components of this spread. The first component compensates market-makers for inventory costs, order processing fees, and/or monopoly profits. This component is transitory since its effect on stock prices is unrelated to the underlying value of securities. The second component, an adverse selection component, arises because market-makers may trade with unidentified informed traders. To recover from losses to informed traders who might have better information, rational market-makers in a competitive environment widen the spread to recover profits from uninformed traders.

As a common measure of liquidity, the bid-ask spread has certain shortcomings. Hasbrouck (1991) points out that a tick size of 1/8 limits the number of values the spread can take, thus price discreteness tends to obscure the effect of liquidity shocks in the cross section of firms. Moreover, Brennan and Subrahmanyam (1996) argue that the bid-ask spread is a noisy measure of liquidity because large trades tend to occur outside the spread while small trades tend to occur inside, which means that bid-ask quotes are only good for limited quantities.

b) Stock Turnover

Stock turnover is calculated as the ratio of trading volume to the number of shares outstanding. It is a trading activity measure that is often used as a proxy for liquidity. Amihud and Mendelson (1986) show that assets with higher spreads are allocated in equilibrium to portfolios with the same or longer expected holding periods. They argue that, in equilibrium, the observed market return must be an increasing function of the relative spread, implying that the observed asset returns must be an increasing function of expected holding periods.

Given that turnover is the reciprocal of a representative investor's holding period and is negatively related to other liquidity costs such as bid-ask spreads, one can use it as a proxy for liquidity and the observed asset return must be a decreasing function of the turnover rate of that asset. Intuitively, in an intertemporal setting with zero transaction costs, investors will continuously rebalance their portfolios in response to changes in the investment opportunity set.

In the presence of transaction costs, such rebalancing will be performed more infrequently, resulting in reduced liquidity. However, Lee and Swaminathan (2000) question the interpretation of turnover as a proxy for liquidity because the relationship between turnover and expected returns depends on how stocks have performed in the past. More specifically, they find that high-volume stocks are generally glamour stocks and low-volume stocks are generally value or neglected stocks. Also, high-volume firms and low-volume firms differ significantly in terms of their past operating and price performance.

c) Illiquid Ratio

A natural measure of liquidity is a stock price's sensitivity to trades. Kyle (1985) postulates that, because market makers cannot distinguish between order flow generated by informed traders and by liquidity (noise) traders, they set prices as an increasing function of the order flow imbalance, which may indicate informed trading. This positive relation between price change and net order flow is commonly called the price impact. The illiquidity ratio of Amihud (2002), which is defined as absolute returns divided by the dollar trading volume, reflects the absolute (percentage) price change per dollar of trading volume and is a low-frequency analog to microstructure high-frequency liquidity measures. While the bid-ask spread captures the cost of executing a small trade, the illiquidity ratio, as a price impact proxy, captures the cost associated with larger trades. Furthermore, Hasbrouck (2003) shows that the Amihud (2002) illiquidity ratio is the best available price-impact proxy constructed from daily data.

d) Return Reversal

Pastor and Stambaugh (2003) develop a return-reversal measure as another form of price impact which reflects order-flow induced temporary price fluctuations. This measure is motivated by the Campbell, Grossman, and Wang (1993) model and its empirical findings. In a

symmetric information setting, risk-averse market makers accommodate trades from liquidity or noninformational traders. In providing liquidity, market makers demand compensation in the form of a lower (higher) stock price and a higher expected stock return, when facing selling (buying) orders from liquidity traders. The larger liquidity-induced trades will result in greater compensation for market makers, causing higher volume-return reversals when current volume is high. This return reversal measure reflects only temporary price fluctuations arising from the inventory control effect of price impact.

3. Empirical Evidence for Liquidity as a Determinant of Asset Returns

The literature on the impact of liquidity on asset pricing is exhaustive, since the impact of liquidity can be observed on the returns on any possible financial asset. However, the focus of this literature review is on stocks and fixed income securities.

The impact of liquidity on asset pricing was first observed by Amihud and Mendelson (1986). They used stock returns for the period 1961–1980 and bid-ask spreads for 1960–1979. For each year, they grouped stocks into 49 portfolios based on the relative spreads and respective betas and further estimated monthly returns for each portfolio. The estimation model is a regression of the portfolio monthly return on estimated betas and average spreads. The regression explicitly accounted for the effect of spread on the portfolios' return and the slope of the return spread relationship. They concluded that the portfolio return increases with the bid-ask spread and the return spread slope decreases in the bid-ask spread. Thus, expected returns are an increasing function of illiquidity costs and the relationship is concave mainly due to the clientele effect.

Eleswarpu (1997) estimated a model where a stock return was regressed on the stock's beta, relative spread, and log (size). The estimation was based on Fama and MacBeth's (1973) methodology. The only consistently significant effect was that of relative spread, whose coefficient was positive and significant, whereas the coefficient of log (size) was negative and insignificant, while that of beta was positive and significant but not consistent.

