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Financial Development and Economic Growth: Evidence from a Heterogeneous Panel of High Income Countries

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Abstract

This paper examines the empirical relationship between financial development and economic growth for high income countries. The study focuses on both indirect finance and direct finance, separately as well as jointly. Applying the methodology of Nair-Reichert and Weinhold (2001) for causality analysis in heterogeneous panel data, two sets of results are reported. First, the evidence regarding the relationship between financial development and economic growth from a contemporaneous non-dynamic fixed effects panel estimation is mixed. Negative and statistically significant estimates of the coefficient of the inflation and financial development interaction variable indicate that financial sector development may even be harmful to economic growth when inflation is rising. Second, in contrast with the recent evidence of Beck and Levine (2003), heterogeneous panel causality analysis applied on a refined model indicates that there is no definite evidence that finance spurs economic growth or growth spurs finance. Most of our findings are in line with the Lucas (1988) view that the importance of financial matters is over-stressed. The only exception is the case of activity in stock markets where our result supports the Robinson (1952) view that finance follows enterprise.

Introduction

The relationship between financial development and economic growth has always fascinated economists. As far back as 1873, Bagehot argued that the financial system played a critical role in igniting industrialization in England by facilitating the mobilization of capital for growth[1]. Schumpeter (1934) noted that banks actively spur innovation and

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[1] Hicks (1969) also came out with the similar conclusion.

future growth by identifying and funding productive investments. McKinnon (1973) and Shaw (1973) brought the relationship between financial development and economic growth at the centre stage of research. Lucas (1988), however, dismisses finance as a major determinant of economic growth calling its role over-stressed by economists. Empirical evidence is also mixed as has been pointed out by Levine (1997, 2003) in extensive reviews of the literature.

In view of the conflicting evidence, Khan and Senhadji (2000) stress that the relationship between financial development and economic growth needs to be refined and appropriate estimation methods employed.

Both the theoretical and empirical literature suggest that increases in the rate of inflation can adversely affect financial market conditions (Khan, Senhadji, and Smith, 2003). A simple way to allow for such an effect is to write the coefficient of financial development as a function of inflation, and to consider both financial development and inflation separately as well as interactively while modeling the relation between financial development and economic growth.

Previous studies have been based either on time series data or on cross-sectional data. Whereas time series analysis is confined to an individual country, the cross-sectional studies have been criticized on the grounds of failure to control effectively for cross-country heterogeneity. No doubt some studies have used a panel GMM estimator to analyze the finance and growth relationship, but as pointed out by Kiviet (1995), panel data models that use instrumental variables estimation often lead to poor finite sample efficiency and bias. Considering the heterogeneous nature of the relationship between financial development and economic growth across countries, Nair-Reichert and Weinhold's (2001) methodology of panel causality analysis has been used in this study.

The main objective of the present study is to investigate the causal relationship between financial development and economic growth by using panel data from 19 High Income Countries (HIC) for the period 1974-2001. The plan of the paper is as follows. The theoretical and empirical work relating to the relationship between financial development and economic growth is reviewed in the next section. The model used in the study and the methodology applied are outlined in section 3. The empirical results are provided in section 4. A summary of the conclusions and policy recommendations are given in the last section of the paper.

2. Review of Literature

The literature on the finance-growth nexus may be grouped into four schools of thought.

i) *Finance promotes growth*: Banks act as an engine of economic growth as noted by Bagehot (1873), Schumpeter, (1934), Hicks (1969), McKinnon (1973), Shaw (1973), and some others.

ii) *Finance hurts growth*: As explained in Levine (2003), it is believed that banks have done more harm to the morality, tranquility, and even wealth of nations than they have done or ever will do good. Although financial institutions facilitate risk amelioration and the efficient allocation of resources, it may not boost growth because better finance means greater returns to saving and lower risk (which may result in lower savings) and resultantly lower growth.

iii) *Finance follows growth*: Robinson (1952) pointed out that the enterprise leads financial development. Economic growth creates a demand for financial arrangements and the financial sector responds automatically to these demands.

iv) *Finance does not matter:* According to Lucas (1988) the role of finance in economic growth has been overstressed.

As pointed out earlier, some studies (such as those of Levine, Loayza and Beck (2000) and Beck, Levine, and Loayza (2000)) have used a panel GMM estimator to analyze the finance and growth relationship to control for cross country heterogeneity, but it has often led to poor finite sample efficiency and bias. Some studies allow for intercept heterogeneity but Pesaran and Smith (1995) show that if slope coefficients are assumed to be constant, the traditional panel estimators may yield inconsistent estimates. Moreover, using a period average, i.e., collapsing each time series variable into a single observation, has been criticized because of the nonstationary nature of these data [See Van den Berg and Schmidt (1994) and Van den Berg (1997)].

The use of time-series-cross-section panel data estimation allows researchers to control for country-specific, time-invariant fixed effects, and includes dynamic, lagged dependent variables which are also helpful in controlling for omitted variable bias. But the traditional panel data fixed effects estimators (FEE) impose homogeneity assumptions on the coefficients of lagged dependent variables when, in fact, the dynamics are heterogeneous across the panel. Pesaran and Smith (1995) argue that this misspecification

may lead to serious biases that cannot be remedied with instrumental variable estimation. The Mean Group Estimator of Pesaran and Smith (1995) is an unweighted average of the country specific coefficients and is particularly sensitive to outliers. A simple Random Coefficient (RC) estimator, on the other hand, calculates a variance weighted average, but it is not possible to estimate dynamic RC models. The Mixed Fixed Random (MFR) effects approach of Hsiao *et al* (1989) which has been utilized by Weinhold (1999), and Nair-Reichert and Weinhold (2001) falls somewhere in between the two extremes of FEE and MGE in terms of allowing for heterogeneity. This method imposes more structure on the coefficient values of the exogenous variables than the MGE. As compared to the FE estimator with a small T, the MFR coefficients approach produces a considerably less biased parameter estimate [Nair-Reichert and Weinhold (2001)]. Weinhold (1999) shows that the MFR coefficients model performs very well compared to instrumental variables (GMM), and it has other features well suited for the causality analysis in heterogeneous panel data sets.

Nausser and Kugler (1998) use the heterogeneous panel data approach for a limited number of OECD countries and after doing panel cointegration analysis, individual country causality analysis has been applied. Christopoulos and Tsionas (2003) use panel unit root tests and panel cointegration analysis to examine the relationship between financial development and economic growth in ten developing countries. But for causality analysis they use time-series tests to yield causality inferences within a panel context.

Chari, Jones and Manuelli (1996) argue that financial regulations and their interaction with inflation have substantial effects on growth. Choi, Smith, and Boyd (1996) argue that inflation reduces the real return to savings and makes the adverse selection problems in capital markets more severe inducing a high degree of credit rationing and a negative impact on financial development. In a monetary growth model, Huybens and Smith (1999) show that, at the steady state, higher rates of money creation reduce the real return on all assets and, under certain conditions, lead to a reduction in the volume of trading in equity markets. Boyd, Levine and Smith (2001) consider an alternative theory regarding the relationship between inflation and financial sector performance: governments combine high inflation with various restrictions on the financial sector to help fund expenditures. As a result, they have both poorly developed financial systems and high inflation. Barro (1997) finds that permanent increases in the rate of inflation have significant negative effects on long run real growth rates. Khan, Senhadji, and Smith (2003) assert that the real effects of inflation derive from the consequences of inflation for financial markets conditions.

3. Model, Data, and Econometric Methodology

3.1 Model Specification

Following King and Levine (1993), the relationship between financial development and economic growth using the linear regression equation is given below:

$$G = \alpha + \beta F + \gamma X \tag{3.1}$$

where G is growth in real GDP per capita;

F is the proxy for financial development; and

X is the set of conditioning information to control for other factors associated with economic growth.

For the heterogeneous panel data, the model may be specified as

$$G_{it} = \alpha_i + \beta_i^{'} F_{it} + \gamma_i X_{it} + \varepsilon_{it} \tag{3.2}$$

where $i = 1,2,...,N$, and $t = 1,2,...,T_i$.

N refers to the number of countries;

T_i refers to the number of observations over time for country i in the panel.

Parameter α_i is the country specific intercept, or fixed effect parameter, which of course is also allowed to vary across individual countries[2].

The slope coefficient is also allowed to vary across countries to take into account the possible heterogeneity[3] among the various countries in a panel.

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[2] Country specific fixed effects heterogeneity is assumed on the basis of differences in technology.

[3] Even though we have grouped countries according to their level of income, there may still be heterogeneity between the countries in the panel. There are different sources of such heterogeneity such as differences in population size, differences in political and economic institutions, differences in geography, and differences in culture.

The other factors associated with economic growth (i.e. the variables in X) include two types of variables: state as well as control variables. State variables are the initial stock of physical capital and the initial stock of human capital. The available data on physical capital seem unreliable (Barro and Sala-i-Martin, 2004). Following Barro and Sala-i-Martin (2004) we assume that for a given stock of human capital, a higher level of initial income reflects a greater stock of physical capital or larger quantity of natural resources. For the initial level of income we use real GDP per capita with a one year lag. Because of diminishing returns to reproducible factors, a richer economy tends to grow at slower rate. Therefore, the influence of the higher initial level of income on the growth rate of real GDP per capita in equation (3.2) would be negative.

There are some very interesting and path breaking models which shed light on the role of human capital in economic growth. One of the most prominent and influential contributions is that of Lucas (1988), which in turn is related to the previous work by Uzawa (1965). In the long run, sustained growth is linked with human capital. Human capital is a broader concept. We use educational attainment as a stock of human capital. The variable we use to proxy the educational attainment is the secondary school enrollment ratio. The influence of the higher (initial) secondary school enrollment ratio on the growth rate of real GDP per capita in equation (3.2) would be positive because educational attainment affects productivity positively.

Previous empirical studies [for example Barro (1997), Barro and Sala-i-Martin (2004)] have shown that growth in real GDP per capita is negatively related to the initial level of GDP. So we also expect, in our study, the sign of the coefficient of initial level real per capita GDP to be negative and the sign of the coefficient of the initial level of secondary school enrollment ratio to be positive in equation (3.2).

Following the recent literature on the analysis of financial development and economic growth, the control variables we use are: inflation rate (denoted by INFL) as measure of macro economic instability, government consumption to GDP ratio (denoted by GCGR) as fiscal policy variable, and international trade openness (denoted by TRGR) as international trade policy variable.

Temple (2000) asserts that inflation increases uncertainty. It will tend to introduce unwelcome noise into the workings of the markets, for instance raising relative price variability. Planning will become more difficult. Heyman and Leijonhufvus (1995) argue that high inflation rates will increase the complexity of contracts, raise the frequency of negotiations,

and perhaps lead to certain contracts being avoided altogether. Planning horizons shorten, and firms avoid long run commitments. In this way, inflation tends to have negative effects on growth.

The issue of the effect of government consumption is complicated. Government consumption is a component of aggregate demand, and if there is slack in production and prices and/or wages are sticky downward, it will have a positive effect on GDP according to Keynesian hypothesis. Moreover, the public sector may raise the productivity of the private sector by providing legal, defense, judiciary and police services, enforcing property rights, and correcting failures in the markets etc. On the other hand, government interventions generate disincentive effects caused by revenue raising and transfer activities. Taxes to meet the expenditures can result in serious resource misallocation. Additionally, potential inefficiencies caused by rent-seeking and principal-agent problems in the provision of government output may result in substantial negative impact on productivity. This can mitigate or even offset the potential positive effects of government consumption on economic growth and we may have a negative sign of the impact of government consumption to GDP ratio on growth rate of real GDP per capita.

Overall, the trade to GDP ratio is a measure of the openness of a country to international trade. It is argued in the literature that the greater the openness the greater the competition or exposure to a larger set of ideas or technologies which increases the technological progress and hence, permanently rises growth rates (Winter, 2004).

Accordingly (3.2) is written as

$$GRGPC_{it} = \alpha_i + \beta'_{1i} F_{it} + \beta_{2i} INFL_{it} + \beta_{3i} GCGR_{it} + \beta_{4i} TRGR_{it} + \beta_{5i} SSER_{it-5} + \beta_{6i} RGPC_{it-1} + \varepsilon_{it} \quad (3.3)$$

where ε_{it} are assumed to be idiosyncratic errors.

We first estimate the contemporaneous non-dynamic fixed effects panel model of economic growth by regressing the GRGPC on conditioning variables (INFL, GCGR; TRGR; SSER[4]; and initial RGPC) and we name it as the **general model**. Dropping the insignificant variables (if any) we will be left with a parsimonious **basic model** for economic

[4] We use secondary school enrollment ratio with 5 year lag because people in secondary school at time t will generally be entering the labour force in some latter time and will not be productive for 5 years or so.

growth. To this basic model we add a proxy for financial development and have an **intermediate model** to see how financial development contributes to economic growth. In order to capture the impact of changes in the rate of inflation on financial market conditions, it is hypothesized that the financial development effect, β'_{1j}, is a function of the inflation rate, i.e.; $\beta'_{1j} = \beta_{1j} + \beta_{7i} INFL_{it}$. By substituting it back into equation (3.3) we get:

$$GRGPC_{it} = \alpha_i + \beta_{1j} F_{it} + \beta_{2i} INFL_{it} + \beta_{3i} GCGR_{it} + \beta_{4i} TRGR_{it} + \beta_{5i} SSER_{it-5} + \beta_{6i} RGPC_{it-1} + \beta_{7i} (F * INFL)_{it} + \varepsilon_{it} \quad (3.4)$$

This gives us the **final model** which includes the proxy for financial development and inflation, both individually as well as interactively.

To analyze whether there is a causal relationship between economic growth and financial development we turn to the dynamic panel form of (3.4) in which GRGPC is modeled as a function only of lags of itself and of all other right hand side variables in (3.4). That is:

$$GRGPC_{it} = \alpha_i + \gamma_i GRGPC_{it-1} + \beta_{1j} F_{it-1} + \beta_{2i} INFL_{it-1} + \beta_{3i} GCGR_{it-1} + \beta_{4i} TRGR_{it-1} + \beta_{5i} SSER_{it-6} + \beta_{6i} RGPC_{it-2} + \beta_{7i} (F * INFL)_{it-1} + \varepsilon_{it} \quad (3.4a)$$

To take care of the linear influences of the remaining right-hand side variables in (3.4a) on the candidate causal variable, we orthogonalize the candidate causal variable[5] and thus our **final model in dynamic form** becomes:

$$GRGPC_{it} = \alpha_i + \gamma_i GRGPC_{it-1} + \beta_{1j} F^{0}_{it-1} + \beta_{2i} INFL_{it-1} + \beta_{3i} GCGR_{it-1} + \beta_{4i} TRGR_{it-1} + \beta_{5i} SSER_{it-6} + \beta_{6i} RGPC_{it-2} + \beta_{7i} (F * INFL)_{it-1} + \varepsilon_{it} \quad (3.5)$$

All the variables in the model are assumed to be stationary.

[5] Our causal candidate variable is the proxy for financial development and we orthogonalize only this variable in order to ensure that the estimated coefficients are independent. We base our non-causality inference on estimated coefficient of the causal candidate variable to be zero.

3.2 Data

One of the important issues pertaining to the analysis of the finance growth nexus is the selection of proxies to measure financial development and economic growth. For economic growth, following King and Levine (1993), we use real per capita GDP growth. We denote it by GRGPC[6]. There is no single accepted empirical definition of financial development. Following King and Levine (1993); Levine and Zervos (1998); and Beck, Demirguc-Kunt, and Levine (2001) various indicators of size and activity of indirect as well as direct finance proxy for financial sector development. We also combine the size and activity measures of direct and indirect finance to proxy overall financial sector development. As a whole, we have six measures of financial sector development which will be used in this study. These measures are discussed below.

i) *The size of indirect finance:* The size of the financial intermediaries is measured as currency plus demand and interest bearing liabilities of banks and other financial intermediaries, divided by GDP, generally known as liquid liabilities to GDP ratio (LLGR). This is the broadest available indicator of financial intermediation. However, the size of the financial sector may not accurately measure the functioning of the financial system.

ii) *The activity of indirect finance:* To measure the activity of financial intermediaries we consider the private sector credit (by deposit money banks and other financial institutions) to GDP ratio (PCGR).

iii) *The size of direct finance:* As an indicator of the size of direct finance we use the stock market capitalization to GDP ratio (MCGR), which equals the market value of listed shares divided by GDP.

iv) *The activity of direct finance:* As an indicator of the activity of direct finance we use the total value of the shares traded in the stock market to GDP ratio (VTGR).

v) *The size of the overall financial sector:* Combining the two size measures we have an overall size measure of the financial sector. We call it the financial depth to GDP ratio, denoted by FDGR.

[6] For a complete list of data, variables, and sources of data see Appendix A.

vi) *The activity of the overall financial sector:* Combining the two activity measures we have an overall activity measure of the financial sector, i.e., the financial activity to GDP ratio (FAGR).

Stock variables are measured at the end of a period and the flow variables are defined relative to a period. This presents a problem in the first type of measure, both in terms of correcting timing and deflation. To address these problems, we deflate the end-of-year financial aggregates by end-of-year consumer price indices (CPI_e) and deflate the GDP series by annual consumer price index (CPI_a), following Demirguc-Kunt and Levine (2001). Then we compute the average of the real financial aggregate in year t, and $t-1$ and divide this average by real GDP measured in year t. The end-of-year CPI is either the value for December, or, where the December-CPI is not available, for the last quarter. The formula, for LLGR[7], is the following:

$$LLGR = 0.5 * \left(\frac{LLB_t}{CPI_{e,t}} + \frac{LLB_{t-1}}{CPI_{e,t-1}} \right) \Big/ \left[\frac{GDP_t}{CPI_{a,t}} \right] \qquad (3.6)$$

In the case of the ratio of two flow variables measured in the same time, deflating is not necessary.

We use a dataset of 19 HIC countries listed in the Appendix A. The countries have been selected from the overall list of High Income Countries for which World Bank publishes income classification in its World Development Indicators[8]. The countries included are selected on two criteria: there is data both on indirect as well direct finance; and that data are available for at least 15 observations for both types of finance.

3.3 Methodology

For testing the stationarity of the variables we apply the Im, Pesaran and Shin (2002) panel unit root test for dynamic heterogeneous panels which is based on the average (across countries) of the (augmented) Dickey-Fuller statistics.

[7] The same is also done for MCGR.

[8] The World Development Indicators for 2002 have been used. The country classification is based on World Bank estimates of per capita GNI during 2000. Countries for which estimates of per capita GNI are US$ 9265 or more are classified as High Income Countries.

3.3.1 Panel Unit Root Tests

First we consider the calculation of individual country unit root (augmented) Dickey-Fuller test-statistics denoted by $\tilde{t}_{iT_i}$. The process starts by estimating the following (augmented) Dickey-Fuller regression:

$$\Delta y_{it} = \alpha_i + \delta_i t + \rho_i y_{it-1} + \sum_{j=1}^{p_i} \Delta y_{it-j} + \varepsilon_{it} \tag{3.7}$$

for each of the cross sectional units in the panel and estimating the value of the t-statistics and then averaging them. The decision on the number of lags of the dependent variables to be included depends on the stationarity of the error term and here we will be using a step down procedure starting at a maximum lag of four.

The null hypothesis for the IPS panel unit root test is

$$H_0 : \rho_i = 0 \text{ for all } i \tag{3.8}$$

against the alternatives

$$H_1 : \rho_i < 0, \text{ for } i = 1,2,..,N_1, \text{ and } \rho_i = 0, \text{ for } i = N_1 + 1, N_1 + 2,...,N \tag{3.9}$$

This formulation of alternative hypothesis allows for ρ_i differing across groups. It allows for some (but not all) of the individual series to have unit roots under the alternative hypothesis. Essentially, the IPS test averages the ADF individual unit root test statistics that are obtained from estimating (3.7) for each i (allowing each series to have a different lag length, p_i if necessary); that is:

$$\tilde{t} - bar_{NT} = \frac{1}{N} \sum_{i=1}^{N} \tilde{t}_{iT_i} \tag{3.10}$$

which is referred to as the $\tilde{t} - bar$ statistic.