Brennan et al. (1998) use the stock's trading volume as a measure of liquidity in a multifactor asset pricing model, a version of the APT, where the stock's excess return is a function of the loadings of the stock return on factors. They obtained risk-adjusted returns and regressed these

returns cross sectionally on the stock's volume as well as other factors such as size, book-to-market ratio, price, dividend yield, and past returns. These factors were included to capture the momentum effect. The results demonstrated that volume has a negative and significant impact on risk-adjusted stock returns.

Datar et al. (1998) used stock turnover as a measure of liquidity. They estimated the cross section of stock returns on stock turnover, controlling for size, book-to-market ratio, and beta. They observed that the cross section of stock returns was significant and negatively related to stock turnover. The turnover coefficient was also negative and significant. They concluded that lower liquidity (based on a longer holding period) of a stock resulted in higher expected returns.

All the above studies used historical returns to investigate the effects of liquidity on expected returns. Clearly, realized return is a very noisy measure of expected return. Loderer and Roth (2005) departed from this method and investigated how stock prices are affected by liquidity. Clearly, controlling for future cash flow growth and dividend payout, price is a measure of the expected return and, after controlling for risk, the results give the effect of liquidity on expected returns. Loderer and Roth used data from the Swiss Stock Exchange for the period 1995–2001 and regressed stock P/E, the price-earning ratio, on liquidity, measured by the relative bid-ask spread, after controlling for projected earnings growth obtained from analysts' reports, dividend payout ratio, risk, and size. The results show that the spread has a negative and significant effect on the cross section of stock prices.

Fixed income markets provide a fruitful area for examining the effects of liquidity on asset prices, since cash flows for fixed-income instruments are typically known with greater certainty than in the case of stocks. Studies of the effects of liquidity on bonds examine the effect of liquidity on the bond's yield to maturity, which—for riskless bonds, such as government securities—measures the expected return if the bond is held to maturity. For corporate bonds which can default, the yield to maturity after controlling for the effect of default provides a low-noise estimate of the expected return, compared to stocks where realized returns are used to estimate expected returns.

Warga (1992) studies holding period returns on constant duration portfolios of US Treasury notes and bonds, and measures the yield premium generated by liquidity differences in bonds. He constructs

portfolios of off-the-run and on-the-run bonds using durations with narrow ranges and finds a consistent, positive, and significant yield differential between them of 55 basis points per annum.

Kamara (1994) studies the determinants of the yield differentials for matched-maturity note-bill pairs using 91 observations of bid and ask prices for treasury bills and notes with about 14 weeks to maturity over the period January 1977–July 1984. He posits that the note-bill yield differential reflects differences in liquidity, tax treatment, and dealer inventories. He proposes measuring the liquidity difference between notes and bills as the product of the volatility of the underlying rate by the ratio of the bills' turnover to the notes' turnover, where turnover is calculated using the ratio of dealer transactions to the absolute value of their net positions. Kamara finds that an average note-bill bid yields a differential of 34 basis points, a statistically and economically significant difference. The note-bill bid yield differential is found to increase in the liquidity risk, supporting the role of liquidity in the pricing of bonds.

Elton and Green (1998) examine the effect of liquidity on treasury securities, where liquidity is measured by the trading volume in the inter-dealer market. Controlling for the tax type of securities, they find significant differences between similar maturity bonds that differ in their trading volumes. The difference between the price of a low-volume bond and the weighted average of a pair of high-volume bonds with the same maturity but different coupons is negative and highly significant, meaning that the low-volume bond is cheaper and has a higher yield to maturity.

Krishnamurthi (2002) studies the price difference between the on-the-run and the most recent off-the-run 30-year bond. The price difference follows a systematic pattern over the auction cycle: It is highest right after the auction date and it declines to a small spread by the following auction date. To test whether the old bond-new bond yield difference results from a demand for liquid assets, Krishnamurthy regresses it on the yield spread between commercial paper and treasury bills (both for three months), which represent demand for liquidity since commercial paper is less liquid than bills. Studying all 30-year bond auctions in the 1990s, he finds that the yield difference increases when the yield spread between commercial paper and bills increases, and that the relation is stronger far from an auction date, when the liquidity demand is strongest.

4. Conclusion

Traditional asset pricing models assume frictionless markets, thus ignoring the impact of market frictions on investors' required rate of return. In reality, investors, while making investment decisions, take into account the liquidity of that particular asset. The result is that all financial assets with same expected cash flows yield different market prices, thus making liquidity an important determinant of asset returns. However, like all other asset pricing variables (beta, etc.) the liquidity impact is not constant over time and, consequently, the pricing of liquidity (or illiquidity) risk varies.

The literature on the existence of the liquidity effect in determining asset returns is exhaustive and empirical evidence supports the presence of the liquidity effect. The empirical results show that both the level of liquidity and liquidity risk are priced. The concept of liquidity is broad and various methods have been deployed to measure its impact. The most widely used are bid-ask spread, stock turnover, and illiquid ratio. However, an inherent deficiency of empirics is that all aspects of liquidity cannot be captured by a single measure, so the results have a tendency to be biased. Moreover, the noise factor in the variance of ex post and ex ante returns further complicates the situation. Lastly, at times, the nonavailability of high-frequency data could be a possible constraint.

Despite estimation difficulties, it is well known that liquidity, estimated by any possible measure, has an impact on asset returns. A reduction in stock liquidity results in a reduction in stock prices and an increase in expected stock returns. Although we cannot discard traditional asset pricing models as a whole, their shortcomings should be addressed, including that of a frictionless market. The existence of the liquidity effect has solved many financial puzzles that were previously considered market anomalies. These include the small firm effect, the equity premium puzzle, and the risk-free rate puzzle.

References

Amihud, Y., and Mendelson, H. (1986). Asset Pricing and the Bid-Ask Spread. *Journal of Financial Economics*, 17, 223-249.

Amihud, Y. (2002). Illiquidity and Stock Returns: Cross-Section and Time-Series Effects. *Journal of Financial Markets*, 5(1), 31-56.

Bachelier, L. (1900). Theorie De La Speculation. *Annales de l'Ecole Normale Superieure de Paris*.

Banz, R. W. (1981). The Relationship between Return and Market Value of Common Stocks. *Journal of Financial Economics*, 9, 3-18.

Brennan, M.J., and Subrahmanyam, A. (1996). Market Microstructure and Asset Pricing: On the Compensation for Illiquidity in Stock Returns. *Journal of Financial Economics*, 41, 441-464.

Brennan, M.J., Chordia, T., and Subrahmanyam, A. (1998). Alternative Factor Specifications, Security Characteristics, and the Cross Section of Expected Stock Returns. *Journal of Financial Economics*, 49, 345-373.

Campbell, J. Y., Grossman, S. J., and Wang, J. (1993). Trading Volume and Serial Correlation in Stock Returns. *Quarterly Journal of Economics,* 108, 905-939.

Chordia, T., Roll, R., and Subrahmanyam A. (2002). Order Imbalance, Liquidity and Market Returns. *Journal of Financial Economics,* 65, 111-130.

Datar, V. T., Naik, N.Y., and Radcliffe, N. (1998). Liquidity and Stock Returns: An Alternative Test. *Journal of Financial Markets*, 1, 205-219.

Eleswarapu, V.R. (1997). Cost of Transacting and Expected Returns in the Nasdaq Market. *Journal of Finance*, 52, 2113-2127.

Elton, E. J., and Green, T.C. (1998). Tax and Liquidity Effects in Pricing of Government Bonds. *Journal of Finance*, 53, 1533-62.

Fama, E., and MacBeth, J. (1973). Risk, Return and Equilibrium: Empirical Tests. *Journal of Political Economy*, 81, 607-636.

Fama, E., and French, K. (1992). The Cross Section of Expected Stock Returns. *Journal of Finance*, 47(2), 427.

Hansen, L.P., and Jagannathan, R. (1997). Assessing Specification Errors in Stochastic Discount Factor Models. *Journal of Finance*, 52, 557-590.

Hasbrouck, J. (1991). Measuring the Information Content of Stock Trades. *Journal of Finance*, 46, 179-207.

Hasbrouck, J. (2003). Intraday Price Formation in US Equity Index Markets. *Journal of Finance*, 58(6), 2375-2400.

Kamara, A. (1994). Liquidity, Taxes, and Short-Term Treasury Yields. *Journal of Financial and Quantitative Analysis*, 29, 403-416.

Keynes, J.M. (1930). *Treatise on Money*. London: Macmillan.

Krishnamurthi, A. (2002). The Bond/Old-Bond Spread. *Journal of Financial Economics*, 66, 463-506.

Kyle, A.S. (1985). Continuous Auctions and Insider Trading. *Econometrica*, 53, 1315-1335.

Lee, C.M.C., and Swaminathan, B. (2000). Price Momentum and Trading Volume. *Journal of Finance*, 55(5), 2017-2069.

Lintner, J. (1965). The Valuation of Risk Assets and the Selection of Risky Investments in Stock Portfolios and Capital Budgets. *Review of Economics and Statistics*, 47, 13-37.

Loderer, C., and Roth, L. (2005). The Pricing Discount for Limited Liquidity: Evidence from SWX Swiss Exchange and the Nasdaq. *Journal of Empirical Finance*, 12, 239-268.

Markowitz, H. (1952). Portfolio Selection. *Journal of Finance*, 77-91.

Mossin, J. (1966). Equilibrium in a Capital Asset Market. *Econometrica*, 34, 768-783.

Pastor, L., and Stambaugh, R. (2003). Liquidity Risk and Expected Stock Returns. *Journal of Political Economy*, 111, 642-685.

Rosenberg, B., Reid, K., and Lanstein, R. (1985). Persuasive Evidence of Market Inefficiency. *Journal of Portfolio Management*, 11, 9-17.

Ross, S.A. (1976). The Arbitrage Theory of Capital Asset Pricing. *Journal of Economic Theory*, 13, 341-360.