IPS shows that under the assumption that $\varepsilon_{it}, i = 1,2,...,N, t = 1,2,...,T_i$ in (3.7) are independently and identically distributed for all i and t with mean zero and finite heterogeneous variances σ_i^2, $\tilde{t}_{iT_i}$ are independently (but not identically) distributed for $T_i > 9$ and that the standardized $\tilde{t} - bar$ statistic:

$$Z_{tbar} = \frac{\sqrt{N}\left[\tilde{t} - bar_{NT} - N^{-1}\sum_{i=1}^{N} E(\tilde{t}_{T_i})\right]}{\sqrt{N^{-1}\sum_{i=1}^{N} VAR(\tilde{t}_{T_i})}} \qquad (3.11)$$

converges to standard normal variate[9] as N increases indefinitely.

When testing for panel unit roots at level we take both the unobserved effects and heterogeneous time trend as in equation (3.7). If in no case we reject the null hypothesis that every country has a unit root for the series in levels, we then test for a unit root in first differences.

If the proxy for economic growth and for financial development are of the same order of integration and none of the control variables is of a higher order than that of the dependent variable, we move towards testing for possible cointegration between financial development and economic growth. Otherwise, the order of integration of the series of interest does not support a move to cointegration analysis. On the basis of the evidence documented in Lee, Pesaran and Smith (1997) and in Canning and Pedroni (1999), we expect our dependent variable (growth in real GDP per capita) and the variables of interest to be stationary and therefore we may not have to apply panel cointegration analysis.

3.3.2 Contemporaneous Fixed Effects Model Estimation

Assuming the slope coefficients to be homogeneous, we estimate the model in (3.4) using a fixed effects methodology in which the country specific fixed effects are wiped out and each variable is replaced by its deviation form cross-sectional means. On this transformed data the OLS method is applied. However, for calculating the estimated t-values robust variance estimator proposed in Arellano (1987) is used to address the issue of possible heteroscedasticity.

3.3.3 Panel Causality Analysis for Dynamic Heterogeneous Panel Data Model

We examine the direction of causality between financial development and economic growth, and *vice versa*, using the methodology introduced by Weinhold (1999) and Nair-Reichert and Weinhold (2001) for causality

[9] IPS standardized their test statistics based on simulations of the mean and variance (with different values obtained depending on the lag length used in the ADF tests and the value of N). These simulated values are given in IPS (2002).

analysis in heterogeneous panel data which is based upon the mixed fixed random (MFR) coefficients approach of Hsiao *et al* (1989).

Following Nair-Reichert and Weinhold (2001), we consider the model

$$y_{it} = \alpha_i + \gamma_i y_{it-1} + \beta_{1i} x^{0}_{1it-1} + \beta_{2i} x_{2it-1} + \varepsilon_{it} \qquad (3.12)$$

where $\beta_{ji} = \overline{\beta}_j + \eta_i$. η_i is a random disturbance. Here $\beta_{ji} \sim N(\overline{\beta}_j, \sigma^2_{\beta_j})$. The variable x^{0}_{1it-1} denotes the orthogonalized candidate causal variable after the linear influences of the remaining right-hand side variables have been taken into account. Orthogonalization[10] provides for the appropriate interpretation of the estimated variances by making sure that the coefficients are independent. Unobserved effects (α_i) and the coefficient of the lagged dependent variable are fixed and country specific; and the coefficients on the exogenous explanatory variables are drawn from a random distribution with mean $\overline{\beta}_j$ and finite variance[11]. The estimator and the corresponding standard error are discussed in Appendix B.

4. Results

4.1 Statistical properties of the data

Table-4.1A shows the summary statistics of various variables used in this study. The comparison of within and between-country standard deviation for all the variables shows that most of the variability in all the variables is between countries which shows the heterogeneity amongst the countries.

The pair-wise correlations matrix, presented in Table 4.1B, shows that the growth in real per capita GDP is positively related to openness measured by trade to GDP ratio and to all the indicators of financial development, except private credit to GDP ratio. The secondary school

[10] For the purpose of orthogonalization of the lagged causal candidate variable, we regress the lagged causal candidate variable on the constant, lagged dependent variable and all other explanatory variables. We use errors of this regression as orthogonalized (lagged) causal candidate variable.

[11] Weinhold (1999) explains why to model this particular combination of fixed individual specific coefficients on the lagged dependent variable and random coefficients on the lagged independent variables.

enrollment to GDP ratio is negatively correlated with growth in real per capita GDP[12] because it may not be a good proxy for education in a high income country; higher education may have a strong positive correlation with real per capita GDP growth. Real GDP per capita growth is negatively related to the government consumption to GDP ratio and to the rate of inflation. Finally, the inflation rate is negatively correlated with all the measures of financial development. Interestingly, the correlation coefficients between inflation and financial development are higher compared to the correlation coefficients between financial development and economic growth, i.e. the negative contribution of financial development and inflation interaction outweighs the positive contribution from financial development to real GDP per capita growth.

4.2 Im-Pesaran-Shin Panel Unit Root Test

Table-4.2 presents the results of the Im-Pesaran-Shin (2002) panel unit root (IPS PUR) test on all variables used in this study. All the variables are stationary at level except (initial) RGPC, GCGR, TRGR, INFL*PCGR, and FDGR. These variables are nonstationary and become stationary after first differencing [13].

While testing for panel unit roots at level, we consider both the unobserved effects and heterogeneous time trend as in equation (3.7). It can be argued, particularly in the case of the growth rate of real GDP per capita and inflation, that there is no reason to include the heterogeneous time trend while testing for the unit root. However, it has been observed that the orders of integration of growth and inflation are insensitive to whether or not we include the heterogeneous time trend.

4.3 Contemporaneous Fixed Effects Model Estimation

In order to explore the relationship between financial development indicators and economic growth, we start with the estimation of the contemporaneous non-dynamic fixed effects panel estimation of the most general form which relates growth rate of real GDP per capita to inflation, government consumption to GDP ratio, overall trade to GDP ratio, (initial) secondary school enrollment ratio and the (initial) level of per capita GDP[14].

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[12] In Table-4.3.1 we can also see that SSER is found to be insignificant in contemporaneous non dynamic fixed effects panel estimation.

[13] We will be using first differences of such variables in the panel causality analysis.

[14] All the variables are in log form.

4.3.1 Indirect Finance and Economic Growth

Inflation, government consumption to GDP ratio, overall trade to GDP ratio, and initial per capita income are the significant determinants of growth in per capita GDP in High Income Countries (see Table 4.3.1). These results show that all the four explanatory variables in the basic model have the appropriate sign. These results are consistent with standard growth theory. Inflation depresses growth due to its adverse implications for working markets. Government consumption affects growth negatively, because of well known inefficiencies associated with the larger size of the government. A negative significant coefficient of the initial level of per capita GDP is in accordance with the conditional convergence growth theories. Overall the trade to GDP ratio has a positive effect on the growth rate of real GDP per capita.

By including proxies for financial development as regressors besides these four variables and re-estimating the simple contemporaneous non dynamic fixed effects panel regression, we find that the coefficient of the proxy for the size of the financial sector is insignificant, whereas the coefficient of the proxy for the activity of the financial sector is significant with a negative sign. When the interaction of finance with inflation is introduced, then the coefficients of the proxies of both the size and the activity of the financial sector become insignificant. However, the interaction term is negative and significant in the case of interaction with the size indictor and is insignificant in the case of interaction with the activity indicator of financial development. Thus in the HIC, we do not find any relationship between financial development and economic growth when we have the interaction variable in the model. However, the economic growth returns of further financial development in the size of indirect finance declines with increased inflation.

4.3.2 Direct Financial Development and Economic Growth

Table-4.3.2 gives the results of the simple contemporaneous non-dynamic fixed effects panel estimation. By including proxies for direct finance as regressors in the basic model, the simple contemporaneous non-dynamic fixed effects panel regression has been re-estimated and the results are shown in the column under the intermediate model. Both the proxies of size and activity of the (direct) financial sector are significant irrespective of whether the interaction variables are included or not. Interaction variables themselves are found to be insignificant. This shows that size and activity of direct finance has a strong positive relationship with economic growth for HICs.

4.3.3 Overall Financial Development and Economic Growth

Table-4.3.3 gives the results of the simple contemporaneous non-dynamic fixed effects panel estimation. The proxy of the size of the overall financial sector is statistically significant irrespective of whether we take finance alone or as an interaction variable with inflation. However, the proxy of the activity of the overall financial sector is statistically insignificant, irrespective of whether we take finance alone or along with an interaction variable with inflation. The implications are clear: economic growth has a relationship with only the size of the overall financial sector and is independent of financial development expressed in terms of activities of the (overall) financial sector. The coefficient of the interaction variable is insignificant for both the size as well as activity of the overall financial sector.

It is also observed that the magnitude of the partial effect of inflation on growth rate of GDP per capita is larger in the final model as compared to the basic model. It shows that inflation may be a much more serious issue in the financially developed stage of the economy as its impact is greater than that which can be at the lesser (financially) developed stage of the economy.

4.4 Panel Causality Analysis

The entire analysis of the contemporaneous non-dynamic fixed effects panel estimation presented above is based on the underlying assumption about the homogeneity of the relationships across countries in the panel. Heterogeneity is restricted to the intercept but is not permitted in the slope coefficients. We apply the Nair-Reichert and Weinhold (2001) panel causality method to our final model in the dynamic form in equation (3.5). In this model, the coefficient on the lagged dependent variable is country specific and the coefficients on the other right hand side variables are allowed to have normal distribution. We choose a lag length of one due to the large number of explanatory variables and relatively short time series for each country. The results are presented in Table 4.4 where we report the mean of the estimated coefficient, standard error of the mean of the estimated coefficient, and the variance estimate of the estimated coefficient on the causal variable.

For causality testing, we build confidence intervals around zero (here we will use the first element in the estimated vector $\widetilde{\theta}_1$ which is $\widetilde{\theta}_{1[1]}$ which is to be tested to be zero) to test for the mean of the estimated

coefficient on the causal variable to be zero. The lower and upper bounds are given below:

LB (Confidence Interval): $[(-2) * \sqrt{N}\,\tilde{\sigma}_{\tilde{\theta}_{1[1]}} - \tilde{\theta}_{1[1]}] \Big/ \Delta_{r11}$

UB (Confidence Interval): $[2 * \sqrt{N}\,\tilde{\sigma}_{\tilde{\theta}_{1[1]}} - \tilde{\theta}_{1[1]}] \Big/ \Delta_{r11}$

The area that falls within this interval is interpreted to correspond to observations that are not significantly different from zero.

We do not find evidence that the mean of the estimated coefficient of the orthogonalized causal candidate variable is significantly different from zero. Thus the results of the tests of causality from indirect finance to growth as well as that of causality from growth to indirect finance show that both are independent of each other and hence we find support for Lucas' view that economists overstress the role of finance. These results hold for the overall financial development proxies as well. In the cases of direct finance also we do not find any evidence of the causal effect of financial development on economic growth as the estimated coefficient of the orthogonalized causal candidate variables are insignificant. However, when we conduct the reverse causality analysis we find that economic growth has a positive impact upon the activity in the financial sector in the case of direct finance. This result supports the Robinson (1952) view 'where enterprise leads finance follows' and thus economic growth creates demand for financial arrangements and financial sector responds automatically to these demands.

5. Conclusion

This study examines the empirical relationship between financial development and economic growth while incorporating the inflation rate effect on financial development. The panel data of 19 High Income Countries suggests a mixed picture of the relationship between financial development and economic growth from the contemporaneous non-dynamic fixed effects panel estimation. Whereas there had been no positive and significant relationship between indirect finance and economic growth, direct finance is significantly and positively related to economic growth. We also find a significant and positive relationship between the size of overall financial development and economic growth.

A negative and, in most cases, significant coefficient of the inflation and financial development interaction variable indicates that financial sector

development is actually more harmful for economic growth when inflation is high, especially at a more developed stage of the financial system. In the cases where the interaction term is significant, the magnitude of the partial effect of inflation on the growth rate of GDP per capita is found to be larger in the final model as compared to that in the basic model, i.e. inflation may be a much more serious issue in the financially developed stage of the economy as its impact is greater than that which can be at the lesser (financially) developed stage of the economy.

The use of the Nair-Reichert and Weinhold (2001) panel causality methodology for the dynamic heterogeneous panel and a refined model employed in this study show that there is no indication that financial development spurs economic growth or growth spurs financial development. Most of our findings are in line with the Lucas view on finance that the importance of financial matters is very badly over-stressed. The only exception is the case when we conduct the reverse causality analysis and find that economic growth has a positive impact upon activity in the financial sector in the case of direct finance. This result supports the Robinson (1952) view that where enterprise leads finance follows. Therefore it follows thus that economic growth creates a demand for financial arrangements and the financial sector responds automatically to these demands[15].

We examined the empirical relationship between financial development and economic growth for a panel of high income countries. All of the countries in the sample had, during the time period under consideration, relatively developed and sophisticated financial markets, in which 'marginal' improvements in financial sector size and/or activity might have only modest effects on growth and thus might be the conclusion we reached above. Thus we would like to caution about generalizing these results on all countries, particularly low income countries. The causal relationship between financial development and economic growth may be different for low income countries than for high income countries.

[15] During the 1990's, information technology revolution has changed the nature and speed of financial transaction which coupled with globalization of stock markets and banking structure has given new meanings to financial development. In the light of these comments of one of the anonymous referees we also did the whole above exercise for post 1990 sample. The results of Nair-Reichert and Weinhold panel causality analysis for post 1990 sample are reported in Table 4.4A of the Appendix A which are not much different from those reported for full period sample in Table 4.4. The detailed results on panel unit root analysis and contemporaneous fixed effects panel estimation are available from the corresponding author on request.

Appendix A

Table-3.1: Countries Included in Study

Country	Time Span and Number of Observations			Country	Time Span and Number of Observations		
	From	**To**			**From**	**To**	
Australia	1979	2001	23	Luxembourg	1978	2001	24
Austria	1974	2001	28	Netherlands	1976	2000	25
Belgium	1974	2001	28	Norway	1976	2001	26
Canada	1976	2000	25	Portugal	1978	2001	24
Denmark	1980	2001	22	Singapore	1981	2001	21
Finland	1976	2001	26	Sweden	1974	1999	26
France	1974	2000	27	Switzerland	1976	2001	26
Greece	1974	2001	28	United Kingdom	1974	2001	28
Italy	1976	2001	26	United States	1978	2001	24
Japan	1974	2001	28	**Total Observations**			**485**

Table-3.2: Data Description and Sources

Variable	Data Description and Source
CPIa	Annual Consumer Price Index from IFS (Line 64)
CPIe	End-of-year CPI from IFS (Line 64M, or 64Q where 64M is not available)
GDP	Gross Domestic Product from IFS (Line 99B)
LLB	Liquid Liabilities from IFS (Line 55L or 35L, if 55L is not available)
MCP	Market Capitalization from Global Financial Data Base
PCR	Claims of Private Sector from IFS [Lines 22D.MZF, 22D.TZF, 22D.ZF, 42D.FZF, 42D.GZF, 42D.LZF, 42D.NZF, and 42D.SZF are included]
POP	Population (Line 99Z)
VTD	Value Traded from Global Financial Data Base
GCE	Government Consumption Expenditures from IFS (Line 91F)
TRD	Sum of Exports and Import (Line 90C+98C from IFS) of Goods and Services
GRGPC	Annual percentage growth rate of GDP per capita based on constant local currency from WDI-2004. (Dependent Variable)
LLGR	Liquid Liabilities to GDP ratio
PCGR	Private sector credit to GDP ratio
MCGR	Stock market capitalization to GDP ratio
VTGR	Stock market total value traded to GDP ratio
FDGR	(Overall) financial depth to GDP ratio
FAGR	(Overall) financial activity to GDP ratio
INFL	Inflation Rate Calculated from CPIa
GCGR	Government Consumption Expenditures to GDP ratio
TRGR	International Trade (sum of Exports and Import of Goods and Services) to GDP ratio
SSER	Gross Secondary School Enrollment Ratio from UNESCO
RGPC	GDP per capita based on purchasing power parity from WDI-2004

Table-4.1A: Summary Statistics - Panel Data (yearly observations) of HIC

Variable		Mean	Std. Dev.	Min.	Max.	Observations
GRGPC	Overall	0.0219	0.0229	-0.0678	0.0945	485
	Between		0.0396			19
	Within		0.0220			21, 28
LLGR	Overall	0.8235	0.5272	0.3049	3.4231	485
	Between		2.4992			19
	Within		0.2177			21, 28
PCGR	Overall	0.7998	0.3606	0.1985	2.2463	485
	Between		1.5275			19
	Within		0.2119			21, 28
MCGR	Overall	0.5516	0.5513	0.0036	2.9530	485
	Between		2.1076			19
	Within		0.3796			21, 28
VTGR	Overall	0.2962	0.5536	0.00001	6.6322	485
	Between		1.5594			19
	Within		0.4737			21, 28
FDGR	Overall	1.3751	0.8889	0.4275	5.2424	485
	Between		3.7766			19
	Within		0.5193			21, 28
FAGR	Overall	1.0960	0.7931	0.2205	7.9635	485
	Between		2.6485			19
	Within		0.6184			21, 28
INFL (%)	Overall	5.50	4.85	-1.40	25.70	485
	Between		14.69			19
	Within		4.01			21, 28
GCGR	Overall	0.1883	0.0431	0.0845	0.2944	485
	Between		0.2043			19
	Within		0.0177			21, 28
TRGR	Overall	0.7761	0.5990	0.1592	3.3712	485
	Between		3.0445			19
	Within		0.1210			21, 28
Initial SSER (%)	Overall	90.08	18.11	37.18	148.25	485
	Between		63.30			19
	Within		13.64			21, 28

Table-4.1B: Pair wise Correlations-Panel Data (485 Annual Observations of HIC)

	GRGPC	LLGR	PCGR	MCGR	VTGR	FDGR	FAGR	INFL	GCGR	TRGR	SSER
GRGPC	1.0000										
LLGR	0.1530	1.0000									
PCGR	-0.0151	0.4936	1.0000								
MCGR	0.2673	0.3677	0.3909	1.0000							
VTGR	0.1918	0.0665	0.3377	0.6585	1.0000						
FDGR	0.2515	0.8403	0.5369	0.8131	0.4255	1.0000					
FAGR	0.1045	0.3496	0.8288	0.6369	0.8066	0.5901	1.0000				
INFL	-0.1847	-0.2145	-0.3785	-0.4506	-0.4060	-0.3969	-0.4791	1.0000			
GCGR	-0.2672	-0.4201	-0.2543	-0.3185	-0.1536	-0.4487	-0.2510	-0.0188	1.0000		
TRGR	0.2857	0.3376	0.2721	0.5976	0.2126	0.5597	0.2972	-0.2503	-0.3445	1.0000	
SSER	-0.1144	-0.1683	0.0839	0.0500	0.3104	-0.0762	0.2372	-0.4509	0.3710	-0.2372	1.0000

Table-4.2: IPS PUR Test

Variable	IPS-PUR test at Level	IPS-PUR test at First Difference	I(0)/I(1)
INFL	-6.2101**		I(0)@
GCGR	-1.2399	-24.2779**	I(1)@
TRGR	-1.0099	-33.0263**	I(1)@
SSER	-2.0165**		I(0)
RGPC	0.7392	-10.8977**	I(1)@
GRGPC	-8.3566**		I(0)@
LLGR	-2.4721**		I(0)
PCGR	-2.9472**		I(0)
INFL.LLGR	-6.0404**		I(0)@
INFL.PCGR	-1.1889	-12.0460**	I(1)
MCGR	-2.9005**		I(0)@
VTGR	-4.6956**		I(0)@
INFL.MCGR	-4.3908**		I(0)@
INFL.VTGR	-3.1746**		I(0)@
FDGR	-0.4946	-24.4457**	I(1)
FAGR	-2.0728**		I(0)
INFL.FDGR	-5.4697**		I(0)@
INFL.FAGR	-2.3877**		I(0)@

*: Significant at 10% level where critical value is -1.28

**: Significant at 5% level where critical value is -1.64

@: Order of integration is insensitive to maximum lag selection for general to specific methodology between 4 (for which these results are presented) and 1 (results for maximum lag selected 3, 2, and 1 are not presented here).

Table-4.3.1: Indirect Finance and Economic Growth

Contemporaneous "Fixed Effects" Panel Regressions: Dependent Variable= GRGPC: Heteroscedasticity Consistent t-statistics in parentheses

Variable	General Model	Basic Model	Intermediate Model		Final Model	
			Size	Activity	Size	Activity
INFL	-0.3247 (-8.94**)	-0.3255 (-9.19**)	-0.3275 (-9.96**)	-0.3184 (-8.50**)	-0.3882 (-10.6**)	-0.3286 (-7.77**)
GCGR	-0.0728 (-5.25**)	-0.0729 (-5.35**)	-0.0725 (-5.09**)	-0.0747 (-5.50**)	-0.0767 (-5.72**)	-0.0750 (-5.68**)
TRGR	0.0472 (3.30**)	0.0473 (3.25**)	0.0475 (3.30**)	0.0490 (3.50**)	0.0503 (3.94**)	0.0491 (3.55**)
SSER	0.0011 (0.15)					
RGPC	-0.0212 (-4.64**)	-0.0210 (-5.04**)	-0.0216 (-5.19**)	-0.0156 (-3.59**)	-0.0222 (-5.47**)	-0.0159 (-3.64**)
LLGR			0.0017 (0.25)		**0.0971 (1.25)**	
PCGR				-0.0121 (-2.80**)		**-0.0108 (-1.50)**
INFL.LLGR					-0.1481 (-2.25**)	
INFL.PCGR						-0.0195 (-0.28)
NT	471	471	471	471	471	471
R^2	0.2837	0.2837	0.2838	0.3014	0.2933	0.3016

**Significant at 5%;*Significant at 10%.

Table-4.3.2: Direct Finance and Economic Growth

Contemporaneous "Fixed Effects" Panel Regressions: Dependent Variable= GRGPC: Heteroscedasticity Consistent t-statistics in parentheses

Variable	General Model	Basic Model	Intermediate Model		Final Model	
			Size	Activity	Size	Activity
INFL	-0.3247 (-8.94**)	-0.3255 (-9.19**)	-0.2500 (-5.75**)	-0.2790 (-6.89**)	-0.3086 (-5.58**)	-0.3151 (-6.83**)
GCGR	-0.0728 (-5.25**)	-0.0729 (-5.35**)	-0.0714 (-4.61**)	-0.0695 (-4.98**)	-0.0693 (-4.15**)	-0.0668 (-4.66**)
TRGR	0.0472 (3.30**)	0.0473 (3.25**)	0.0443 (2.99**)	0.0452 (3.01**)	0.0407 (2.65**)	0.0431 (2.75**)
SSER	0.0011 (0.15)					
RGPC	-0.0212 (-4.64**)	-0.0210 (-5.04**)	-0.0267 (-6.63**)	-0.0245 (-4.80**)	-0.0295 (-8.03**)	-0.0263 (-5.22**)
MCGR			0.0069 (4.34**)		**0.0103 (3.59**)**	
VTGR				0.0021 (1.90*)		**0.0033 (1.99**)**
INFL.MCGR					-0.0302 (-1.36)	
INFL.VTGR						-0.0104 (-1.01)
NT	471	471	471	471	471	471
R^2	0.2837	0.2837	0.3070	0.2920	0.3127	0.2941

**Significant at 5%;*Significant at 10%.

Table-4.3.3: Overall Finance and Economic Growth

Contemporaneous "Fixed Effects" Panel Regressions: Dependent Variable= GRGPC: Heteroscedasticity Consistent t-statistics in parentheses

Variable	General Model	Basic Model	Intermediate Model		Final Model	
			Size	Activity	Size	Activity
INFL	-0.3247 (-8.94**)	-0.3255 (-9.19**)	-0.3137 (-8.00**)	-0.3304 (-8.47**)	-0.3291 (-8.93**)	-0.3696 (-9.82**)
GCGR	-0.0728 (-5.25**)	-0.0729 (-5.35**)	-0.0675 (-4.27**)	-0.0753 (-4.93**)	-0.0702 (-4.75**)	-0.0756 (-5.11**)
TRGR	0.0472 (3.30**)	0.0473 (3.25**)	0.0425 (2.89**)	0.0499 (3.20**)	0.0420 (3.17**)	0.0496 (3.34**)
SSER	0.0011 (0.15)					
RGPC	-0.0212 (-4.64**)	-0.0210 (-5.04**)	-0.0272 (-8.59**)	-0.0184 (-4.80**)	-0.0273 (-8.18**)	-0.0193 (-5.04**)
FDGR			0.0127 (2.34**)		**0.0172 (2.62**)**	
FAGR				-0.0042 (-1.02)		**0.0004 (0.07)**
INFL.FDGR					-0.1260 (-1.88*)	
INFL.FAGR						-0.1029 (-1.67*)
NT	471	471	471	471	471	471
R^2	0.2837	0.2837	0.2973	0.2867	0.3045	0.2929

**Significant at 5%;*Significant at 10%.

Table-4.4: Reichert and Weinhold Panel Causality Analysis (Full Sample)

		Causality		Reverse Causality	
		Size	**Activity**	**Size**	**Activity**
Indirect Finance	Estimated Coefficient	**-0.0460**	**-0.0246**	**0.1185**	**-0.1911**
	Standard Error	0.0194	0.0201	0.1731	0.3684
	LB (Confidence Interval)	**-1.1651**	**-2.4902**	**-2.4124**	**-1.9209**
	UB (Confidence Interval)	**2.0340**	**3.3034**	**2.0611**	**2.1640**
	Est. Coefficient Variance	0.0112	0.0037	0.4553	2.4722
Direct Finance	Estimated Coefficient	**-0.0003**	**0.0004**	**-1.0713**	**2.4375****
	Standard Error	0.0028	0.0012	0.8431	1.9222
	LB (Confidence Interval)	**-1.3145**	**-0.8474**	**-1.9328**	**-2.4661**
	UB (Confidence Interval)	**1.3493**	**0.7796**	**2.5923**	**1.8397**
	Est. Coefficient Variance	0.0003	0.0002	10.5528	60.5836
Overall Finance	Estimated Coefficient	**0.0496**	**-0.0178**	**0.1270**	**-0.2003**
	Standard Error	0.0196	0.0092	0.3432	0.4977
	LB (Confidence Interval)	**-2.1991**	**-1.0345**	**-3.2416**	**-1.5984**
	UB (Confidence Interval)	**1.2086**	**1.6218**	**2.9776**	**1.7532**
	Est. Coefficient Variance	0.0100	0.0037	0.9259	6.7026

**Significant at 5%, *Significant at 10%.

Table-4.4A: Reichert and Weinhold Panel Causality Analysis (Sample - post 1990)

		Causality		Reverse Causality	
		Size	**Activity**	**Size**	**Activity**
Indirect Finance	Estimated Coefficient	**0.2887**	**-0.1565**	**-0.3202**	**-0.6105**
	Standard Error	0.3609	0.2092	1.2714	0.9886
	LB (Confidence Interval)	**-2.9885**	**-1.2253**	**-4.3260**	**-4.0780**
	UB (Confidence Interval)	**2.4862**	**1.4553**	**4.5834**	**4.7050**
	Est. Coefficient Variance	1.3210	0.0037	6.1905	3.8515
Direct Finance	Estimated Coefficient	**0.1516**	**0.0345**	**1.5350****	**8.2387****
	Standard Error	0.0691	0.0164	2.1890	4.3030
	LB (Confidence Interval)	**-3.8963**	**-2.8346**	**-1.6065**	**-2.5638**
	UB (Confidence Interval)	**2.3285**	**1.7303**	**1.3673**	**1.6405**
	Est. Coefficient Variance	0.0374	0.0039	164.7161	318.4377
Overall Finance	Estimated Coefficient	**0.3190**	**0.2554**	**0.8985**	**0.4887**
	Standard Error	0.1509	0.1070	1.1809	1.4061
	LB (Confidence Interval)	**-4.3078**	**-2.3833**	**-1.5281**	**-1.6072**
	UB (Confidence Interval)	**2.6264**	**1.3589**	**1.2828**	**1.4839**
	Est. Coefficient Variance	0.1440	0.2487	53.6608	62.8985

**Significant at 5%, *Significant at 10%.

Appendix B

Let Y be the dependent variable; Z contains vector of 1s for the intercept, and the lagged dependent variables, i.e. those for which we have fixed coefficients; X has the orthogonalized causal candidate variable and other control variables, i.e. all other right hand side variables for which we have random coefficients. We denote the vector of all the right hand side variables (including unobserved effects) by W, i.e. it contains all the variables that are in Z and X. Let θ_2 be a vector of fixed coefficients (which are f in number) and θ_1 be vector of random coefficients (which are r in number). Let θ denote the vector of all fixed as well as random coefficients.

We estimate θ_1 by

$$\tilde{\theta}_1 = [\sum_{i=1}^{N} X_i' \phi_i^{-1} X_i - \sum_{i=1}^{N} X_i' \phi_i^{-1} Z_i (Z_i' \phi_i^{-1} Z_i)^{-1} Z' \phi_i^{-1} X_i]^{-1} [\sum_{i=1}^{N} X_i' \phi_i^{-1} Y_i - \sum_{i=1}^{N} X_i' \phi_i^{-1} Z_i (Z_i' \phi_i^{-1} Z_i)^{-1} Z' \phi_i^{-1} Y_i] \quad (3.13)$$

which is the GLS estimate of θ_1 under MFR coefficients assumption. Here

$$\phi_i = (X_i \Delta_r X_i' + \hat{\sigma}_i^2 I_{T-1}) \quad (3.14)$$

and $\hat{\sigma}_i^2$ is OLS estimate of error variance of individual regression of Y_i upon W_i, i.e. $Y_i = W_i \theta_i + error$, and Δ_r is the covariance matrix which is sub-matrix for random coefficients from

$$\Delta = \frac{1}{N-1} \sum_{i=1}^{N} (\hat{\theta}_i - \bar{\hat{\theta}})(\hat{\theta}_i - \bar{\hat{\theta}})' \quad (3.15)$$

where $\hat{\theta}_i$ is the OLS estimate from individual regression of Y_i upon W_i, i.e. $Y_i = W_i \theta_i + error$ and $\bar{\hat{\theta}}$ is the average of such $\hat{\theta}_i$s for the individuals countries in the panel.

We estimate individual coefficients under MFR effects approach by

$$\tilde{\theta}_{1i} = [\frac{1}{\hat{\sigma}_i^2}\{X_i'X_i - X_i'Z_i(Z_i'Z_i)^{-1}Z_i'X_i\} + \Delta_r^{-1}]^{-1}[\frac{1}{\hat{\sigma}_i^2}\{X_i'X_i - X_i'Z_i(Z_i'Z_i)^{-1}Z_i'X_i\}\hat{\theta}_{1i} + \Delta_r^{-1}\tilde{\theta}_1] \quad (3.16)$$

and

$$\tilde{\theta}_{2i} = (Z_i'Z_i)\{Z_i'(Y_i - X_i\tilde{\theta}_{1i})\} \quad (3.17)$$

We have

$$\tilde{u}_{it} = Y_{it} - \tilde{\theta}_{2i}Z_{it} - \tilde{\theta}_1X_{it}$$

and mean square error is

$$\tilde{\sigma}^2 = (\sum u_{it}^2)/\{\sum T_i - (f * N + r)\}$$

and $Var(\tilde{\theta}) = \tilde{\sigma}^2(W'W)^{-1}$ from which we can have standard errors ($\tilde{\sigma}_{\tilde{\theta}}$) of the MFR effects estimates.

For causality testing, we have to build the confidence interval around zero[16] (here we will use the first element in the vector $\tilde{\theta}_1$ which is $\tilde{\theta}_{1[1]}$) for which the lower and upper bounds are given below:

Lower Bound (Confidence Interval): $[(-2) * \sqrt{N}\tilde{\sigma}_{\tilde{\theta}_{1[1]}} - \tilde{\theta}_{1[1]}]/\Delta_{r_{11}}$

Upper Bound (Confidence Interval): $[2 * \sqrt{N}\tilde{\sigma}_{\tilde{\theta}_{1[1]}} - \tilde{\theta}_{1[1]}]/\Delta_{r_{11}}$

The area that falls within this interval is interpreted to correspond to observations that are not significantly different from zero[17].

[16] Theoretically speaking; for population parameter under the null hypothesis that $\theta_{1[1]}$ is zero.

[17] For panel causality analysis, we use the SAS version of the program (which calculates the estimate of the coefficient of the causal variable, its standard error, the confidence interval and the estimate of the variance of the estimated random coefficient) developed by Diana Weinhold and available on her site linked with that of the London School of Economics, UK. This SAS program does not orthogonalize the candidate casual variable, however, we did it.

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Currency Substitution, Capital Mobility and Functional Forms of Money Demand in Pakistan

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Abstract

The demand for M2 in Pakistan is positively influenced by real GDP and currency appreciation and negatively influenced by the domestic interest rate and the foreign interest rate. These results confirm international capital mobility and currency substitution. The Box-Cox transformation indicates that the log-linear function cannot be rejected while the linear function can be rejected at the 5% significance level. The log-linear form of the demand for M2 shows a small value of the mean absolute percent error and performs better in the CUSUM and CUSUMSQ tests than the linear form.

Keywords: Currency substitution, capital mobility, Box-Cox model, CUSUM and CUSUMSQ tests

JEL Classification: E41

Introduction

Several seminal works (Tobin, 1958; Chow, 1966; Goldfeld, 1973, 1976; Judd and Scadding, 1982; Gordon, 1984; Friedman, 1988; Laidler, 1990; Goldfeld and Sichel, 1990) have contributed substantially to the understanding of the demand for money. Small and Porter (1989), Hetzel and Mehra (1989), Hafer and Jansen (1991), Mehra (1993, 1997), Duca (2000), Carlson, Hoffman, Keen and Rasche (2000), and others examined the behavior and stability of M2 for the U.S. For example, Mehra (1997) indicated that the demand schedule for M2 shifted leftward during the early 1990s and that the behavior of M2 has remained relatively stable since 1994, making it useful for the analysis of monetary policy. Duca (2000)

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showed that the decline in M2 and the rise in the velocity of M2 in the early 1990s were matched by the increase in bond mutual funds. He suggested that M2 demand can be modeled better if the market for bond mutual funds is also taken into consideration. Sarno, Taylor, and Peel (2003) indicated that the money demand function for the U.S. was stable during 1869-1997 and that there existed a nonlinear relationship that was adjusted toward the long-term equilibrium.

Literature Review

There are several studies of the demand for money for Pakistan. Bahmani-Oskooee and Malixi (1991) regressed the demand for M1 in Pakistan on the inflation rate, real output, and the real exchange rate, defined as units of the rupee per foreign currency, and reported that in the long-run, depreciation of the rupee caused the demand of money to decrease. Arize (1994) showed that in estimating the money demand function for Pakistan, the error-correction model performed well and that the inclusion of a foreign interest rate or monetary variable would be appropriate due to its influence on money demand. In studying the demand for money for Pakistan and three other Asian countries, Hsing (1998) indicated that the Box-Cox transformation should be employed to test whether the constant elasticity hypothesis may be valid. Khan, Arby, and Lodhi (2000) revealed that currency and demand deposits in Pakistan were extremely sensitive to real income but insensitive to exchange rates and interest rates, while quasi-money was insensitive to real income but sensitive to exchange rates and interest rates. Bahmani-Oskooeea and Rehman (2005) found that the demand for M2 in Pakistan has a positive relationship with real output and the exchange rate, and a negative relationship with the inflation rate and that M2 demand was relatively stable. The positive effect of the exchange rate suggests that the demand for M2 would increase as the rupee depreciates or that the wealth effect dominates the substitution effect. Because the domestic interest rate and the foreign interest rate were not included in the estimated regression, the response of money demand to interest rate changes cannot be measured.

This paper differs from previous studies in several aspects. First, the extended Box-Cox transformation (Box-Cox, 1964; Seaks and Layson, 1983; Greene, 2003) is applied to test whether the log-linear form or the linear form cannot be rejected. Most previous studies chose the log-linear form without *a priori* knowledge of whether it is appropriate. Second, comparative-static analysis is applied to analyze the importance of the sensitivity of money demand to a change in the interest rate and its potential impacts on fiscal policy and a change in the exchange rate or the

foreign interest rate on the equilibrium real output. Third, the Newey-West (1987) method is employed to generate consistent estimates for standard errors and covariance when the forms of heteroskedasticity and autocorrelation are unknown.

The Model

Extending previous studies, the demand for real money balances in Pakistan can be expressed as:

$$M = L(Y, R, E, R^{*}), \tag{1}$$

$$L_Y > 0, L_R < 0, L_E > or < 0, L_{R^*} > or < 0$$

where

M = demand for real money balances,

Y = real output,

R = the domestic interest rate,

E = the real effective exchange rate, and

R^* = the foreign interest rate.

Note that in the money demand function, the conventional approach is to use the nominal interest rate. Because the nominal interest rate is equal to the real interest rate plus the expected inflation rate, the real interest rate is implicitly considered (Romer, 2006, p. 226). In money market equilibrium, it can be shown that the slope of the LM curve is given by:

$$\left.\frac{dR}{dY}\right|_{LM} = -\frac{\partial M / \partial Y}{\partial M / \partial R} > 0 \tag{2}$$

If $|\partial M / \partial R|$ is very small, or if money demand is very insensitive to an interest rate change, the slope of LM will be very steep, and *vice versa*. When LM is very steep, any expansionary fiscal policy would be less effective in raising real output. This can be analyzed by the general equilibrium in the goods and money markets. The potential impact of increased government spending on the equilibrium real output can be expressed as:

$$\partial \overline{Y} / \partial G = -H_G L_R / |J| > 0 \quad (3)$$

Where H_G is the partial derivative of aggregate spending with respect to government spending, L_R is the partial derivative of money demand with respect to the interest rate, and $|J|$ is the Jacobian with a positive value. Hence, a small value of $|L_R|$ is expected to reduce the impact of increased government spending on the equilibrium real output.

In a similar manner, the impact of government tax revenue on the equilibrium real output can be written as:

$$\partial \overline{Y} / \partial T = -H_T L_R / |J| < 0 \quad (4)$$

Where H_T is the partial derivative of aggregate spending with respect to government tax revenue. Thus, the effect of a tax cut will be small if the value of $|L_R|$ is small.

The impact of a change in the nominal exchange rate or the foreign interest rate on the equilibrium output can be expressed as:

$$\partial \overline{Y} / \partial E = (-H_E L_R + H_R L_E) / |J| > or < 0 \; if \; L_E > 0 \; and > 0 \; if \; L_E < 0 \quad (5)$$

$$\partial \overline{Y} / \partial R^* = H_R L_{R^*} / |J| > 0 \; if \; L_{R^*} < 0 \; and < 0 \; if \; L_{R^*} > 0 \quad (6)$$

where H is aggregate spending and H_x is the partial derivative of H with respect to any right-hand side variable X. As shown, the sign of $L_E \; and \; L_{R^*}$ is crucial in determining whether a change in one of the variables would affect the equilibrium real output positively or negatively.

The extended Box-Cox model (Box and Cox, 1964; Seaks and Layson, 1983; Greene, 2003) is employed to transform all the variables with positive values as follows:

$$\begin{aligned} M^{(\lambda)} &= (M^{\lambda} - 1) / \lambda \\ X^{(\lambda)} &= (X^{\lambda} - 1) / \lambda \end{aligned} \quad (7)$$

where X is any of the right-hand-side variables and λ is the transformation parameter. It can be shown that when λ approaches zero, equation (1) reduces to a double-log form, and when λ=1, equation (1) becomes a

linear form. The test statistic has a χ^2 distribution with one degree of freedom and is given by:

$$J(\lambda) = 2[L(\hat{\lambda}) - L(\lambda = 0 \text{ or } 1)] \sim \chi^2_{(1)} \quad (8)$$

The elasticity of real money demand with respect to any explanatory variable X at the means is given by:

$$E_X = \beta(\overline{X} / \overline{M})^{\lambda} \quad (9)$$

where E_X is the elasticity of M with respect to any variable X and β is the estimated coefficient for any variable X.