Rouwenhorst, K.G. (1999). Local Return Factors and Turnover in Emerging Stock Markets. *Journal of Finance*, 54, 1439-1464.

Sharpe, W. (1964). Capital Asset Prices: A Theory of Market Equilibrium under Conditions of Risk. *Journal of Finance*, 425-442.

Tobin, J. (1958). Liquidity Preference as Behaviour towards Risk. *Review of Economic Studies*, 67.

Warga, A. (1992). Bond Returns, Liquidity, and Missing Data. *Journal of Financial and Quantitative Analysis*, 27, 605-617.

LAHORE SCHOOL OF ECONOMICS
ALUMNI – EMBA, MBA, M.Sc., BBA, and B.Sc., 2010

Aadil Rehman, BBA
Aamnah Ahmad, BSC
Aamnah Haroon, BSC
Abdul Basit, BBA
Abdul Rafeh Iqbal, BSC
Abdul Rasheed, MBA
Abdullah Aamer Qureshi, BBA
Abdullah Khan, BSC
Abdullah Khan, BSC
Abeeha Islam, BSC
Abeer Fatima, BBA
Abeer Pervaiz, BBA
Abeera Iqbal, BSC
Abeera Zia, BBA
Abid Anwar Ali Khan, BBA
Abid Naseem, BBA
Abrar Ali, BSC
Abu Zar Salman Khan, BBA
Adeel Ahmad, EMBA
Adil Saghir, EMBA
Adnan Rauf, MBA
Affaf Muzaffar Ali, MBA
Affan Hameed, BBA
Afifa Ali, BBA
Afzan Ahmed, BSC
Agha Ammad Ahsan, BSC
Ahmad Khalid, BBA
Ahmad Maaz, BBA
Ahmad Saeed, BBA
Ahmad Waqar, BSC
Ahmed Arslan Khan, BBA
Ahmed Javed, BBA
Ahmed Jawad, BBA
Ahmed Nawaz, MBA
Ahmed Ozaif, MBA
Ahmed Rasool Baig Mirza, BBA
Ahmed Zafar, BBA
Ahmer Mubashar, BBA
Ahsan Ali, BBA
Ahsan Javed, BSC
Ahsan Malik, BBA
Ahsen Ullah Saeed, BBA
Aimen Majeedullah Bucha, BBA
Aisha Farrah Hussain, BSC
Aisha Wajid, BBA
Aiza Ayaz, BSC
Aiza Khan, BBA
Aleena Aijaz, BBA
Aleena Irfan, BSC
Ali Akarma, BBA
Ali Akhtar Awan, BBA
Ali Mansoor Malik, BBA
Ali Mehdi, BBA
Ali Mehmood Khan, MBA
Ali Nasir Mirza, BBA
Ali Raza Khan, BSC
Ali Tariq, BBA
Ali Zaheer Faiz, BBA
Ali Zahid Khan, BBA
Ali Zer Malik, BBA
Alina Asif, BSC
Alina Iqbal, MBA
Alizeh Haider Malik, BBA
Amal Javaid, BBA
Amal Khurram, BBA
Amarah Mubasher, BBA
Amber Nasir Ahmad, BSC
Ameera Bint Safdar, BBA
Amina Iqbal, BBA
Amjad Hussain, EMBA
Amjad Iqbal, MBA
Ammal Syed, BBA
Ammar Malik, BBA
Ammara Riasat, BBA

Amna Rashid, BBA
Amnah Farooq, BBA
Anam Batool, BSC
Anam Haroon, BSC
Anam Iftikhar, BSC
Anam Jahangir, BBA
Anam Rauf, BBA
Anam Toseef, BSC
Anam Usman, BSC
Aniqa Siddiq, BBA
Annahiya Javed, BBA
Annam Gohar, BSC
Anub Munawar, BBA
Anum Gul, BBA
Anum Humayun Malik, BBA
Anum Imtiaz, BBA
Anum Javed, BSC
Anum Khawar, BSC
Anum Masood Siddiqi, BBA
Anum Rasheed, BBA
Anum Saulat Hameed, BSC
Anum Tanveer Mir, BBA
Aqdas Tanweer, BBA
Aqdus Jehanzeb, BSC
Aqsa Tariq Sufi, BBA
Arif Sajjad, BSC
Arish Hanan, BBA
Arooj Hussain, BBA
Arooj Shafaque, BBA
Arsalan Ahmed, BBA
Asad Dad Khan, BBA
Asad Haider Khan, BBA
Asad Mujeeb, BSC
Asad Raza Jaffery, BSC
Asfandyar Sadiq, BSC
Asha Gul, BSC
Asif Malik, BBA
Asif Shafat, BSC
Asim Khan, BSC
Asima Ahmed, BSC
Asma Usman, BBA
Asra Kaleem, BBA
Athar Ali Siddiqui, MBA
Atif Masood, EMBA
Atif Munir, BBA
Awais Ahmed Khan, MBA
Awais Amin Ahmed, BBA
Awais Mussaddiq, EMBA
Ayana Qureshi, BBA
Ayaz Khalid Othi, BBA
Ayesha Anjum, BBA
Ayesha Arif Butt, BBA
Ayesha Bilal, BBA
Ayesha Hassan, BSC
Ayesha Jamil, BSC
Ayesha Karim Mian, BBA
Ayesha Laleka, BBA
Ayesha Mirza, BSC
Ayesha Naseer, BSC
Ayesha Rasheed, MBA
Ayesha Shabbir, BBA
Ayyaz Farrukh Nizami, BBA
Ayza Qayyum, BBA
Azhar Hussain, MBA
Azka Munir Aslam, BSC
Babar Khan, BSC
Batool Mohsin, BBA
Bilal Ali, BBA
Bilal Arif, BBA
Bilal Ilyas, BBA
Chaudhary Ahsan Saeed, BBA
Chaudhry Adeel Nisar, BBA
Danish Ahmed, BBA
Danish Altaf Mufti, BSC
Danish Imtiaz Ahmed, BSC
Danish Niaz, BSC
Danish Rehman, BBA
Daniya Ahson Atta, BBA
Daniyaal Shahid, BSC
Daniyal Mansoor, BSC
Danyaal Jehangir, BBA
Danyal Gulzar Butt, BBA
Dawood Moiz, BBA
Ejaz Chaudhry, BBA