Data and Variables

All the data were taken from the *International Financial Statistics* which is published by the International Monetary Fund. Nominal M2 is divided by the CPI to derive real M2 measured in millions. Real GDP is measured in billions at 2000 prices. The call money rate is chosen to represent the domestic interest rate. The real effective exchange rate is used mainly because people are likely to react to a basket of foreign currencies in determining whether they may like to hold more or less foreign currencies. The 3-year U.S. T-bond rate is selected to represent the foreign interest rate.

The sample ranges from 1980 to 2005 because earlier data for the real effective exchange rate are not available. Quarterly data are not used because of lack of quarterly statistics for real GDP.

Empirical Results

Unit root tests show that all the variables have unit roots in levels and are stationary in first differences. In the ADF cointegration test, $\Delta U_t = \alpha U_{t-1}$ where *U* is the regression residual, the test statistic of -3.82 is greater than the critical value of -3.41 (in absolute value) at the 5% level. $\Delta U_{t-1}, \Delta U_{t-2}$, etc. are not included due to the insignificance of the coefficients. Hence, the demand for money and four explanatory variables have a stable long-term relationship.

The functional form is tested. The critical value with a χ^2 distribution and 1 degree of freedom is 3.841 and 6.635 at the 5% and 1% levels, respectively. As shown in Table-1, the value of $L(\hat{\lambda})$ is -320.171 with

an estimated λ of 0.170. The value of $L(\lambda=0)$ for the double-log form is -320.218. The test statistic is 0.094. Hence, the log-linear form cannot be rejected at the 5% level. The linear form can be rejected because the value of the test statistic of 8.500 is far greater than the critical values at the 5% or 1% level.

Table-1 presents the estimated regression and related statistics for the demand for M2. The paper does not employ the first-difference form because the results would become obscure due to the loss of important information (Greene, 2003). In the Box-Cox model, 98.8% of the variation in the demand for M2 can be explained by the four right-hand side variables. All the coefficients are significant at the 1% or 5% level. The demand for M2 is positively associated with real GDP and the real effective exchange rate and negatively influenced by the call money rate and the 3-year U.S. T-bond rate.

Table-1. Estimated Regressions of the Demand for M2 in Pakistan

Variable Name	Box-Cox Model	Log-linear Function	Linear Function
Real GDP	4.522	1.573	716.860
	(7.722)	(6.630)	(13.614)
Call money rate	-0.803	-0.078	-33178.570
	(3.562)	(2.202)	(6.510)
REER	.272	0.636	6964.399
	(3.365)	(2.604)	(6.170)
U.S. T-Bond Rate	-1.296	-0.178	-24400.900
	(2.169)	(2.518)	(2.266)
Intercept	-39.413	-1.206	-141204.000
	(2.296)	(0.396)	(4.945)
R^2	0.988	0.987	0.987
D-W	1.345	1.290	1.414
λ	0.170	0.000	1.000
$L(\lambda)$	-320.171	-320.218	-324.421
$J(\lambda)$		0.094	8.500
MAPE	4.248	4.282	5.639

Notes:

λ is the Box-Cox transformation parameter.

$L(\lambda)$ is the log-likelihood function.

$J(\lambda)$ is the value of the test statistic.

MAPE is the mean absolute percent error.

In the log-linear function, 98.7% of the variation in the demand for M2 can be explained by the four explanatory variables. All the coefficients are significant at the 1% or 5% level. The demand for M2 has a positive relationship with real output and the real effective exchange rate and a negative relationship with the call money rate and the foreign interest rate. The log-linear form has smaller mean absolute percent error than the linear form.

The positive sign of the real effective exchange rate shows that appreciation of the rupee leads to an increase in the demand for money and implies that the substitution effect is greater than the wealth effect (Arango and Nadiri, 1981; McKinnon, 1982; Bahmani-Oskooee and Techaratanachai, 2001; Bahmani-Oskooee and Ng, 2002). The negative sign of the U.S. T-bond rate suggests that the capital mobility effect is greater than the cost of borrowing effect (Marquez, 1987; Bahmani-Oskooee and Ng, 2002).

The CUSUM and CUSUMSQ tests in Figure 1 show that in the log-linear form, the demand for M2 for Pakistan is relatively stable as most of the cumulative sum of the recursive residuals, or squared residuals, falls inside of the 5% critical lines and that in the linear function, money demand is relatively unstable as some of the cumulative sum of the recursive residuals, or squared residuals, fall outside of the 5% critical lines. In comparison, it appears that the log-linear function for the demand for M2 is better than the linear function in the stability test.

The expected inflation rate was considered in estimating the demand for M2. The coefficient is negative and insignificant. Thus, it is dropped from the final estimated regression. A possible reason of the insignificant coefficient is because the monetary aggregate is divided by the CPI and measured in real terms. Hence, a change in the price level has been included in the specification of the money demand function.

To make a comparison, the demand for M1 is estimated. The log-likelihood test based on the Box-Cox transformation shows that the log-linear form and the linear form can be rejected at the 5% level. In the general functional form, the coefficient of the real effective exchange rate is negative and significant at the 1% level, and the coefficient of the foreign interest rate is positive and insignificant even at the 10% level. M1 demand is positively associated with real output and negatively affected by the deposit rate and the real effective exchange rate. The CUSUM test shows the stability in the parameters while the CUSUMSQ test indicates the instability in the parameters. The mean absolute percent error of 5.050 is greater than

that in the demand for M2. To save space, these results are not presented here.

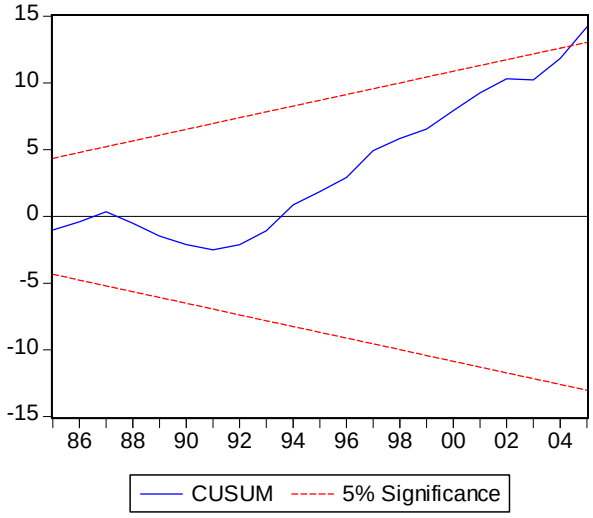
Summary and Conclusions

This study has examined the demand for money for Pakistan. The extended Box-Cox transformation is applied to test whether the log-linear form and the linear form are appropriate. The Newey-West method is employed in empirical work to yield consistent estimates when the forms of autocorrelation and heteroskedasticity are unknown. The sample runs from 1980 to 2005. For M2 demand, the analysis shows that the widely used log-linear form cannot be rejected while the linear form can be rejected. Based on the mean absolute percent error, the log-linear form for M2 demand performs better the linear form in forecasting. The demand for M2 has a positive relationship with real output and currency appreciation and a negative relationship with the call money rate and the foreign interest rates. Hence, when the exchange rate appreciates or depreciates, the substitution effect dominates the wealth effect. When the foreign interest rate rises, investors tend to reduce the holding of M2. In comparison, the demand for M2 is a better monetary aggregate than the demand for M1 in terms of the functional form, stability of the parameters, and forecasting errors.

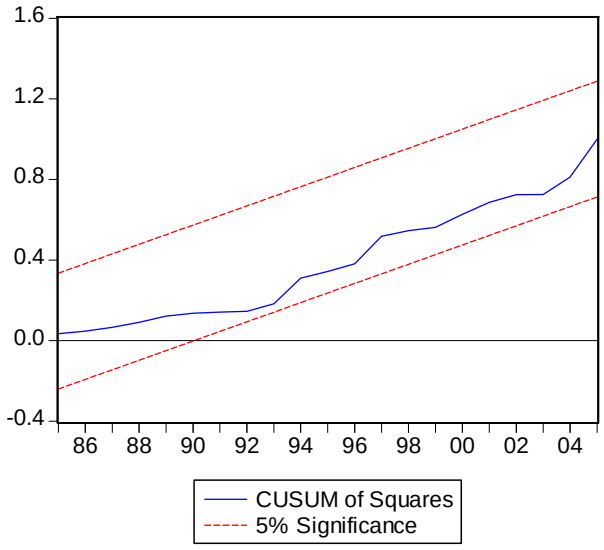
There may be areas for further research. The Box-Cox model can be further extended to include different transformation parameters for the dependent variable and the explanatory variables. Quarterly data may be considered if manufacturing production can be used as a proxy for economic activity. The money market equilibrium may interact with the goods market equilibrium to determine the equilibrium values for real output and the interest rate. Also, the expected inflation rate could be constructed using other methods.

Figure 1. CUSUM and CUSUMSQ Tests for M2 Demand

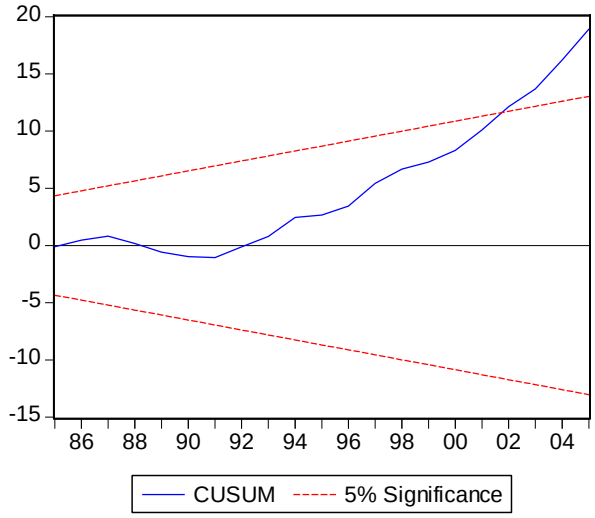
CUSUM Test for M2 Demand:
Log-Linear Function



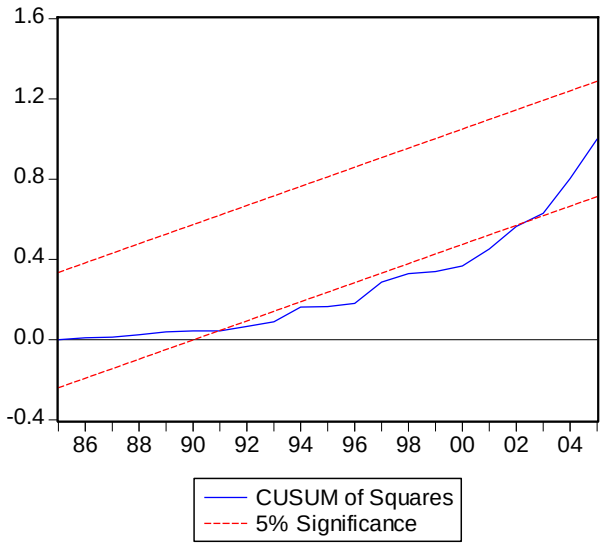
CUSUMSQ Test for M2 Demand:
Log-Linear Function



CUSUM Test for M2 Demand:
Linear Function



CUSUMSQ Test for M2 Demand:
Linear Function



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Effects of the Exchange Rate on Output and Price Level: Evidence from the Pakistani Economy

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Abstract

The question of whether devaluation of the currency affects output positively or negatively has received considerable attention both from academic and empirical researchers. A number of empirical studies have supported the contractionary devaluation hypothesis using pooled time series data from a large number of heterogeneous countries. Since the effects of devaluation on output and the price level may not be uniform across all developing countries, the empirical results can not be generalized for all countries. In addition, almost none of the empirical studies used to test the contractionary devaluation hypothesis separate the effects of devaluation from import prices. Thus, a country specific study is needed that separate the effects of devaluation from the import price effects. This paper uses a VEC model to analyze the effects of the exchange rate on output and the price level in Pakistan for the period 1975-2005. Our analysis shows that devaluation has a positive effect on output but a negative effect on the price level. Thus, the evidence presented in this paper does not support the contractionary devaluation hypothesis for the Pakistani economy.

I. Introduction

There are numerous channels through which the effects of currency fluctuations are transmitted onto the domestic price level and output. Under a fixed exchange rate system, official changes in the value of a country's currency relative to other currencies are called devaluations and revaluations. Whereas under a flexible exchange rate system, market force-generated changes in the value of the country's currency are known as depreciations and appreciations. In this paper, the terms depreciation and devaluation are used interchangeably.

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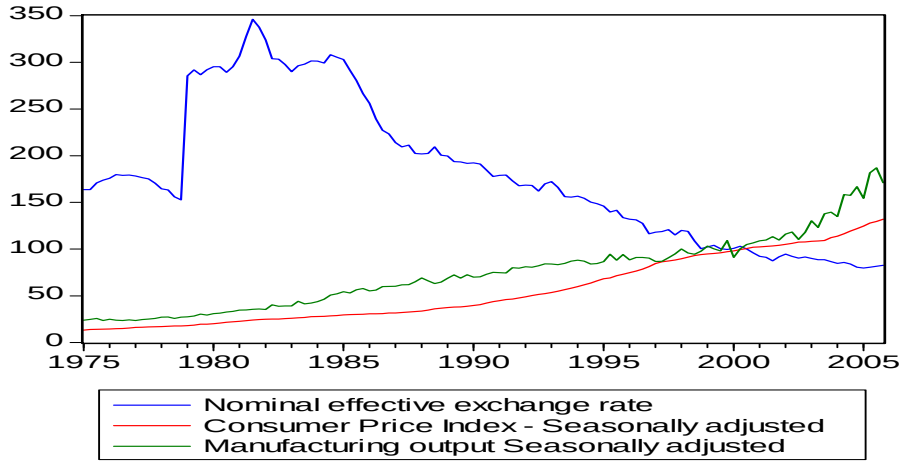
According to the conventional textbook model, depreciation of the domestic currency makes the country's exports relatively cheaper for foreigners and makes foreign goods relatively more expensive for domestic consumers. This helps to increase the countries exports and switches demand towards domestically produced goods, and therefore shifts the aggregate demand curve to the right (Dornbusch 1988). In the short-run, when the economy is operating at a positively sloped aggregate supply curve, a depreciation of the domestic currency will cause both output and the price level to increase. However, in the long-run when the economy is operating on the vertical portion of the aggregate supply curve, the price level will increase proportionately with no effect on the output level. Under the assumption that devaluations are expansionary, Pakistan like many other developing countries, resorted to large devaluations in the hope of reaping economic benefits[1]. During the fixed exchange rate period (1971-81), the Pak rupee was devalued from 4.79 to 9.90 per US dollar. During the managed float period (1982-1999) the rupee was devalued from 9.90 to 51.78 per US dollar. During the flexible exchange rate period (2000-2006) the rupee has depreciated from 51.78 to 60.6 per US dollar. The nominal effective exchange rate, which measures the value of the Pak rupee against a weighted average of foreign currencies, shows a similar trend. As shown in figure 1, the nominal effective exchange rate (2000=1000) has continually declined since 1982.

Figure 1



As mentioned above, the conventional textbook view predicts that the price level and output are negatively related to the value of the domestic currency. To illustrate this negative correlation, the consumer

price index and manufacturing output index are plotted in figure 1 and their correlation coefficients are given below in Table-1.

Table-1: Correlation Coefficients between Exchange Rate – Price Level and Output

Variables	Period	Correlation Coefficient
NEER-CPI	1975:1– 2005:4	-0.80
NEER-Output	1975:1 – 2005:4	-0.75

Note: CPI denotes consumer price index seasonally adjusted, Output is manufacturing production, NEER is nominal effective exchange rate. The correlation coefficients are all different from zero at the 5% significance level.

As shown in Table-1, the correlation between the exchange rate and price level is -0.80; between exchange rate and output, it is -0.75. These negative and statistically significant coefficients indicate that devaluations have an expansionary effect on the Pakistan economy as predicted by the conventional view. Yet, one should not read too much from the correlation analysis. This strong negative correlation between the exchange rate and other variables as shown in figure 1 and in Table-1 may be a spurious correlation. Furthermore, the bivariate results do not provide information regarding the channels through which the exchange rate might affect output.

However, this textbook view is not uniformly supported either by prior theoretical research or actual historical experience. In recent years, a growing literature argues for contractionary devaluation by concentrating on aggregate demand and aggregate supply models. The most important channels through which devaluation may create negative effects on aggregate demand and thus contraction in output are:

Income Redistribution Channel: Devaluation can generate a redistribution of a given level of real income from wages to profits (Diaz-Alejandro, 1963; Cooper, 1971a; Knight, 1976; and Krugman and Taylor, 1978). The effect of income redistribution is based on the argument that there are different consumer groups in a society. These groups can be broadly divided into two categories: wage earners and profit earners. The marginal propensity to save is assumed to be higher for profit recipients than for wage earners. Devaluation leads to higher prices and profits in export and import competing industries while sticky nominal wages reduce

real wages. Since the marginal propensity to save is higher from profits than from wages, the economy's average propensity to save will rise and this will tend to be demand contractionary.

Interest Rate Channel: Devaluation leads to higher interest rates (Bruno, 1979, and Van Wijnbergen, 1986). An increase in the domestic price level as a result of devaluation will increase the demand for nominal money (which is same thing as a decrease in real money balances) and thus the nominal interest rates. The increase in the interest rate will tend to reduce investment and consumption expenditure through traditional mechanisms.

Investment Channel: A decline in new investment (Branson, 1986; Buffie, 1986 and Van Wijnbergen, 1986). Since a substantial portion of any new investment in developing countries consists of imported capital goods, depreciation raises the cost of imported capital and reduces its imports. This discourages new investment and exerts contractionary pressure on aggregate demand.

External Debt Channel: Devaluation results in a higher cost of large external debts (Cooper, 1971b; Gylfason and Risager, 1984 and Van Wijnbergen, 1986). In developing countries, most external debt is denominated in dollars or in another strong foreign currency. If a country having large debt devalues its currency, then both residents and the government need more domestic currency to pay for the same amount of foreign debt. This reduces the net wealth and therefore aggregate expenditure. Another argument is that in developing countries, a very large proportion of the external debt is owed by the public sector. Devaluation increases the domestic currency costs of serving debt. The government can finance increased debt service payments by reducing its expenditures, increased taxation or domestic borrowing. All these modes of financing have contrationary effects on aggregate demand.

Real Balance Channel: Devaluation causes a decrease in real balances (Bruno, 1979; Gylfason and Radetzki, 1991). Devaluation increases the prices of traded goods and that leads to an increase in the general price level. An increase in the general price level decreases real cash balances and real wealth which tends to decrease personal spending.

Redistribution of income from the private sector to the government sector (Krugman and Taylor, 1978). Since the demand for imported goods is inelastic, devaluation increases the domestic currency value of imports while their volume remains unchanged. This increased domestic currency

value of trade causes *ad valorem* trade taxes (tariff revenue) to rise. As a result, there will be a redistribution of income from the private sector to the government. An increase in government's tax revenue means less is left for the private sector. In the short-run, the marginal propensity to save for the government sector is close to one, thus government spending remains unchanged and aggregate demand decreases due to decrease in private consumption.

Similarly, a number of supply-side channels are identified through which devaluation can be contractionary. Some of these supply-side channels are discussed below:

Higher cost of imported inputs channel (Krugman and Taylor, 1978; Bruno, 1979; Gylfason and Schmid, 1983; Hanson, 1983; Gylfason and Risager, 1984; Solimano, 1986; Edwards, 1986; VanWijnbergen, 1986 and Gylfason and Radetzki, 1991). In many developing countries imports consist of predominately noncompetitive intermediate inputs or capital goods. Devaluation increases the domestic currency cost of imported inputs and reduces the volume of imported inputs. A reduction in imports implies insufficient inputs necessary for production. Thus, because of the lack of inputs and higher cost relative to the prices of their domestic final products, firms tend to produce less, which leads to a reduction in aggregate supply.

Higher wage costs channel (Krugman and Taylor, 1978; Bruno, 1979; Gylfason and Schmid, 1983; Hanson, 1983; Gylfason and Risager, 1984; Solimano, 1986; Edwards, 1986; VanWijnbergen, 1986 and Gylfason and Radetzki, 1991). Increased prices of traded goods caused by devaluation ultimately result in a general price level increase. As real wages decrease, the workers will demand higher nominal wages to protect their purchasing power. If wages are flexible or there exists a wage indexation mechanism, the nominal wages will adjust proportionately to the general price level. Such increases in wages increase the cost of production and could produce adverse supply effects.

Higher cost of working capital channel (VanWijnbergen, 1986). Working capital is basically short-term funds needed by the firms to carry out their daily business. Devaluation increases the price level hence the real money supply decreases. This leads to a decline in the real volume of credit. If the credit supply decreases relative to demand, interest rates tend to climb, making working capital more costly. This will push up the cost of production, hence adversely affecting the supply of output.

Foreign exporters as price taker in the domestic economy (knitter, 1989). Foreign exporters face an upward sloping marginal cost curve and a horizontal marginal revenue curve. The quantity produced and supplied by the foreign producer is determined by the intersection of marginal revenue and marginal cost curves. Now suppose that the value of the domestic currency decreases. The price received by a foreign producer in terms of his own currency will be lower. In other words the marginal revenue curve faced by foreign producer will shift down and it will intersect the marginal cost curve at a lower level of output. At a given price level in the domestic economy, the output supplied by the foreign producer will decrease and this will result in a leftward shift of aggregate supply curve in the domestic economy.

In spite of the renewed theoretical interest in the possible contractionary effects of devaluations, the empirical evidence is mix at best. A review of existing studies indicates that four major empirical approaches have been utilized to investigate the effects of devaluation on output: *The control group approach, the before and after approach, the macro-simulation approach* and *the econometric approach.*

The control group approach (Donovan, 1982; Gylfason, 1987; Kamin, 1988; Edwards, 1989 and Khan, 1990). This approach aims at separating the effect of devaluation from other factors on output. Donovan (1982) studied 78 IMF-supported devaluations. He concluded that economic growth fell by more than the average decline experienced by non-oil developing countries in one-year comparisons but by less in three years comparisons. Gylfason (1987) studied 32 IMF-supported programs during 1977-1979 and found that differences in output growth between countries with IMF programs and non-program countries were not statistically significant. Kamin (1988) analyzed 107 devaluations between 1953 and 1983 and concluded that devaluation has either an expansionary or no effect. Contraction takes place prior to devaluation and continues after devaluation. Edwards (1989) studied 18 devaluations in Latin America and concluded that declines in output growth were not due to devaluation, but due instead to the accompanying restrictions that have accompanied devaluations. Khan (1990) studied the effects of IMF supported programs in a group of 69 developing countries over 1973-1988. He found that devaluations were contractionary but this result was not statistically significant.

The before and after approach (Diaz-Alejendro, 1965; Cooper, 1971a; Killick, Malik, and Manuel, 1992). This approach studies changes in country performance at the time of devaluation. Diaz-Alejendro (1965) examined the experience of Argentina over the period 1955-1961. He

concluded that the 1959 devaluation of the peso was contractionary as it shifted the income distribution toward high savers, which depressed consumption. Cooper (1971a) analyzed 24 devaluations that took place between 1953 and 1966 in less developed countries. After looking at the behavior of the major components of aggregate demand, he concluded that devaluations had a contractionary effect on output. Killick, Malik, and Manuel (1992) examined the results of 266 IMF-supported programs implemented during the 1980s. Many of them incorporated nominal devaluation as a key policy measure. They concluded that these programs had no noticeable effect on output growth in short term; however, over the longer term growth rates were improved.

The macro-simulation approach (Gylfason and Schmid, 1983; Gylfason and Risager, 1984; Solimano, 1986; and Roca and Priale, 1987). This approach uses simulation models to analyze the impact of exchange rate changes on output. Gylfason and Schmidt (1983) constructed a small macro model of an open economy. They found that a devaluation causes expansionary effects through aggregate demand and contractionary effects through aggregate supply. Their study concluded that devaluation was expansionary in 8 out of 10 countries. Gylfason and Risager (1984) studied the effects of devaluation for 8 developing and 7 developed countries. They concluded that devaluation was expansionary in developed countries and contractionary in developing countries. Solimano (1986) constructed a macroeconomic model for Chile and concluded that devaluation was contractionary in the short to medium run. Roca and Priale (1987) constructed a macroeconomic model for the Peruvian economy and concluded that devaluations were contractionary.

The econometric approach (Sheehey, 1986; Edwards, 1989; Morley, 1992; Upadhyaya, 1999 and Bahmani-Oskooee and Miteza, 2006). This approach applies econometric methods to time series data to investigate the effect of devaluations on output. Sheehey (1986) used cross section data from 16 Latin American countries and concluded that devaluations had a contractionary effect on output. Morley (1992) also used cross section data from 28 developing countries and found support for the contractionary devaluation hypothesis. Edwards (1989) used panel data regressions for 12 developing countries and found that devaluations were contractionary in the short-run. Upadhyaya (1999) applied cointegration and error correction modeling techniques to data from 6 Asian countries and concluded that devaluations were contractionary for Pakistan and Thailand but neutral for India, Sri Lanka, Malaysia and Philippines in the long-run. Bahmani-Oskooee and Miteza (2006) applied panel unit root and panel cointegration techniques to annual data from 42

countries and concluded that in the long-run devaluations were contrationary in non-OECD countries.

In addition to cross-section econometric studies, a number of econometric studies have also used time series data to investigate the contractionary devaluation hypothesis. Bahmani-Oskooee and Rhee (1997) using Korean quarterly data over the period 1971-1974 applied Johansen's cointegration and error-correction technique. Their error-correction model confirmed that there exists a long-run relationship between output, money and the real exchange rate variables. They concluded that real depreciations were expansionary in the long-run and the most important expansionary impact of real depreciations appeared with a lag of three quarters. Domaç (1997) examined the contractionary devaluation hypothesis in Turkey for the period 1960-1990 by distinguishing the growth effects of anticipated and unanticipated devaluations. He found that unanticipated devaluations had a positive impact on real economic activity, while anticipated devaluations did not exert any significant effect on output. Bahmani-Oskooee (1998) used quarterly data from 23 LDCs countries over the 1973-1988 periods to investigate the long-run effects of devaluation. He used ADF tests to check whether output and effective exchange rate were cointegrated. He concluded that devaluations were neutral with respect to output in the long-run for most LDCs. However, when Bahmani-Oskooee et al. (2002) applied Johansen's cointegration technique, they found that devaluations were expansionary in the Philippines and Thailand but contractionary in Indonesia and Malaysia. De Silva and Zhu, (2004) considered the case of Sri Lanka and applied the VAR technique. Using quarterly data over the period 1976-1998, they concluded that devaluation improved the trade balance but had a contractionary impact on the Sri Lankan economy.

The studies reviewed above show that results concerning the effects of devaluation on output are quite mixed. This leaves room for new empirical research. The econometric approach has desirable properties because it enables the researcher not only to capture the effects of devaluation but also the effects of other factors on output. Almost all econometric studies that support the contractionary devaluation hypothesis use pooled time series data from a large number of heterogeneous countries. Since the effects of devaluation on output and price level may not be uniform across all developing countries, an empirical study of the individual experience of Pakistan can be a valuable addition to the literature.

The objective of this paper is to examine the effects of exchange rate changes on the price level and real output using data on Pakistan. In section II, the methodology used in this paper is discussed. Section III describes the data, estimation and evaluation of empirical results. Section IV gives the concluding remarks.

II. Methodology

The main objective of this paper is to investigate the effects of exchange rate fluctuations on inflation and output growth. As is well known, under a fixed exchange rate system monetary authorities maintain the exchange rate at a predetermined level and allow the macroeconomic variables such as the price level and output to fluctuate. Thus, under a fixed exchange rate system, the exchange rate is treated as an exogenous variable and causality runs from exchange rate to other macroeconomic variables. However, in a flexible exchange rate system, the exchange rate like many other macroeconomic variables, is determined by the market conditions. Thus, under a flexible exchange rate system, the exchange rate, price level and output are expected to affect each other. Since this study covers the flexible exchange rate period, a vector autoregression (VAR) methodology is appropriate because it allows interaction among macroeconomic variables. The basic version of VAR is regarded as an unrestricted reduced form of a structural model. One advantage of this approach is that the specification is purely determined on the information contained in the available data and does not need any additional non-testable a priori restrictions.

We assume that the economy is described by a system of six equations: an import price level equation, an exchange rate equation, an interest rate equation, a money supply equation, a price level equation and an output level equation. We set up the following VAR model with the vector of six endogenous variables[2]:

$$Z_t = (F_t, M_t, R_t, E_t, P_t, Y_t) \quad (1)$$

where

F =Unit value of imports. The unit value of imports is included in the VAR to capture the effects of foreign supply shocks on domestic macroeconomic variables. To separate the effects of the unit value of imports from the foreign exchange rate effects, the unit value of imports is measured in U.S. dollars.

M=M2 definition of money supply.

R =Short-term interest rate measured by call money rates.

E =Nominal effective exchange rate. Although many studies have used bilateral exchange rates in their analysis, Mohsen Bahmani-Oskooee and Iler Mteza (2006) have pointed out that a country's currency could depreciate against one country and appreciate against an other country and thus the effective exchange rate is the appropriate concept to capture variation in the overall value of the currency.

P =Domestic price level measured by consumer price index.

Y =Real output. Since quarterly data on real output is not available for Pakistani economy, manufacturing output is used as a proxy for real output.

We assume that the dynamic behavior of Z_t is governed by the following structural model:

$$B(L)\Delta Z_t = \mu_t \qquad (2)$$

where B(L) is a k^{th} order matrix polynomial in the lag operator L such that $B(L) = B_0 - B_1L - B_2L^2 - \ldots\ldots - B_kL^k$. B_0 is a non-singular matrix normalized to have one on the diagonal and summarizes the contemporaneous relationship between the variables contained in the vector Z_t. μ_t is a vector of structural disturbances and is serially uncorrelated. $E(\mu_t\mu_t) = \Sigma_\mu$ and it is a diagonal matrix while E represents the expectations sign. Σ_μ is a diagonal matrix where diagonal elements are the variance of the structural disturbances and off-diagonal elements are zero (structural error terms are assumed to be mutually uncorrelated).

The empirical estimation of (2) is achieved by applying the **Wold** representation theorem and inverting it to derive the reduced form VAR which is given below:

$$A(L)\Delta Z_t = \varepsilon_t \qquad (3)$$

where A(L) is matrix polynomial in the lag operator L, ε_t is a vector of serially uncorrelated reduced form disturbances and $E(\varepsilon_t \varepsilon_t') = \sum_{\varepsilon}$. The components of equation (3) to equation (2) are related as given below:

$$A(L) = B_0^{-1} B(L) = I - A_1 L - A_2 L^2 - \ldots\ldots\ldots - A_k L^k \quad (4)$$

$$\varepsilon_t = B_0^{-1} \mu_t \quad (5)$$

In order to recover the structural parameters of the VAR model specified by equation (2) from the estimated reduced form coefficients of equation (3), the model must be either exactly identified or over identified. Exact identification requires that number of parameters in B_0 and Σ_{μ} are equal to number of parameters in the covariance matrix Σ_t. Using equations (4) and (5), the parameters of structural equation (2) and of reduced form equation (2) are related as below:

$$A(L) = I - B_0^{-1}[B_1 L - B_2 L^2 - \ldots\ldots\ldots - B_k L^k] \quad (6)$$

$$\sum_{\varepsilon} = B_0^{-1} \sum_{\mu} B_0^{-1} \quad (7)$$

Estimates of B_0 and Σ_{μ} can be obtained only through sample estimates of Σ_t. Given that the diagonal elements of B_0 are all unity, B_0 contains (n^2-n) unknown parameters. Σ_{μ} contains n unknown values. Thus, the right hand side of equation (7) has a total of n^2 unknown values. Since Σ_t is symmetric, it contains only $(n^2+n)/2$ distinct known elements. In order to identify the n^2 unknown structural parameters from the known $(n^2+n)/2$ distinct elements of Σ_t, the minimum requirement is to impose $(n^2-n)/2$ restrictions on the system. In the structural VAR model, B_0 can be any structure as long as it satisfies the minimum restriction requirement.

There are several ways of specifying the restrictions to achieve identification of the structural parameters. A simple method is to orthogonalize reduced form errors by Choleski decomposition as originally applied by Sims (1980). This is fairly popular method because it is easy to handle econometrically. This approach to identification requires the assumption that the system of equations follows a recursive scheme. However, this approach should only be used when the recursive ordering implied by this identification is supported by theoretical consideration. The alternative and more common approach to identify a structural VAR is to

use the restrictions that are implied from a fully specified macroeconomic model. The structural VAR model estimated by Blanchard and Watson (1986), who uses theory to impose short-run restrictions, is an example of this approach. Since the Choleski decomposition is a special case of a more general approach used by Blanchard and Watson and it is easy to handle econometrically, we use this approach to identify the restrictions. The relationship between the reduced form VAR residuals and the structural innovations is given below in equation (8):

$$\begin{bmatrix} \varepsilon_f \\ \varepsilon_m \\ \varepsilon_r \\ \varepsilon_e \\ \varepsilon_p \\ \varepsilon_y \end{bmatrix} = \begin{bmatrix} f_0 \\ m_0 \\ r_0 \\ e_0 \\ p_0 \\ y_0 \end{bmatrix} + \begin{bmatrix} 1 & 0 & 0 & 0 & 0 & 0 \\ a_{21} & 1 & 0 & 0 & 0 & 0 \\ a_{31} & a_{32} & 1 & 0 & 0 & 0 \\ a_{41} & a_{42} & a_{43} & 1 & 0 & 0 \\ a_{51} & a_{52} & a_{53} & a_{54} & 1 & 0 \\ a_{61} & a_{62} & a_{63} & a_{64} & a_{65} & 1 \end{bmatrix} \begin{bmatrix} \mu_f \\ \mu_m \\ \mu_r \\ \mu_e \\ \mu_p \\ \mu_y \end{bmatrix} \quad (8)$$

where f_0, e_0, r_0, m_0, p_0 and y_0 are constants and a_{ij} represent coefficients. As shown in equation (8), the import price level equation is ordered first because the reduced form residuals in this equation are unlikely to be contemporaneously affected by any other shocks other than their own. This restriction implies that import prices do not respond to contemporaneous changes from other variables but all other variable in the system are contemporaneously affected by change in import prices in a small open economy like Pakistan. The money supply equation is ordered next because it reasonable to assume that monetary shocks have contemporaneous effects on all domestic variables in the system. The nominal interest rate equation is ordered third because in Pakistan, the interest rate is effectively managed by the State Bank of Pakistan at a predetermined level and does not respond to contemporaneous changes in other macro economic variables except import prices as it puts pressure on the country's limited foreign reserves. The nominal effective exchange rate equation is ordered next because import prices and monetary shocks have a contemporaneous effect on the exchange rate. The price level equation is ordered fifth because contemporaneous shocks in all nominal variables in the system are likely to affect the residuals in the price level equation. The output equation is ordered last by assuming that output is contemporaneously affected by all shocks in the system.

To avoid spurious statistical inferences, the VAR models are usually estimated in first difference form if the data series are non-stationary in the

level form. Shocks to the differenced variables will have a temporary effect on the growth rate but a permanent effect on its level. Estimation of a VAR model with stationary variables is consistent regardless whether the time series are cointegrated or not. If, however, the series are integrated of order one, I(1), and cointegrated, then we need to include additional information gained from the long-run relationship to get efficient estimates. This requires the inclusion of a vector of cointegrating residuals in the VAR with differenced variables. This is known as a vector error correction model (VECM).

III. Data and Estimation Results

Data

The key macroeconomic variables are manufacturing output index (Y_t), consumer price index (P_t), M2 definition of money supply (M_t), nominal effective exchange rate (E_t), short-term interest rate measured by call money rates (R_t) and unit value of imports (E_t). The unit value of imports index (2000=100) is measured in U.S. dollars by using the bilateral nominal exchange rate of Pakistan rupee and U.S. dollar. The nominal effective exchange rate index (2000=100) is a weighted average of major trading partners and an increase in index means appreciation. The data are quarterly and the sample period for the variables is 1975:1-2005:4. All variables are in nominal values, except manufacturing output. In addition, all variables are taken from International Financial Statistics (IFS) and measured in logarithmic form. Manufacturing output, consumer price index, unit value of imports and money supply series are seasonally adjusted using X12 program.

Unit root tests

We first test the hypothesis that a time series contains a unit root and thus follows a random walk process. The implication of this test is to determine whether the VAR model should be estimated in the level or first difference form. To test for unit roots, we use the augmented Dicky-Fuller (ADF) test and and the Philips-Perron test. Test results for unit roots are reported in Table-2.

Table-2: ADF and PP tests for unit roots

Variable	ADF test for a unit root		Pp test for a unit root	
	Without trend	**With trend**	**Without trend**	**With trend**
F_t	-0.80	-3.20	-0.70	-2.19
E_t	-0.03	-2.53	-0.07	-2.53
R_t	-2.78	-2.94	-3.76**	-4.04**
Y_t	0.18	-1.19	-0.34	-2.02
P_t	-0.88	-1.34	-1.14	-1.30
M_t	-0.65	-2.60	-1.40	-2.93
ΔF_t	-5.77**	-5.75**	-11.95**	-11.92**
ΔE_t	-10.21**	-10.41**	-10.21**	-10.39**
ΔR_t	-5.05**	-5.02**	-15.59**	-15.52**
ΔY_t	-11.40**	-11.37**	-16.60**	-16.53**
ΔP_t	-5.08**	-5.12**	-9.04**	-9.04**
ΔM_t	-3.71**	-3.56*	-10.76**	-10.87**
Critical Values for rejecting the null hypothesis of unit root				
	ADF test		**PP test**	
	Without drift	**With drift**	**Without drift**	**With drift**
1%	-3.49	-4.04	-3.48	-4.03
5%	-2.89	-3.45	-2.88	-3.45
10%	-2.58	-3.15	-2.58	-3.15

Note: unit root tests are performed for the period 1975:1-2005:4

ADF test: $$\Delta X_t = \phi_0 + \phi_1 X_{t-1} + \sum_{j=1}^{k} \alpha_j \Delta X_{t-j} + \eta_t$$

PP test: $$X_t = \beta_0 + \beta_1 X_{t-1} + \varepsilon_t$$

where X_t represent the natural log of a time series in the level form. Δ is the first difference operator. The tabulated values are t-statistics to test the null hypothesis of unit root ($\varphi_1 = 0$) for ADF test and ($B_1 = 0$) for PP test. The appropriate lag length (k) was selected using Akike information criterion with maximum lags(k)=8. *indicates significant at 5% level. **indicates significant at 1% level.

As shown in Table-2, the ADF and PP tests are reported with and without the time trends. Examination of the test results in table 2 shows that the ADF test fails to reject the null hypothesis of single unit root for all variables. However, the PP test strongly rejects the null hypothesis of single unit root for the interest rate variable. Since the ADF and PP tests provide conflicting results for the interest rate series, we also performed the Kwiatkowski, Phillips, Schmidt, and Shin (KPSS) (1992) test to check for unit roots in the interest rate series. The KPSS test differs from the other unit root tests because it reverses the null (unit root) and the alternative (stationary) hypotheses. The KPSS test strongly rejected the null hypothesis of stationary for interest rate series.

The null hypothesis of two unit roots is rejected by both tests for all variables at the 5% significance level. Thus, the evidence suggests that first differencing is sufficient for modeling the time series considered in our study.

Tests for cointegration

Unit root tests reveal that variables included in the VAR model are I(1). Next, we perform Johansen's cointegration test (Johansen, 1991) to see whether these variables are cointegrated. To determine the number of cointegrating vectors, Johansen developed two likelihood ratio statistics: Trace statistics (λ_{trace}) and maximum eigenvalue statistic (λ_{max}). The results of cointegration tests are reported in Table-3.