Fahad Ahmed, BBA
Fahad Nabeel Gondal, EMBA
Faiza Qayyum, BBA
Faiza Tariq Shad, BBA
Faizan Akram, BBA
Faizan Saleem Sheikh, BBA
Faizan Ul Haq, BBA
Fakeha Iqbal, BSC
Faliha Mujeeb Chaudhry, BBA
Farah Sher Alam, BSC
Faraz Anwar, BBA
Faraz Mehmood Rehmani, BBA
Farhan Athar, BBA
Farhan Javeed, BBA
Fariha Shahid Hanif, BBA
Farina Bashir, MBA
Fariya Hashmat, BBA
Farrukh Javed, BBA
Fatima Asad, BBA
Fatima Aziz, BBA
Fatima Javaid Toosy, BBA
Fatima Liaquat, BBA
Fatima Mehmood, BSC
Fatima Shahid, BSC
Fatima Tariq, BBA
Fatima Zehra Rizwi, BSC
Fizza Khan, EMBA
Fizza Nasir, MBA
Fozaib Shahzad, BBA
Furwa Baig, BBA
Ghassan Ahmed Bilal, BBA
Ghazal Ilyas, BSC
Ghulam Mustafa, BBA
Haadiah Qaiser, MBA
Hafiz Faisal Mehmood, BBA
Hafsa Amir, BBA
Hafsa Amjad, BSC
Haider Naqvi, BBA
Hajra Rahman, MBA
Haleema Tariq Ameen, BBA
Hammad Ameer, BBA
Hammad Anwar, BBA
Hammad Mazhar, BBA
Hammad Nasir Khan, BBA
Hammad Sohail, BBA
Hammad Zafar, BBA
Hamza Ali Akbar Raja, BBA
Hamza Mir, BSC
Hamza Sohail Qureshi, MBA
Hamzah Riaz, BBA
Haris Ali Khan, BBA
Haris Masood, MBA
Haroon Ahmad Shah, BSC
Haroon Dawood, MBA
Haroon Farooq, BBA
Haroon Mubashar Janjua, BSC
Harris Ahmad Khan, BBA
Harris Qari, BBA
Hasan Fayyaz, BBA
Hassam Ali, BBA
Hassan Bashir, BBA
Hassan Cheema, BBA
Hassan Javaid Khan, MBA
Hassan Javed, BBA
Hassan Shehzad, MBA
Hiba Imran, BBA
Hina Naz, MBA
Hina Shahid, MBA
Hina Zafar Iqbal, BBA
Hira Khalid Mela, BSC
Hira Mirza, BSC
Huda Waqar Farooqi, BBA
Huma Abdul Malik, BBA
Huma Akhtar, BBA
Huma Zia, BSC
Humza Saeed, BBA
Hussain Mehdi, BBA
Iftikhar Ahmed Qureshi, BSC
Imaad Latif, BSC
Imran Ali Sheikh, BBA
Imran Iftikhar, BBA
Imran Khalid, BBA
Imran Mansoor, BBA
Imran Parvez Hashmi, BBA