Table-3: Johansen Cointegration tests

Trace test (λ_{trace})		K=2		Maximum eigenvalue test (λ_{max}) k=2			
H0	HA	(λ_{trace})	Critical Values 5%	H0	HA	(λ_{max})	Critical Values 5%
$r \leq 0$	$r > 0$	108.01	95.75	$r = 0$	$r = 0$	44.45	40.07
$r \leq 1$	$r > 1$	63.56	69.82	$r = 1$	$r = 1$	21.30	33.88
$r \leq 2$	$r > 2$	42.26	47.86	$r = 2$	$r = 2$	19.23	27.58
$r \leq 3$	$r > 3$	23.03	29.80	$r = 3$	$r = 3$	15.74	21.13
$r \leq 4$	$r > 4$	7.28	15.49	$r = 4$	$r = 4$	6.98	14.26
$r \leq 5$	$r > 5$	0.30	3.84	$r = 5$	$r = 5$	0.30	3.84

Note: r represents number of cointegrating vectors and k represents the number of lags in the unrestricted VAR model.

Cointegration tests are performed under the assumption of a linear trend in the data, and an intercept but no trend in the cointegrating equation. With maximum lags set to eight, the lag length was selected using different lag selection criteria in the unrestricted VAR model. Sequential modified likelyhood ratio test, final prediction error criterion and Akaike's information criterion all selected two lags in the unrestricted VAR model. As shown in table 3, the null hypothesis that the variables in the VAR are not cointegrated (r=0) is rejected at the 5% significance level under both tests. However, the null hypothesis of one cointegrating relation among the variables (r=1) can not be rejected under either test.

Reduced Form Estimation Results

Having established that all variables in the model are I(1) and cointegrated, a VECM with one cointegrating relation and two lags in each equation was estimated. The VECM allows the long-run behavior of the endogenous variables to converge to their long-run equilibrium relationship while allowing a wide range of short-run dynamics. To save space, only the estimated coefficients of the cointegrating equation and other statistics in VECM are reported in table 4 below.

Table-4: Summary of VECM estimation

	Import Prices (F)	**Money Supply (M)**	**Interest Rate (R)**	**Exchange Rate (E)**	**Price level (P)**	**Output (Y)**
Error Correction Term	-0.046 (4.27)	0.007 (1.78)	-0.016 (0.32)	-0.019 (1.43)	0.001 (0.51)	-0.039 (4.35)
Adjusted R^2	0.10	0.14	0.11	-0.02	0.27	0.31
Term	0.05	0.02	0.25	0.06	0.01	0.04

Note: The VECM was estimated using two lags in each equation. Absolute t-values are given in parentheses. SEE stands for the standard error of the equation.

Examination of Table-4 shows that the long-run relationship is established at the 1% significance level for output and import prices and at the 10% level for money supply within two quarters. However, for other variables convergence to their equilibrium path takes longer than two quarters.

Granger Causality Tests

The VECM approach not only enables us to determine the direction of causality among the variables, but it also allows us to distinguish between the two types of Granger causality: short-run and long-run causality. The long-run causality from independent variables to the dependent variable is evaluated by testing the null hypothesis that the coefficient (λ) of the error correction term (EC_{t-1}) is zero. Short-run causality from an independent variable to the dependent variable is evaluated by testing the null hypothesis that each coefficient (β_i) on the independent variable is zero. By rejecting either of the two hypotheses, we conclude that independent variables Granger cause the dependent variable. Based on our VECM, Granger causality tests are reported below in Table-5.

Table-5: Results of Granger causality tests

	Independent variables						
	EC_{t-1}	ΔF_t	ΔM_t	ΔR_t	ΔE_t	ΔP_t	ΔY_t
	t(= 0)			F(βi = 0)			
Dependent variable							
ΔF_i	-4.27***	- - - -	1.69	0.64	0.14	2.32*	0.56
ΔM_i	1.78*	1.14	- - - -	0.87	0.44	2.35*	2.01
ΔR_i	-0.32	0.08	1.65	- - - -	0.50	2.12	2.73*
ΔE_i	-1.43	0.26	0.28	0.67	- - - -	2.19	0.90
ΔP_i	0.51	3.32**	4.46**	0.35	7.80***	- - - -	0.70
ΔY_i	-4.35***	2.67*	0.62	0.74	0.10	1.70	- - - -

Note: t(λ=0) and F(βi=0) are the t-statistic for testing the null hypothesis that the coefficient of error correction term is zero and the standard F-statistic for testing the null hypothesis that all coefficients on the independent variables are zeroes, *** , ** , * indicate significance at the 1% , 5% and 10%, levels respectively.

Results presented in Table-5 indicate the presence of long-run causality from all the variables to output growth. However, there is only short-run causality from imported inflation, money growth and exchange rate to domestic inflation. In short, we can say that exchange rate does Granger cause inflation and output growth.

Variance decomposition results

Table-6 presents the variance decomposition of the variables in the model. The table shows the percentage of the forecast error variance for each variable that is attributable to its own shocks and to shocks in the other variables in the system. The most important conclusions from the variance decomposition are as follows. First, for all variables except the output (LY), the predominant source of variation are own shocks. Second, over the medium-term (first 6 quarters), about 76 percent of variance in output forecast errors is explained by own shocks and only 24 percent by shocks in all other variables in the system. Over the long-term (24 quarters), the situation is reversed where own shocks account only about 25 percent while shocks in other variables explain 75 percent of the forecast error variance of output. Over the longer period, the domestic price level is the predominant source of variation in output. Domestic price shocks explain about 38% of the forecast error variance of output. The effect of interest rates, import prices and money shocks to output is about 19%, 10% and 7% respectively. However, surprisingly the impact of nominal effective exchange rate on output is quite unimportant. Exchange rate shocks account for only 0.5 to 1.5% of the forecast error variance of output. Third, over the short-term (two quarters), import price shocks are relatively more important in explaining variation in the price level than shocks in other variables. Import price shocks interpret 6.27% while shocks in all other variables combined explain only 6.23% of the forecast error variance of price level over a time span of two quarters. However, in the long-run, money and exchange rate shocks become more important to explain variation of price level. The long-term effect of money, the exchange rate, and import price shocks on price level variation is about 18%, 9% and 6% respectively. The effect of output shocks on the price level is statistically insignificant at all time horizons. Fourth, almost all of the variation in the exchange rate and interest rates is explained by own shocks and money shocks, while the impact of other variables on the exchange rate and interest rates is insignificant. Money shocks explain 13.4% and 11.9% of the forecast error variance of the exchange rate and interest rates, respectively. We can conclude that effects of monetary policy are transmitted through both the exchange rate channel and the interest rate channel. Fifth, the variance of money supply is explained primarily by its own shocks and by output shocks. In summary, output and the price level do not explain any variation in the exchange rate but exchange rate shocks do explain variation in the price level.

Table-6: Variance decomposition from the Vector Error Correction Model

Variance Decomposition of LFP:							
Period	**S.E.**	**LFP**	**LM2**	**LR**	**LNEER**	**LP**	**LY**
2.00	0.07	96.46	0.12	0.00	0.00	1.03	2.40
4.00	0.09	91.15	0.42	0.41	0.67	1.80	5.55
6.00	0.11	84.91	2.12	1.84	1.38	1.26	8.50
8.00	0.13	78.28	4.47	4.01	1.47	1.14	10.62
10.00	0.15	72.04	6.58	6.28	1.35	1.61	12.13
12.00	0.17	66.73	8.17	8.30	1.17	2.42	13.21
14.00	0.19	62.44	9.27	9.99	1.01	3.30	13.98
16.00	0.20	59.01	10.04	11.37	0.87	4.14	14.56
18.00	0.22	56.26	10.58	12.49	0.77	4.89	15.01
20.00	0.23	54.03	10.98	13.40	0.68	5.53	15.37
22.00	0.24	52.19	11.29	14.16	0.61	6.08	15.67
24.00	0.26	50.66	11.53	14.79	0.55	6.55	15.91
Variance Decomposition of LM2:							
Period	**S.E.**	**LFP**	**LM2**	**LR**	**LNEER**	**LP**	**LY**
2.00	0.03	1.42	96.77	0.36	0.30	1.15	0.01
4.00	0.05	0.81	96.42	0.49	0.37	1.18	0.73
6.00	0.06	0.76	95.93	0.36	0.52	1.03	1.40
8.00	0.07	0.85	95.41	0.27	0.62	0.80	2.06
10.00	0.08	1.00	94.75	0.28	0.65	0.63	2.69
12.00	0.09	1.19	93.95	0.39	0.64	0.57	3.26
14.00	0.10	1.38	93.12	0.56	0.60	0.60	3.75
16.00	0.10	1.55	92.30	0.74	0.55	0.69	4.16
18.00	0.11	1.71	91.55	0.92	0.51	0.81	4.50
20.00	0.12	1.85	90.88	1.08	0.47	0.94	4.78
22.00	0.12	1.97	90.29	1.23	0.44	1.06	5.01
24.00	0.13	2.07	89.77	1.36	0.41	1.17	5.21
Variance Decomposition of LR:							

Period	S.E.	LFP	LM2	LR	LNEER	LP	LY
2.00	0.30	0.05	1.31	95.27	0.69	0.29	2.39
4.00	0.39	0.17	2.15	93.19	0.51	2.20	1.78
6.00	0.47	0.24	3.82	90.96	0.41	2.98	1.58
8.00	0.54	0.29	5.66	88.95	0.38	3.32	1.41
10.00	0.59	0.30	7.25	87.40	0.35	3.41	1.29
12.00	0.65	0.30	8.51	86.24	0.32	3.41	1.22
14.00	0.69	0.30	9.46	85.38	0.30	3.38	1.17
16.00	0.74	0.30	10.19	84.74	0.28	3.36	1.13
18.00	0.78	0.30	10.76	84.24	0.27	3.33	1.10
20.00	0.82	0.30	11.21	83.85	0.25	3.31	1.07
22.00	0.86	0.30	11.58	83.52	0.24	3.30	1.05
24.00	0.90	0.30	11.90	83.25	0.23	3.28	1.04

Variance Decomposition of LNEER:

Period	S.E.	LFP	LM2	LR	LNEER	LP	LY
2.00	0.10	0.87	2.05	0.32	95.86	0.89	0.01
4.00	0.13	0.69	4.35	0.22	93.54	0.56	0.62
6.00	0.17	0.57	6.76	0.27	90.99	0.64	0.77
8.00	0.19	0.49	8.65	0.42	88.66	0.88	0.90
10.00	0.22	0.42	10.03	0.58	86.82	1.16	0.99
12.00	0.24	0.37	11.01	0.73	85.41	1.42	1.06
14.00	0.26	0.33	11.70	0.85	84.35	1.66	1.11
16.00	0.28	0.30	12.22	0.94	83.53	1.85	1.15
18.00	0.29	0.28	12.61	1.02	82.89	2.01	1.19
20.00	0.31	0.26	12.92	1.09	82.37	2.15	1.22
22.00	0.32	0.24	13.17	1.14	81.94	2.26	1.24
24.00	0.34	0.23	13.38	1.19	81.58	2.36	1.26

Variance Decomposition of LP:							
Period	**S.E.**	**LFP**	**LM2**	**LR**	**LNEER**	**LP**	**LY**
2.00	0.02	6.27	3.12	2.78	0.22	87.50	0.11
4.00	0.03	6.47	7.41	3.85	5.42	76.82	0.04
6.00	0.04	6.41	11.14	3.75	7.45	71.22	0.02
8.00	0.05	6.35	13.81	3.66	8.33	67.84	0.02
10.00	0.05	6.31	15.52	3.62	8.75	65.77	0.03
12.00	0.06	6.30	16.55	3.65	8.96	64.50	0.04
14.00	0.07	6.30	17.14	3.70	9.10	63.71	0.05
16.00	0.07	6.31	17.48	3.77	9.19	63.18	0.07
18.00	0.08	6.32	17.68	3.84	9.25	62.83	0.08
20.00	0.09	6.33	17.80	3.91	9.31	62.57	0.09
22.00	0.09	6.34	17.87	3.97	9.35	62.37	0.10
24.00	0.10	6.35	17.92	4.02	9.39	62.22	0.11
Variance Decomposition of LY:							
Period	**S.E.**	**LFP**	**LM2**	**LR**	**LNEER**	**LP**	**LY**
2.00	0.05	6.23	0.03	0.20	0.46	4.08	89.01
4.00	0.06	5.78	0.44	1.32	0.55	6.13	85.77
6.00	0.06	6.96	1.72	3.96	0.43	11.11	75.82
8.00	0.07	7.91	3.35	7.29	0.42	17.02	64.00
10.00	0.08	8.49	4.69	10.29	0.53	22.31	53.70
12.00	0.10	8.90	5.56	12.63	0.69	26.56	45.66
14.00	0.11	9.19	6.08	14.38	0.87	29.83	39.65
16.00	0.12	9.41	6.38	15.69	1.03	32.33	35.16
18.00	0.13	9.56	6.56	16.68	1.18	34.26	31.75
20.00	0.13	9.69	6.68	17.45	1.30	35.78	29.10
22.00	0.14	9.78	6.75	18.07	1.40	36.99	27.01
24.00	0.15	9.86	6.80	18.56	1.49	37.97	25.31

Impulse Response Functions Analysis

Having shown the dynamic effects of variance decompositions, we analyze the impulse responses. The variance decompositions do not show the direction of the dynamic effects of the shocks on the variables in the system but the impulse responses do. The impulse response function (IRF) describes the impact of an exogenous shock in one variable on the other variables of the system. A unit (one standard deviation) increase in the i^{th} variable innovation (residual) is introduced at date *t* and then it is returned to zero thereafter. In general the path followed by the variable $X_{j,t}$ in response to a one time change in $X_{i,t}$, holding the other variables constant at all times *t*, is called the IRF. The traditional impulse response method based on Cholesky decomposition has been criticized because results are subject to the orthogonality assumption. If the residuals of two (or more) equations contained in the VAR system are contemporaneously correlated, then the impulse responses are not robust to the ordering of the variables. In fact, the impulse responses may display significantly different patterns Lutkenpohl (1991). Recently, Pesaran and Shin (1998) have developed a method called the generalized impulse response function (GIRF) which does not impose the orthogonality restriction and thus impulse responses are not sensitive to the ordering of the variables in the VAR and provide more robust results. In this paper we report results both from traditional IRF and generalized IRF. Each figure shows the response of a particular variable to a one time shock in each of the variables included in the VEC model. It should be noted that a one time shock to the first differenced variable is a permanent shock to the level of that variable.

Figure 2 contains the impulse-response functions for output (LY). Examination of the graph shows that the impulse responses meet a priori expectations in terms of the direction of impact. A positive shock to import prices has a significant contractionary effect on the output. The effect of a unit shock to import prices on output occurs immediately and stabilizes after 15 quarters with output decreasing by approximately one percent of its baseline level. The effect of a unit shock to money supply on output occurs after approximately the third quarter, reaching its peak after 12 quarters. Thereafter the cumulative effects of money supply stabilize with output increasing by approximately one percent of its baseline level. Positive interest rate shocks have permanent and negative effects on output. Positive exchange rate shocks (appreciation) lead to an immediate and long lasting decrease in output. The impact of the exchange rate appreciation is rather immediate and long lasting. A unit shock to the exchange rate (appreciation) causes output to decrease approximately 0.5 percent from its base level. Positive price level shocks have a very strong negative effect on output. A

one unit shock in the price level leads to a 1% decrease in output by the second quarter and then by more than 2% over a longer time span.

Figure 2

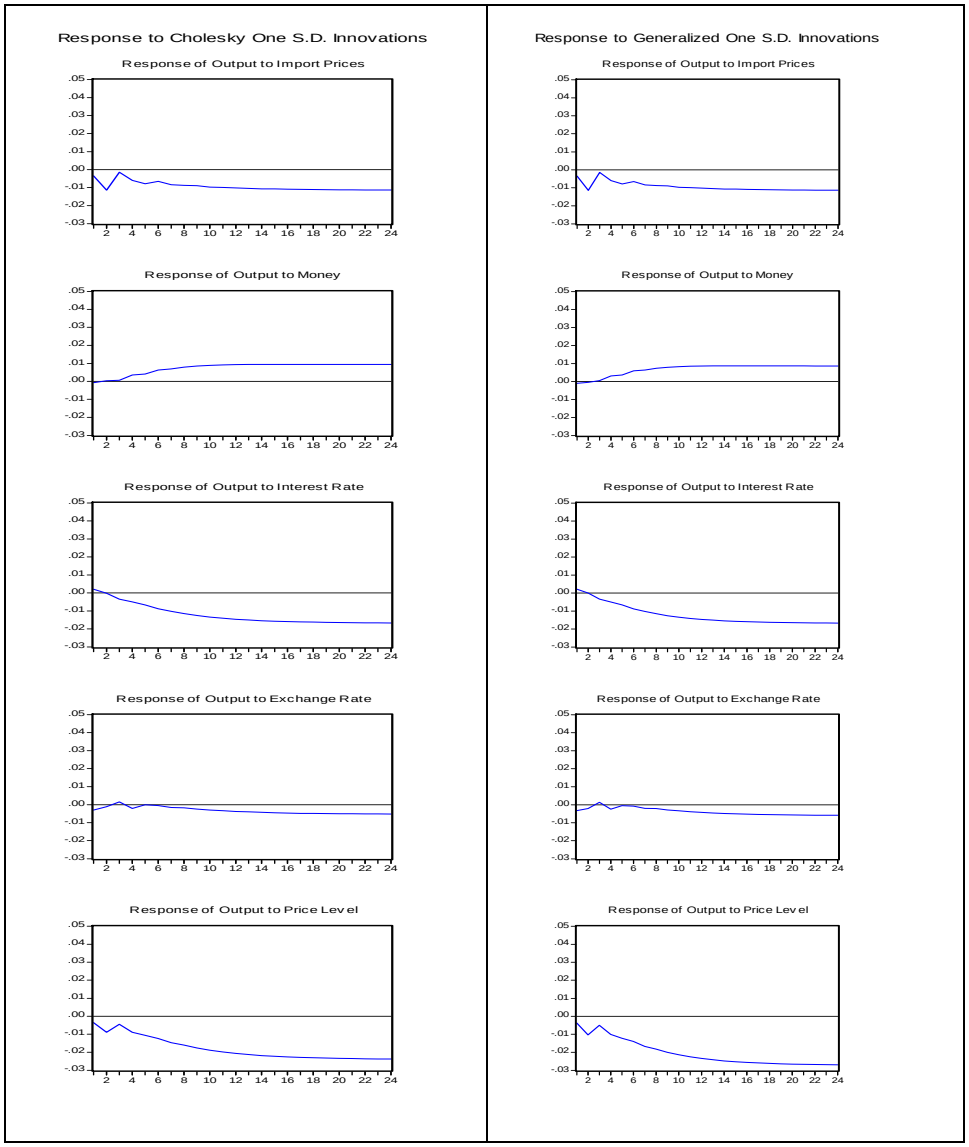
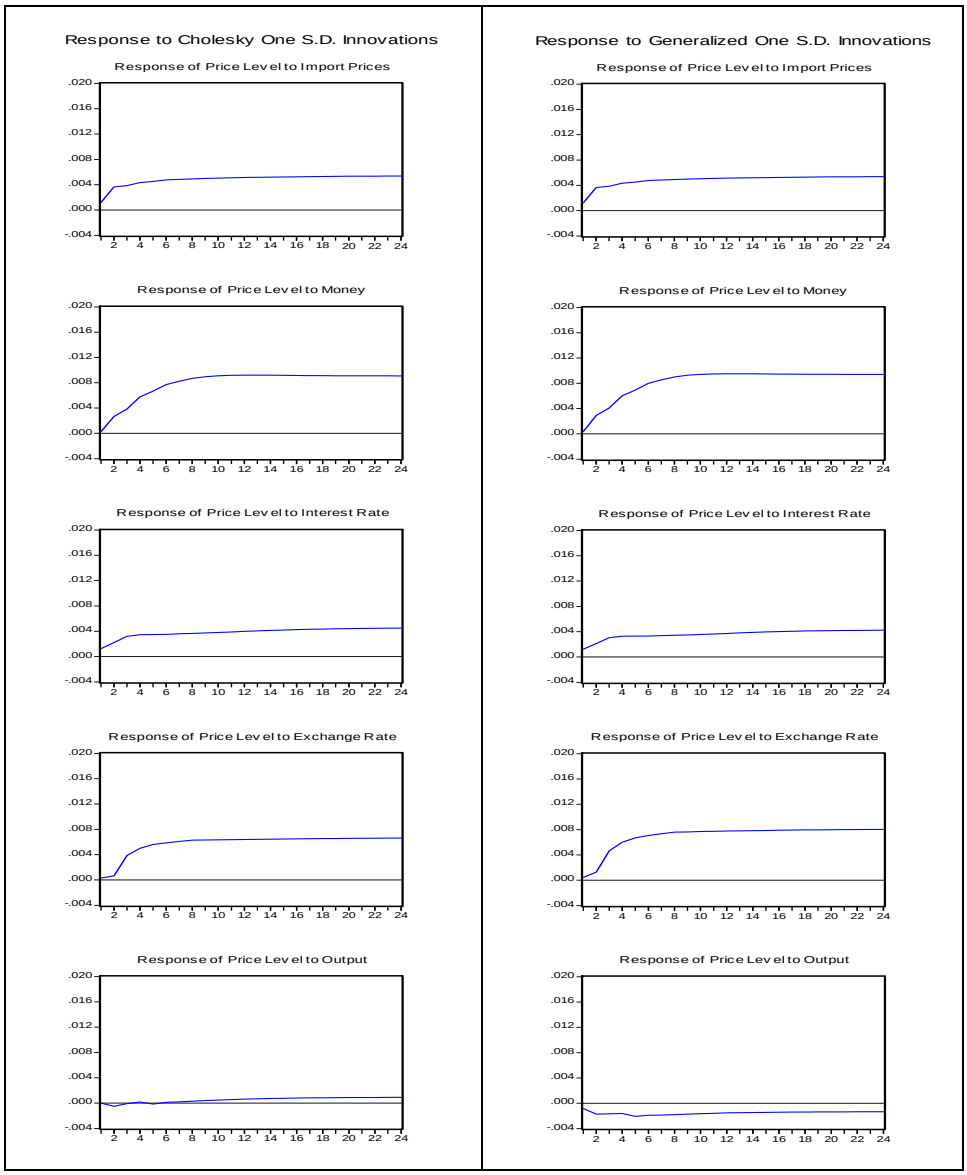


Figure 3 contains the impulse-response functions for the price level (LP). An examination of figure 3 shows that positive shocks in import prices, money supply, the interest rate and exchange rate (appreciation) all have a significant positive and lasting effect on the price level. The effect of output shocks on the price level is marginally negative in the shorter period but

unclear over the longer period as it is slightly positive in Cholesky innovation where as negative in generalized innovations. Over a period of two quarters, the effect of money supply on the price level is stronger than the effect of exchange rate appreciation. However over a longer period, the effect of an exchange rate appreciation on the price level is almost as strong as the effect of money supply.