Iqra Rehman, BSC
Iram Mumtaz, BBA
Irtaza Mehdie, BBA
Ismail Asad Rasul, BBA
Izza Naeem, BBA
Jahan Shaikh, BSC
Jam Amad Rafiq Khalti, BBA
Jamal Nasir, BBA
Javeria Ejaz Khan, BBA
Jawad Arshad, BBA
Junaid Rao, EMBA
Jza Abbas Rizvi, BSC
Kainat Kamil, MBA
Kamil Murad, BBA
Kanwal Hussain Khan, BBA
Khan Barkat, BBA
Khawaja Abdullah Hassan, MBA
Khola Zaman, BBA
Kinza Malik, BBA
Kissa Batool Zaidi, BBA
Komal Agha, BBA
Komal Sultan Butt, BBA
M. Shoaib Hameed Mirza, MBA
Maaheen Shuja Durrani, BSC
Maaz Mansoor, BBA
Maaz Muazzam, MBA
Madeeha Tauseef, MBA
Madiha Kamran, BBA
Madiha Mohsin, BBA
Mahak Khalid, BBA
Maham Qasim, BBA
Maham suhail, BBA
Maheen Aamer, BSC
Maheen Khan, BBA
Mahin Amjad, BBA
Mahnaz Iram, BBA
Mahnoor Shahzad, BSC
Mahwish Khalil, BSC
Mahwish Zahra, MBA
Maidah Syed, BBA
Maira Sajjad, BBA
Maira Taj, BBA
Majid Hussain, BBA
Malik Tamoor Adil, BBA
Malik Umer Nasir, BBA
Maman Afzal Siddiqui, BBA
Maria Fawad, BBA
Maria Taqi, BBA
Mariam Ahsan, BSC
Mariam Javed, BBA
Mariam Manzoor, BBA
Mariam Tariq, BBA
Mariam Tariq, MBA
Maryam Ali Chohan, BBA
Maryam Niazi, BBA
Maryam Omer, BSC
Maryem Zia, MBA
Maryiam Haroon, BSC
Masooma Hyder, BBA
Mawal Sara Saeed, BBA
Meer Bilal Ahmed, BBA
Meera Shafqat, BSC
Mehreen Jahanzeb, MBA
Mehreen Mehmood, BBA
Mehreen Rizwan, MBA
Mehroz Nida Dilshad, BBA
Mehroz Tariq, BBA
Mehvish Khalid, BBA
Mir Ozair Imran, BBA
Misbah Ali, BBA
Misbah Kanwal, BSC
Mishal Chaudhry, BBA
Mishal Qadri, BBA
Misheal Khan, BBA
Mishelle Syed, BBA
Mnal Taimur, BBA
Mobeen Ahmad Khan, BBA
Moeen Naseer, BBA
Mohammad Aarij Saghir, BBA
Mohammad Fawad Riaz, BBA
Mohammad Mohsin Mughal, BBA
Mohammad Salman Ayub, BBA
Mohammad Salman Mueen, BBA
Mohammad Talha Wasim, BSC

Mohammad Yahya Munir, BBA
Mohammad Zeewaqar Drishak, BBA
Mohsin Abbas, MBA
Mohsin Ali Nasir, EMBA
Mohsin Ali Tariq, BSC
Mohsin Nasim, BBA
Mohsin Saeed Khan, BBA
Mohsin Shafiq, BBA
Momna Fareed, BBA
Moona Yaqub Awan, BBA
Mubashir Altaf, BBA
Mueed Tahir, BBA
Mueed Tahir, MBA
Muhammad Abbas Haider, BSC
Muhammad Abbas, BBA
Muhammad Afzal Rasheed, EMBA
Muhammad Ali Ajmal, BBA
Muhammad Ali Amir, BBA
Muhammad Ammar Bukhari, BBA
Muhammad Asad Raza, BBA
Muhammad Azeem Feroze Wattoo, EMBA
Muhammad Faizan Zaheer, BBA
Muhammad Farhan Shamir, BBA
Muhammad Fayyaz Ahmed Khan, BBA
Muhammad Hamza Tariq, BBA
Muhammad Hamza Zahid, BBA
Muhammad Haroon Choudhry, BSC
Muhammad Hasan Saeed Khan, BBA
Muhammad Haseeb, BSC
Muhammad Hashim Raza, BBA
Muhammad Huzaifa, BSC
Muhammad Imran Khan, BBA
Muhammad Junaid Jamshaid, BBA
Muhammad Kamil Tariq, BBA
Muhammad Kazim Hussain, BBA
Muhammad Kazim Hussain, MBA
Muhammad Khan Balwana, BBA
Muhammad Khizer Shahid, BBA
Muhammad Mateen Khalid, BBA
Muhammad Mohsin Khan, BSC
Muhammad Mohtshim Jawaid, BBA
Muhammad Murtaza Hassan, MBA
Muhammad Omar Sardar, BBA
Muhammad Omar Shahid, BBA
Muhammad Omar Siddique, BBA
Muhammad Qasim Ali Hayat Khan, BBA
Muhammad Qasim Naqvi, MBA
Muhammad Raza, BBA
Muhammad Saad Raufi, BBA
Muhammad Saad Rizwan, BBA
Muhammad Saad Zafar, BSC
Muhammad Saad, BBA
Muhammad Sarfaraz Khan, BBA
Muhammad Shabbeer Malik, BBA
Muhammad Shafai Darab, BBA
Muhammad Sohaib Anwar, BSC
Muhammad Talha Saleem, BSC
Muhammad Umair Ahmed, BBA
Muhammad Umair Ayaz Jaskani, BSC
Muhammad Umair Tariq, BBA
Muhammad Umair, BBA
Muhammad Umar Qureshi, BBA
Muhammad Umer Anwer, BBA
Muhammad Usman Ashraf, BBA
Muhammad Usman Azam, BBA
Muhammad Usman Mian, BBA
Muhammad Usman Tariq, BSC
Muhammad Usman, BBA
Muhammad Yasser Rizwan, BBA
Mujeeb Mustafa Rizvi, BBA
Muneeba Said, BBA
Muneeba Saqib, BBA
Murad Shahid, BSC