Figure 3



The effect of a unit shock to money supply on the price level occurs quickly and reaches its peak within 10 quarters. The cumulative effects of money supply stabilize with the price level, increasing it by approximately one percent of its baseline level. The effect of a unit shock to exchange rate (appreciation) on the price level is rather slow for the first two quarters and then accelerates quickly and reaches its peak within 10 quarters. The cumulative effects of the exchange rate stabilize with the price level, increasing it by approximately 0.8 percent of its baseline level. The positive effect of the interest rate on the price level confirms the hypothesis that higher interest rates in the developing countries increase the cost of working capital (VanWijnbergen, 1986) and thus causes a leftward shift in the aggregate supply curve.

In summary, a devaluation (negative exchange rate shocks) has a positive effect on output and a negative effect on the price level. The negative effect of a devaluation on the price level fits quite well with the competitive devaluations or "beggar thy neighbor" policies followed by Pakistan and other developing countries exporting similar products and desperately attempting to increase their market share in a world of shrinking markets. Thus, the evidence presented in this paper does not support the contractionary devaluation hypothesis.

IV. Conclusion

The traditional view was that devaluations are expansionary and that led Pakistan, like many other developing countries, to resort to large devaluations in hope to reap economic benefits. During the fixed exchange rate period (1971-81), the Pak rupee was devalued from 4.79 to 9.90 per US dollar. During the managed float period (1982-1999) the rupee was devalued from 9.90 to 51.78 per US dollar. During the flexible exchange rate period (2000-2006) the rupee has depreciated from 51.78 to 60.60 per US dollar. In recent years, the proposition that devaluations are expansionary has faced a serious threat from new structuralists who claim that devaluations are contractionary. A number of empirical studies have supported the contractionary devaluation hypothesis using pooled time series data from a large number of heterogeneous countries. Since the effects of devaluation on output and price level may not be uniform across all developing countries, it is desirable to conduct country specific studies.

This study has analyzed the effects of exchange rate on output and the price level using a VEC model for the Pakistan economy over the period 1975:1-2005:4. Examination of variance decomposition and impulse responses from a VEC model has revealed a number of important findings.

First, devaluation has a positive effect on output but a negative effect on the price level. Thus, evidence presented in this paper does not support the contractionary devaluation hypothesis. Second, expansionary monetary policy has a (significant) positive effect on both output and the price level. Third, an increase in import prices has a negative effect on output but a positive effect on the price level. Fourth, an increase in the interest rate has a negative effect on output but a positive effect on the price level. This confirms the structuralists' hypothesis that an increase in the interest rate increases the working cost of capital and thus represents an adverse supply shock rather than adverse demand shock.

In conclusion, these findings imply that policy makers in Pakistan should be very careful when considering a revaluation of the currency or using policy tools under their control in such a way as to achieve appreciation. Similarly, we can say that it is recommended for the authorities to implement a flexible exchange rate system because an overvalued currency is not only inflationary but also hinders economic growth.

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Economic Rationale, Trade Impact and Extent of Antidumping – A Case Study of Pakistan

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Abstract

This paper has analyzed the economic and political justification, trade impact and extent of antidumping measures initiated by Pakistan. Screening models for anti-predatory behaviour, Herfindahl-Hireshmann Index (HHI) for concentration and descriptive statistical measures are used to test the antidumping (AD) behaviour. The results are consistent with the earlier literature that AD duties have both a trade reduction and diversion effect. It is evident from the results in half of the cases studied that an economic rationale has been followed in the application of AD duties in Pakistan. Although the number of AD cases is limited, Pakistan has emerged as one of the intensive users of AD, relative to its total import share. It is also evident from the fact that intensive use of AD reduces trade and increases trade barriers, similarly, trade diversion reduces the chances of trade reduction. The key message emerging from this research is that trade diversion persists and in some cases trade diversion is substantial and it offsets the effect of AD measures on named countries to the benefit of non-named countries.

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Introduction

Large-scale recourse[18] to antidumping[19] (AD) has raised fears among researchers, analysts and specialists of its use as a protectionist measure, e.g. Viner (1923), Barcelo (1971), Trebilock and Quinn (1979), Leclerc (1999). While some have raised questions about the ambiguities regarding AD's effects on trade, others have questioned the economic rationale behind such actions. Many scholars suggest that AD measures are inefficient and do not conform to the economic explanation of protection, e.g. Tharakan and Waelbroeck (1994), Tharakan (1995). On the other hand, some economists also argue that charging two or more prices for a similar product in two or more markets separated by tariffs, transport costs and technical standards is economically rational in many situations, e.g. Viner (1923), Willig (1998), Messerlin and Tharakan (1999), or that producers keep prices low strategically when they introduce a product in a new market to create demand for it (Boltuck, 1991). In addition, if a firm produces what is called 'learning by doing' products (Deardorff, 1993) then the firm, by charging lower prices in foreign markets, will gain in experience as well as increase their sales revenue.

The most frequently offered economic justification for antidumping laws is that these laws protect competition and consumers. For most scholars, the consumer welfare standard is the main measure of economic efficiency, which suggests that antidumping laws are created to prevent predatory pricing. Conversely, Stiglitz (1997) considered that there is essentially no connection between national welfare considerations and AD protection; it is simply a strategy to protect the domestic industry. Therefore, strategic trade policy is the other protection-based justification for the imposition of AD duties, as a measure against 'strategic dumping' (Willig, 1998). Strategic trade policy is the investment by the dumping country or firm to occupy a major market share to generate externalities,

[18] The number of antidumping petitions increased very rapidly into the hundreds after the implementation of Article VI of the General Agreement on Tariffs and Trade 1994 which entered into force on January 1995. From 1980-85 four user, US, EU, Australia, Canada, accounted for more than 99% of all filings (Finger, 1993). Prior to 1988 none of the developing countries filed any cases. Total AD initiations by all the AD users in 1995 were 157, then increased to 364 in 2001 and reached 191 in 2005. This surge of AD activity has been noticed on face value of AD petition numbers without taking into consideration the economic rationale.

[19] Broadly speaking a product is said to have been dumped if it is introduced into the commerce of another country at less than the normal value of the product and it causes/threaten material injury to an established industry of the importing country (Aggarwal, 2002). Antidumping duties are imposed against the dumped products by the host country.

e.g. Katrak (1977), Svedberg (1979). In theory, a role for strategic trade policy emerges in two situations: imperfect competition and economies of scale in production.

For the legal imposition of AD duties, three basic conditions need to be satisfied: first, the existence of a dumping margin must be established; second, the material injury to concerned domestic industries must be shown; and third, the causal relationship between dumped imports and material injury to domestic industries must be demonstrated (Lee-Mah, 2003). Difficulties arise when firms exercise market power. In such instances, government intervention can be justified. The problem arises because the instruments that are usually available to a government to discipline a domestic firm, such as anti-trust regulation, are not effective in the case of foreign-based enterprises[20]. In the absence of antitrust instruments, the government resorts to other alternatives. A resurrection of trade barriers is a possibility. Another option is the use of antidumping policies, which allow governments to impose duties whenever goods are sold in export markets at less than their 'fair value'. These policies, in essence, prevent the country's (firms) attempts at price discrimination between markets, which could lead to material injury of the domestic industry. Given the international dimension, the advantage of AD is that it does not require any supranational powers. The disadvantage of AD policies is that these policies do not fully address the problem of market power and indeed often induce more distortions in the market than they resolve, and are often captured by special interest groups. It is generally believed that the negative impact of AD outweigh the positive ones. Therefore, a major part of this paper is an investigation of the economic motives behind AD.

It is possible that dominant domestic producers in concentrated industries use AD laws to protect themselves from foreign competition. This 'small firm' argument is supported by researchers, yet they are unable to establish that concentrated industries are more likely to gain favourable decisions, e.g. Finger *et al.* (1982). Oligopolists may use their lobbying power effectively to obtain protection from import competition, see e.g. Tharakan (1994), Tharakan and Waelbroeck (1994) and Hutton and Trebilcock (1990). Similarly, politics play a significant role in the widespread use of AD [Hansen and Prusa, (1996, 1997) Agarwal, (2002)], while another

[20] The exporting country could, of course, also use anti-trust policies to force its firms to behave more competitively in foreign markets, but it frequently is not in the interest of the nation to do so (Levinsohn, 1996).

study (Finger *et al*. 1982) found no evidence of political influence on the widespread use of AD.

One way to make a sense of AD use is to observe the pattern of its use among the countries. The worldwide explosion in the use of AD duties has been widely documented e.g. Blonigen and Prusa, (2003), Miranda, Torres, and Ruiz (1998) and Messerlin (1989). If, for no other reason, the widespread use of AD makes it an important research topic. One factor behind the rise of antidumping protection could be that countries are engaged in retaliatory mini-trade wars (Prusa and Skeath, 2002). Similarly, cumulation (which is defined as the practice of aggregating over the exports of several countries) has a super additive effect on the AD surge, see e.g. Tharakan, Greenway, and Tharakan (1998), while increasingly the weak standard of AD is another factor in AD proliferation (Hansen and Prusa, 1995), Miranda, Torres, and Ruiz (1998) Finger, Ng, and Wangchuk (2000). Such indiscriminate use of AD will negatively affect the expected positive outcomes of liberalized trade under the WTO regime. AD measures can be justified as a response to unfair import competition. But the recent surge in AD investigations can clearly not be explained by an increase in unfair trading practices alone. One of the major concerns for international firms is also the growing importance of the so-called 'technical track' of trade policy (Finger, 1993). It increasingly appears that many companies no longer seek competitive victory in the fields of commerce and trade but in the halls of justice and regulators.

According to the review of the empirical work on the impact of AD measures (Blonigen and Prusa, 2003), most of the empirical studies conclude for USA and EU data, that it significantly reduces imports from named-countries, see e.g. Staiger and Wolak (1994), Prusa (1997), Messerlin (1989), and Brenton (2001). As a result, AD sometimes causes trade diversion rather than its reduction, as its effects depend on a number of factors such as: concentration of industries, extent of injury and margin of dumping. For example, in case of severe injury, antidumping duties would be higher, which might be a potential threat to exports of dumping firms, but in the case of minor injury, the AD duty would be small and would likely not pose any threat to other firms/countries that would wish to increase their exports.

Consequently, the objectives of this study are: i) to find out the economic rationale behind the use of AD, and whether it disciplines the behaviour of imperfectly competitive firms in international markets or not.

ii) To examine the use of AD by Pakistan[21]. iii) To check the AD measures/effects on trade reduction/diversion patterns.

The rest of the paper is organized as follows: Section II describes the methodology, hypothesis, variables and data, Section III-discusses the results, and finally Section IV concludes with policy recommendations.

II. Methodology, Hypothesis Variables and Data

The methodology used in this paper is based mostly on statistical and descriptive techniques, but we have also used models for anti-predatory behaviour, such as the screening method, which has the advantage of relying exclusively on published information. The presence of predatory behaviour will provide an economic justification for antidumping. Five screen tests are conducted; the first screen test is based on the foreign firm having a forecasted market share of 40 percent in Pakistan. If the market share is more than 40 percent, it would indicate predatory behaviour of a foreign firm. The second screen test consists of eliminating the cases where antidumping duties are not imposed. The third screen test takes into account the number of countries involved in a given case. If the number of countries is more than four, then the chance of collusion diminishes. The fourth screen test aims at taking into account another aspect of the cost of colluding: the numbers of firms involved in a given case. If the number of firms involved in a case is more than eight then the chances of collusion are low. The fifth screen test considers foreign firm market shares and the number of competitors of the domestic industry. Low foreign firm share and multiple competitors does not suggest the existence of a non-competitive market favourable to predatory behaviour. These screen tests are widely used in the 'EC contingent protection of antidumping instruments'[22], see e.g. also Bourgeioes and Messerline (1998).

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[21] In Pakistan, antidumping investigations are carried out by the government agencies (National Tariff Commission working under the Ministry of Commerce). An investigation is normally initiated by means of an application filed by or on behalf of a domestic industry, which must include evidence of dumping, injury and a causal connection between the two. The investigation determines whether or not there has been dumping, which exists where the export price is below normal value. Normal value may be based on prices of sales to third countries, or constructed value, which is cost of production plus profit, where home market sales is not available or cannot be used. The investigation also determines whether the dumped imports have caused or threaten to cause material injury to a domestic industry producing the like product.

[22] www.iie.com/publications/chapters_preview/102/appbiie2733.pdf, see pg. 355.

We analyzed the composition of foreign firms using the Herfindahl-Hireshmann Index (HHI). For the 'Retaliation' and 'Strategic Industry'[23] arguments, we used descriptive analyses of antidumping cases, the number of producers, the number of petitioners and their market shares, taken as variables for Pakistan and against Pakistan. Case by case analysis is presented in Appendix-A.

The Herfindhal-Hirschman concentration index (HHI or H) is used to measure the concentration in import. It is given by:

$$H = \sum s_i^2$$

where $s_i = m_i/M$

where m_i is the imports or production of firm i and M is total imports or production (i.e. $M=\sum_i m_i$). Thus, s_i is the share of import or production of firm i on total import production.

Spread of Antidumping

The weighted Antidumping Intensity Index (ADI) is used, which measures the intensity of AD for a country that is accused of dumping relative to its export or user of antidumping relative to its import performance. The ADI for a country (or region) i can be calculated as follows:

$$ADI_i = I_i^{t,\,t+n} / I_w^{t,\,t+n}) / (M_i^{t,t+n} / M_w^{,\,t,\,t+n})$$

Where $I_i^{t,\,t+n}$ is the number of AD investigations/measures against country i (or product, region) between years t and t+n; $I_w^{t,\,t+n}$ is the total number of investigations/measures conducted globally in years t and t+n; $M_i^{t,t+n}$ is the value of exports/imports of a country i between years t and t+n; and $M_w^{t,\,t+n}$ stands for world export/import.

If the index value is above unity, then the country or region is intensively affected by (or has used) AD actions relative to its share in global export (import) markets. AD action is considered proportional if the index is at unity, while less than unity means that the country is lightly affected by AD. The trade-weighted ADI index can be applied to the initiation of investigations as well as to definitive measures.

[23] Dominant domestic producer and oligopolists may use their lobbying power effectively to obtain protection from import competition.

Statistical Test for Trade Impact

Mean-differences tests on imports before and after AD is used to calculate the trade impact of AD.

Data

A total of six AD cases, which were successfully concluded in Pakistan before December 2005, are used for analysis. This is a small sample, but it varies in terms of the representation of different sectors. Three out of six cases are from the chemical industry, two are from the rubber and plastic industry and one case is from the base metal industry. The data regarding the number of firms and countries which were investigated, the dumping margin, antidumping duties and the negative or affirmative decisions in the antidumping cases were collected from the non-confidential reports published by the National Tariff Commission, Government of Pakistan.

Export and import data of some selected countries were used to measure the intensity. Export data at f.o.b and import data at c.i.f was gathered from the International Financial Statistics, IMF. PRAL (Pakistan Revenue Automation Limited) provides data on the import of investigated products into Pakistan.

Hypotheses

The following hypotheses are tested.

1. Antidumping measures in Pakistan are anti-predatory in nature.

2. 'Retaliation' and 'Strategic industry' arguments are the real reasons for imposing AD.

3. Concentrated domestic industries are more likely to gain favorable antidumping decisions.

4. Import concentration can be linked to material injury and antidumping duties reduces import concentration.

5. Pakistan is more intensive on average in terms of antidumping measures.

6. The sample mean of imports after AD duty $\leq$ sample mean of import before AD duty.

7. Trade diverts from the named countries to non-named countries.

III. Results

Three rationales for the economic justification of AD, i.e. 'Anti-predation', 'Political Economy' and 'Strategic Trade Industry' are tested in this analysis. We quantify the use of Pakistan's AD intensity as a parameter of spread. The study also considers whether AD use leads to overall import reduction and sometimes import diversion.

Antidumping and Predation

Five simple screening tests are used to tackle the question of whether antidumping cases are anti-predation cases or not. The results in Table-I suggest that the AD cases in Pakistan do not address predation issues at least in three cases. Passing of each test is represented by 1 and in case of failure by 0. For the anti-predatory nature it is necessary for the antidumping case to pass all the five tests: That an antidumping case results into a positive outcome, forecasted market share is above 40 percent, numbers of countries are below four and number of firms below eight. However, it is not certain whether the import market is equally shared by the firms and countries. For this, four years combined index of HHI is used to conduct the fifth test. Minimum HHI is based on the assumption that the aggregate market share for the foreign firm is split equally among them. Maximum HHI is based on the assumption that all foreign firms except one have the market share close to zero. HHI value for a case above or equal to the threshold level of 0.18 is indicated in the Table by 1, which shows severe concentration. Three out of four cases shows HHI value more than 0.18, while HHI is less than the threshold level in one case, that is 'Tinplate' imported from South Africa. Therefore, this case has been dropped from the anti-predation test. Only three cases out of six successfully completed the screen tests, which show that almost half of AD cases in Pakistan cannot be proven to address competition. The result shown in Table-1 is similar to what has been found for US AD cases (Shin 1997). The anti-predation test process demonstrates the acquisition of a large market share by the importer; the atleast capacity exists to exercise and keep market power, once a large market share is obtained.