Murtaza Hasan, BBA
Mussab Aamir, BBA
Nabeel Shaukat Ali, BBA
Najam -uz- Zehra Gardezi, BSC
Naseha Shafaq Tariq, BBA
Nasir Ali, BBA
Natalia Naveed Khan, BSC
Nauman Akram, MBA
Nazish Mohammad, BSC
Neha Ziad, BBA
Nehan Sabahat Husain, BSC
Nermeen Mahmood, BBA
Nida Khan, BSC
Nida Mazhar, BBA
Nida Qadir, BBA
Nida Zahid, BSC
Nighat Ahmed, BBA
Nighat Ahmed, MBA
Nimra Bukhari, EMBA
Novera Anees, BBA
Numera Hameed, EMBA
Omar Chaudhry, BBA
Omar Farooq Malik, BBA
Omar Ghaffar, BBA
Omar Iqbal, BSC
Omar Masood, BBA
Omar Sharif, BSC
Omer Iqbal, BBA
Omer Mukhtar Gondal, BSC
Omer Nadeem, BBA
Omer Nawaz Sheikh, BBA
Omer Saeed, BBA
Onaiz Saeed, BBA
Osama Riaz, BBA
Osama Sabih, BBA
Qasim Ali, BBA
Qasim Shahid Dar, BSC
Qurat -ul-ain Zulfiqar, BBA
Qurat-ul- Ain Ansari, BSC
Qurat-ul-ain Farooq, MBA
Raafay Munir Haider Gill, BBA
Raashid Saleem, BBA
Rabia Ahmed, BSC
Rabia Badar Zia, BBA
Rabia Batool, MBA
Rabia Osman, BBA
Rabia Rohail, MBA
Rachel Zoe Zahid, BSC
Raheel Awan, BBA
Raja Hannan Ullah Khan, BBA
Rakhshanda Anaam Rana, BSC
Rao Muhammad Fahad, EMBA
Raza Ali, BBA
Raza Irshad, BBA
Raza Salman, BSC
Reda Asim, BSC
Reem Hasan, BSC
Reema Akhtar, BSC
Rehan Zahoor, BBA
Resham Naveed, BSC
Reza Mahmud, MBA
Rida Ramzan, BSC
Rooman Anwar, BBA
Rubab Zafar Chaudhry, BBA
Rushdia Amanat, BBA
Saad Ahmad Qureshi, BBA
Saad Ahmed Chaudhary, BSC
Saad Hafeez, BSC
Saad Riaz, BBA
Saad Sarfraz, BSC
Saad Shabbir, BBA
Saad Shahid, BBA
Saba Sharjeel, MBA
Sabeen Bashir, BBA
Sabeen Usman, BSC
Sabina Arif, BSC
Sadaf Farooq Khan, BBA
Sadaf Shakeel, BBA
Sadia Hasan, BBA
Sadia Hassan, MBA
Sadiyya Khan, BSC
Saher Yusuf, BSC
Sahir Qureshi, EMBA
Saif Ullah Khan, BBA

Saima Naveed, BBA
Saira Bano, BBA
Saira Khan Tiwana, BBA
Sajid Ahmad, BBA
Salman Ali Vaqar, BBA
Salman Tahir, MBA
Salman Zafar, MBA
Samiah Ashfaq Ahmed, BBA
Samra Chaudary, BBA
Sana Ahmed Uqaili, BBA
Sana Ahsan Elahi, BSC
Sana Akram, BBA
Sana Bahadur, BBA
Sana Bahadur, MBA
Sana Jamshed Khan, BSC
Sana Khalid, BSC
Sana Khalid, MBA
Sana Khan, BSC
Sana Mehmood, MBA
Sana Sattar, BBA
Sana Sheraz, BSC
Sanaa Ahmed, MBA
Sanaa Anwar, BBA
Sanaa Usman, BBA
Sanam Sajjad, BBA
Saqib Shafique Shami, BBA
Sarah Ahmad, BSC
Sarah Badar, BSC
Sarah Baqai, BSC
Sarah Nasar Qureshi, BSC
Sardar Hassan Imam, BSC
Sarosh Sikander, MBA
Schezreh Rabbani, BBA
Sehar Zafar, BSC
Sehrish Jalil, MBA
Sehrish Nisar, BBA
Shafaq Junaid Aslam, BSC
Shafia Khan, BSC
Shaharyar Ahsan Sheikh, BSC
Shahbaz Farooq Ahmad Khan, BBA
Shaheer Mohammad, BBA
Shahram Niazi, BSC
Shahreen Shahzad, MBA
Shahrukh Mushtaq, BSC
Shahzad Bhatti, BBA
Shahzeb Anwar, BBA
Shakeela Saeed, BBA
Shamza Nasim, BBA
Shaukat Mahmood, BBA
Sheheryar Masood, BBA
Shehryar Ahmed, BBA
Sheikh Abdul Hadi, BSC
Shiraz Naseer, BSC
Shiza Nisar, BSC
Shoaib Ahmad, BBA
Shuja Ur- Rehman, MBA
Sidra Khan, MBA
Sidra Rafique, BSC
Sidra Zia Butt, BBA
Sidrah Izhar, BBA
Sidrah Kaleem, BBA
Sikandar Ahmad Hotiana, BBA
Sikander Ehsan, MBA
Sobia Sohail, BSC
Sofia Khan, BBA
Sohail Irshad B. Anjum, BBA
Suniya Suleman, BSC
Syed Abbass Hussain, BBA
Syed Abid Hussain, BBA
Syed Abuzar Abbas, BSC
Syed Adil Hussain, BSC
Syed Ahmed Jamal, BBA
Syed Ahsan Raza, EMBA
Syed Ali Hassan Gilani, BBA
Syed Ali Hassan Shah, BSC
Syed Ali Hassan, MBA
Syed Ali Shuja Rizvi, BBA
Syed Ammar Mohsin, BBA
Syed Asad Ali Shah, EMBA
Syed Asad Murad, BSC
Syed Asfand Kamal, BBA
Syed Faheem Abbas, BBA
Syed Hashim Hassan Naqvi, BBA

Syed Jawad-ul-haq, BSC
Syed Khalid Mustafa, MBA
Syed Muhammad Ali, BBA
Syed Muhammad Ali, BBA
Syed Muneeb Ali Shah, BBA
Syed Nabeel Haider, BBA
Syed Samir Rizvi, BBA
Syed Sunaa Razvi, BBA
Syed Usman Gillani, BBA
Syed Waqas Javed, MBA
Syed Waqas Khan, BBA
Syed Warris Waqar Kirmani, BSC
Syed Zain Ali, MBA
Syeda Attiya Shareen, BBA
Syeda Ayehsa Ata, BSC
Syeda Kazmi, BBA
Syeda Shehrbano Abbas, BBA
Taha Sajid, BBA
Tahir Ramzan Bhatti, BBA
Tahreem Baig, EMBA
Taimur Asad Khan, MBA
Taimur Ibrahim, MBA
Talha Ahmad, BBA
Talha Bilal, BSC
Talha Bin Aizaz, MBA
Tameha Sultan, BSC
Tanya Shahid, BSC
Tariq Raza, BSC
Tashfeen Warrich, BBA
Tawha Ahmed, BSC
Tehniat Naveed, MBA
Umair Ahmed Dar, BBA
Umair Akhtar, MBA
Umair Farooq, BSC
Umair Mubaraz Bhandari, BBA
Umair Mushtaq, BSC
Umair Usama, BBA
Umair Zahid, BBA
Umais Ahmed, BBA
Umar Farooq, BBA
Umar Farooq, BSC
Umar Hafiz, BSC
Umer Ahmad Khan, MBA
Umer Zeb Akram, BBA
Umer Zia, BBA
Unum Shahid, BBA
Unum Shahid, MBA
Usama Daood, BBA
Usama Nadeem, BBA
Usman Abad Butt, MBA
Usman Bajwa, BBA
Usman Hafeez, EMBA
Usman Hameed, BBA
Usman Pervaiz, EMBA
Usman Saeed, MBA
Usman Salah-ud- Din, MBA
Uzair Naveed, BBA
Wajahat Hussain, MBA
Wajid Hussain, EMBA
Waleed Khawar, BBA
Waqar Aslam, BBA
Waqas Ahmad Mian, BSC
Waqas Ghaffar, BBA
Waqas Mahmood, MBA
Yasir Naeem Ahmed, MBA
Yasir Rana, BBA
Yasir Saeed Naz, BBA
Yumna Ali, BSC
Zahid Ameer Khan, BSC
Zahra Zahid, BBA
Zahrah Sodhi, BSC
Zaib Ghaffar, BBA
Zaighum Abbas Gondal, BBA
Zaima Ashraf, MBA
Zain Bin Azhar, BBA
Zain Khalid, BBA
Zain Naeem, BSC
Zain Sadiq, BBA
Zain Sadiq, BBA
Zain Sajjad, BBA
Zain Ul-Abdeen Rana, BBA
Zain Warrich, BSC
Zainab Nawaz Shah, EMBA
Zaineb Hassan, BBA

Zain-ul-Abdeen, BBA
Zaki Tariq, BBA
Zara Ahmed, BBA
Zareen Shahid, MBA
Zimran Nigel Harrison, BBA
Zubair Ahmed, BBA
Zunarah Siddiqui, BSC
Zunia Saif Tirmazee, BSC