Table-I: Results of Screening Test

HS code	Product Name	Industry	Test.1*	T.2**	T.3***	T. 4****	T.5*****
7210.1200	Tinplate	Base Metal	1	1	1	1	0 (drop)
2905.4400 & 3824.6000	Sorbitol 70% solution	Chemical	1	1	1	1	1
2915.2100	Glacial Acetic Acid	Chemical	1	1	1	1	1
5501.3000	Acrylic Tow (AT)	Rubber plastic	1	1	1	1	1
3904.1000	PVC Resin (PVCR)	Rubber plastic	1	0 (drop)	-	-	-
3909.1010	UFMC	Chemical	1	0 (drop)	-	-	-

*Passing Screen No.1 $\geq$ 40 percent market share = 1, otherwise=0 (Affirmative or negative duty).

** The cases in which antidumping duties are imposed = 1, otherwise=0.

*** Less than four countries investigated = 1, otherwise=0.

**** Less than 8 firms investigated= 1, otherwise =0.

*****HHI (imp) $\geq$ 0.1818 as high concentration = 1, otherwise=0

Antidumping and Political Economy

Table-2 demonstrates that five out of six petitioners are the sole producers in the domestic market while the sixth petitioner holds 83 percent of domestic production. Clearly, the petitioners are the dominant producers in their industry.

Table-2: Market Share of the Petitioner

Product Name	Number of domestic firms	Number of petitioners	Share of petitioner in domestic production
Tinplate	1	1	100%
Sorbitol 70% solution	1	1	100%
Glacial Acetic Acid	1	1	100%
Acrylic Tow (AT)	1	1	100%
PVC Resin (PVCR)	1	1	100%
(UFMC)	3	1	83%

The importer can cause material injury, if the import is highly concentrated. The assertion that the dominancy of only a few countries on the import market provides them the ability to use imports as a political weapon and dump imports. We can consider it as a case of sporadic dumping which occurs at certain points in the business cycle. Therefore, the first question that arises is: Was the increase in international trade evenly distributed across countries or has it been concentrated among a few countries? The second question is: In case of trade diversion does import concentration reduce or remain the same among the importers?

In order to evaluate the level of concentration in total imports, we employed the HHI index. The results are reported in Table-3.

Table-3: Results of HHI

	HHI							
Product/Year	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
Tinplate	0.12	0.16	0.14	0.15	0.13*	0.20	0.14	0.13
Sorbitol	0.62	0.62	0.69	0.48	0.45	0.31*	0.29	0.27
GAA	0.84	0.80	0.76	0.74	0.71	0.48	0.40*	0.85
Acrylic Tow	0	0.32	0	0.15	0.18	0.16	0.20*	0.15
PVC Resin	0	0	0.26	0.28	0.28	0.20	0.27	0.32*
UFMC	0.69	0.82	0.90	0.80	0.90	0.84	0.90	0.92*

*shows antidumping duty imposition year.

The threshold level of HHI is 0.18. Table-3 shows that the value of import concentration is high, ranging from 0.12 to 0.92. This shows severe concentration. The import concentration ratio further increases in some cases after the imposition of an antidumping duty on the alleged producer, as obvious in the case of GAA (Galcial Acetic Acid imported from Taiwan) where import concentration jumped in the year of antidumping imposition, from 0.40 to 0.85 in the next year. This is because after the imposition of the antidumping duty, imports from Taiwan were reduced to zero, while Malaysia, another major exporter of GAA into Pakistan captured the entire import market of Taiwan and increased its exports to Pakistan by 50 percent just after the imposition of the duty.

Strategic Industry and Antidumping

Retaliation is a strategic reaction; therefore, it is necessary to check whether antidumping cases in Pakistan are of a retaliatory nature or not. The result shows that Pakistan's AD cases are neither firm specific nor country specific. Rather, these are of 'strategic industry specific' nature. The results in Table 4 show that most of the measures taken against Pakistan are in the textile sector. It seems quite logical because the textile sector contributes 68 percent to total Pakistani exports.

Table-4: Category Wise Division of AD Measures

Retaliation / strategic Industry					
AD measure taken against Pakistan			**AD measure taken by Pakistan**		
Country	**Category**	**Number**	**Country**	**Category**	**Number**
Egypt	Textile and Textile Artic	1	South Africa	Base Metal	1
EU	Textile	2	Indonesia/ France	Chemical	1
Japan	Textile	1	Taiwan	Chemical	1
Peru	Chemical and allied industries	1	Uzbekistan	Rubber / Plastic	1
South Africa	Textile	1	Iran/Korea	Rubber/ Plastic	1
			China	Chemical	1
Total		**6**			**6**

There is a clear difference in the origin of countries against whom measures are taken and those who take measures against Pakistan. Table-4 shows that 50 percent of AD cases in Pakistan are in the chemical industry, which is a strategic industry[24] and generates positive externalities.

Antidumping Spread[25]

AD intensity index measures how intensive Pakistan is in terms of AD initiation and measures, relative to its import and export share in world trade. AD intensity is estimated for other countries representing different regions and diverse economies to show how intensive Pakistan is in terms of AD measures and initiation relative to other countries. Table 5 shows that Pakistan's AD initiation is 2.62 times more intensive as compared to its share of imports in the world. No doubt, the number of cases initiated by Pakistan is far less than the number of cases initiated by the USA. But the USA is a less intensive user of AD, with an index of 0.84, as compared to its relative share in world imports. Table 5 shows that the most intensive users of AD in the world are Argentina and India.

AD intensity can be considered as a proxy for the spread of AD. The intensity index in Pakistan ranges from 2.6 to 3.3. This shows that AD spread in Pakistan is gaining momentum. If we consider the AD index of the USA as a standard parameter and compare other countries' intensity value with the USA, we arrive at the conclusion that Pakistan is almost four times as intensive a user of AD measures as compared to the USA.

[24] The sector which generates positive externalities, see e.g. Tyson (1992).
[25] Spread is wide and intensive use of AD.

Table-5:.Intensity Measure of AD

Intensity Measure 2000-2005								
Country	**AD Initiation Intensity**		**AD Measure's Intensity**		**AD Initiation Intensity**		**AD Measure's Intensity**	
	Relative to import	**Relative to USA /times**	**Relative to import**	**Relative to USA /times**	**Relative to Export**	**Relative to USA /times**	**Relative to Export**	**Relative to USA /times**
Argentina	26.82	31	29	41	2.8	5.3	1.4	3.2
Australia	4.29	5	3.3	4.7	0.67	1.2	0.50	1
Chili	1.24	1.5	0	0	3	6	3	6.6
China	1.40	1.6	1.15	1.6	3	6	3.3	7.3
Egypt	7.64	9	7	10	3.3	6.3	0	0
EU	0.75	0.86	0.67	0.95	0.12	0.23	0.12	0.26
India	20.15	23.5	26	37	6	11	4.6	10
Pakistan	2.62	3	3.3	4.5	2.6	5.2	2.5	5.6
S. Africa	8.41	10	7.4	10	4	7.7	4.3	9.5
Thailand	2.00	2.4	2.1	3	3.8	7.2	3.8	8.5
USA	0.84	1	0.70	1	0.52	1	0.4	1

Pakistan's AD initiation intensity and measure intensity taken are 2.62 and 3.3 respectively. The value of 2.6 means that Pakistan is almost a two and half time more severe user of antidumping as compared to its import share in world trade. The AD intensity index of being investigated for Pakistan is 2.6 and 2.5 in terms of initiation and measures. This shows that Pakistan has not only emerged as an intensive user of AD investigation but it is one of the most severe victims of AD investigation relative to its share of imports and exports in world trade. For this purpose we estimated symmetry ratios.

Table-6 shows the symmetry ratios of AD measures and initiation. We divided the AD intensity index of investigation by the AD intensity index of being investigated which provides a value of the symmetry ratio. The symmetry ratio of Pakistan (1.2) shows that AD measures taken by Pakistan are more than AD measures taken against Pakistan.

Table-6: Symmetry Ratios

Symmetry Ratio: Antidumping Initiation and Definitive Measures, 2000-2005		
Country	**Measure Symmetry**	**Initiation Symmetry**
Argentina	19.9	9.4
Australia	6.7	6.3
Chili	0	0.3
China	0.34	0.4
Egypt	0	2.2
EU	5.5	6
India	5.5	3.3
Pakistan	1.2	0.98
South Africa	1.7	2
Thailand	0.55	0.5
United States	1.55	6

For Pakistan, AD initiation taken and being investigated are almost the same, with a symmetry ratio of 0.98. In this parameter besides India and Argentina, the USA also joins the race of severe investigators compared to being investigated.

Trade Impact of Antidumping

We developed a null hypothesis for total imports that the mean imports after AD is greater than or equal to the mean imports before AD, which means there is an effect of AD duty on imports. Thus the null hypothesis is: The mean of imports after AD duty > mean of imports before antidumping duty.

Table-7: Statistical Results of Trade Impact

Product	Total Import		Named country import		Non-named country import	
	T value	**Probability**	**T value**	**Probability**	**T value**	**probability**
Tinplate	-3.25	0.01129	-3.36	0.0219	2.78	0.016
Sorbitol	-0.674	0.25	-5.1	0.00069	6.87	0.00012
GAA	-4.55	0.003	-7.125	0.00084	-6.045	0.0002
Acrylic	-1.9	0.0470	-1.77	0.0681	-3.48	0.0064
PVC Resin	-1.45	0.099	-1.43	0.066	1.423	0.102
UFMC	-4.15	0.0016	-4.52	0.0016	0.55	0.314

While looking at Table-7, and on the basis of probability and T values, the null hypothesis for all the products (total import) is rejected, except one, i.e. Sorbitol, for which the probability value is highly insignificant. Our alternative hypothesis is that imports after antidumping duties are imposed are less than the imports before antidumping duties. We can conclude from the significant T values and level of probability that trade of investigated products declined significantly in most cases after the imposition of AD duty.

AD duty reduces the import of the investigated product from the named country. Import from non-named countries sometimes occupies the market of named countries after the imposition of AD duty, which is called trade diversion. Therefore, the null hypothesis for non-named countries is the opposite of the null hypothesis for named countries i.e. the sample mean of imports before duty is greater than or equal to the sample mean after duty for non-named countries.

The value of probability in non-named countries shows that imports from non-named countries increased after the imposition of AD duty on the named countries. In two cases, i.e. PVC Resin and UFMC, imports from non-named countries do not increase significantly after the imposition of AD duty on named countries. This shows that trade in these two cases decreased rather than being diverted. The T test and probability value of named countries in Table 7 clearly show that in all cases trade was reduced significantly when AD duty was imposed. This result also verifies that AD duty imposition reduces trade and it is anti-competitive in nature.

IV. Conclusion

The results are consistent with vast body of literature on trade reduction and diversion after the imposition of AD duty. An economic rationale has been followed in half of the cases in imposing AD duty by Pakistan. Despite a small number of cases, Pakistan emerged as one of the most important AD users on the basis of AD use relative to total import share. Resultantly, intensive use of AD reduced trade and increased the trade barriers, which could lead to a reduction in economic gains, but fortunately, trade diversion reduces the chances of trade reduction in Pakistan. This suggests that AD measures simply reduced imports from targeted countries without any substantial effect. The key message that has emerged out of this research is that trade diversion persists in the case of Pakistan. In some cases, trade diversion is substantial and offsets the effect of AD measures on named countries to the benefit of non-named countries.

Evidence presented in this paper indicates that the political economy argument is the strongest one in explaining Pakistan's AD actions. AD actions protect the highly concentrated industries. In recent years, many observers have begun to note the proliferation of AD measures and the possibility that the established users of this trade policy instrument are being retaliated against. But retaliation (strategic trade policy) seems to play no role in the AD cases of Pakistan.

Results also demonstrate that the AD intensity of Pakistan is significantly high as compared to its share in world imports. Intensive AD use can be justified, if it follows an economic rationale, such as: anti-predation, strategic trade policy and political economy arguments.

The most frequently offered justification for AD is the prevention of predation. Pakistan's AD enforcement has clearly not addressed predation issues. This result is the same as has been found for US AD cases (Shin 1998). The procedure which has been followed in this study for the predation test shows that the necessary conditions for predatory pricing exist, because firms have a large market share.

One can conclude that antidumping policies which are designed to ensure fair competition and improve economic efficiency may in fact reduce fair competition in the case of Pakistan.

Appendix-A

The History of AD cases in Pakistan

S.No	1	2	3	4	5	6
H.S Code	7210.1200	2905.4400 &3824.6000	2915.2100	5501.3000	3904.1000	3909.1010
Custom Duty	25%	25%	25%	20%	25%	25%
Product	Tinplate	Sorbitol Oil	GAA	Acrylic Tow	PVC Resin	Urea
Name of Applicant	M/s Siddiq Sons Tinplate (Pvt) Ltd. Karachi	M/s Habib Arkady (Pvt) Ltd, Karachi	M/s Wah Nobel Acetates Ltd	M/s Dewan Salman Fibre Ltd	Engro sahi Ploymers and Chemicals Ltd	Dynea Pakistan Ltd
Date of Initiation	26-02-2002	06-03-2003	03-09-2003	17-03-2004	25-06-2004	12-01-2005
Exporters	Mac Steel	.Roquette Freres, .P.T Sorini Corp	Chan Chun Petrro-Chemical Co. Ltd	Pumice Trading Co East Sea Sail Co. Pouya Tarabar Naviy Azot	LG Internat: Corporation, Iran Petro-chemical	Bluestar Sinochem Yixing
Origin of Export	South Africa	France Indonesia	Taiwan	Uzbekistan	South Korea Iran	China
Dumping Margin	39.32%	96.50% and 22.26% for Franc and Indonesia respectively	13.77%	12.71%	40.18% & 31.06% for Korea and Iran respective:	10%
Imposition Date of Provisional Duty	22-07-2002	19-07-2003	18-06-2004	10-12-2004	24-02-2005	18-07-2005
Provisional Duty at the rate of	23.91%	96.50% on France & 91.12% on Indonesia	13.77%	12.71%	40.18% on Korea and 31.06% on Iran	10%
Imposition Date of Definitive duty	26-11-2002	19-11-2003	18-06-2004	10-12-2004	24-02-2005	18-07-2005
Definitive Duty at the rate of	27.33%	96.50% on France 22.3% on Indonesia	13.77%	12.71%	40.18% on Korea 36.01% on Iran	10%

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An Empirical Investigation of the Relationship between Trade Liberalization and Poverty Reduction: A Case for Pakistan

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Abstract

In this paper, we have addressed a key issue in the current debate on economic development: the effect of trade liberalization on poverty. We investigated the relationship between trade liberalization and poverty levels both in the long run as well as in the short run for Pakistan. To measure trade liberalization, we used standard indices of trade openness, financial openness and public intervention in the country, while the head-count ratio was used for poverty measurement, and GDP per capita controlled for economic growth. Applying the Johansen Co-integration Techniques and Error Correction Method, for long-run and short-run analyses respectively, our findings suggest that trade liberalization has a cumulative effect on poverty reduction in the long-run but not in the short run in Pakistan. Lower poverty is associated with low taxation and high foreign direct investment, while trade openness does not have a significant impact on poverty reduction, particularly in the short run, in Pakistan.

JEL Classification: **F10, F13, I31**

Keywords: **Trade, Liberalization, Poverty**

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Introduction

World trade has been increasing for centuries as explorers have discovered trade routes and the technology of transport has improved [David and Scott, (2005)]. The last two decades of the twentieth century observed a remarkable movement in the pace of openness or globalization. The integration of countries through flows of goods and services, financial assets, technology and cultural interaction has reached unprecedented levels [Stern, (2001)]. Now it is widely accepted that openness is as an important element of good economic policy and trade liberalization is a necessary step in achieving it [Obstfled and Rogoff, (1996); Winters, (2001); and Mackay and Winters, (2004)]. So the world is becoming more integrated, goods and trade in services are crossing borders in line with globalization and regionalization processes. Trade liberalization is generally an ally in the fight against poverty: it tends to increase incomes, provide more resources to tackle the problem of poverty and while it will generally affect income distribution, it does not do so in a systematically adverse way[26] [Winters, (2001); and David and Scott, 2005)].

Economic theory gives many reasons for trade liberalization to enhance economic growth [Winters, (2002); Stern, (2001); Berg and Krueger, (2003); Mackay and Winters, (2004)]. By allowing easier imports of capital goods, greater allocative efficiency, technological and knowledge spillovers as well as increased competition, trade can enhance growth and also lead to the availability of a greater variety of goods to consumers at cheaper prices. The rewards from exploiting globalization can be substantial, since openness to international trade and investment facilitates the acquisition of inputs and technologies which strengthen growth and increase efficiency. Access to wider markets and more diverse exports reduces the risks of trade volatility and exclusion by particular country markets. Openness to the free flow of capital helps to attract FDI, which can stimulate domestic investment, thus contributing to employment generation and economic growth. Financial openness also helps to increase the depth and breadth of domestic financial markets, leading to increased efficiency in financial markets through lower costs and improved resource allocation, if financial markets are well developed [Obstfled and Rogoff, (1996); and Sharer *et al*, (1998)][27].

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[26] Most trade liberalization will hurt some one, and that some reforms may increase overall poverty even while they boost incomes in total (Winters, 2003).

[27] Countries benefit from opening markets in many ways, one is technological: foreign direct investment which brings innovations in product, processes, and organizational technologies, while importation of goods bring embedded technologies and access-lower

The debate about the impact of globalization on the well-being of people has generated a substantial literature. It is important to realize that the impact of trade liberalization on poverty is important because of the vulnerability of the poor in developing countries. It is widely argued by many commentators that in the short run, trade liberalization harms poor actors in the economy and even in the long run, successful open regimes may leave some people below the poverty line [Winters, (2002b) and Mackay and Winters, (2004)].

Recent work on this issue has concluded that the process of trade liberalization in Pakistan does not appear to have had a significant adverse impact on poverty, but these findings are not robust because the results are based on a single equation estimated by OLS (ordinary least square[28]. So the main purpose of this effort is to find the impact of trade liberalization on poverty reduction by applying the Johansen Co-integration Approach for the long-run and the Standard Error Correction Method (ECM) for the short-run. The literature on trade liberalization emphasizes the elimination of distortions leading to both gains from trade and an increase in domestic economic activities leads[29]. To the extent the poor are also beneficiaries of these outcomes, poverty is expected to decline. This paper examines the impact of trade liberalization on poverty levels in the long-run as well as in the short run. The organization of the paper is as follows: Section II is a brief review of the literature, Section III explains the model and data collection procedure, Section IV describes the methodology and Section V presents the empirical results. Finally, Section VI gives the conclusions and policy recommendations.

II. Literature Review

Over the 1990s, the conviction that 'openness is good for growth' was fostered by several highly visible and well promoted cross country

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cost production inputs and consumer goods. Another benefit is grater efficiency; competition from abroad spurs domestic industry to improve productivity, promote growth and increase employment in the medium term.

[28] They used IEL (Index of Economic Liberalization) as a proxy to measure openness which as a composite of four different outcome measures suffers from weakness inherent any aggregation scheme (SPDC's Annual Report, 2006).

[29] Trade liberalization also leads to reduction in monopoly rents and the value of connections to bureaucratic and political power. In developing countries, it may be expected to increase the relative wages of lower-skilled workers (Berg and Krueger, 2003).

studies [see Dollar (1992); Sachs and Warner (1995); Edwards (1998)][30]. In the medium term, reaping static benefits of trade could look rather like growth. In the long run, potential positive forces include access to technology and appropriate intermediate and capital goods, the benefits of scale and competition, the flexibility induced by relying on market signals, and the constraint on government incompetence or corruption[31] [Grossman and Helpman (1991); and Lucas, (1989)]. Unfortunately, none of the benefits is guaranteed and it is not difficult to construct a model in which openness pushes countries into less dynamic sectors e.g. primary extraction and harms growth [Rodriguez and Rodrik, (2001)]. The traditional theory of trade explained by Stolper-Samulson predicts that a rise in the relative price of a commodity leads to a rise in the real return to factors used intensively in producing that commodity [Dixit and Norman, (1980)][32].

Further, liberal trade is usually one of several indicators of openness used, and one which often seems to weigh rather significantly in overall results [Harrison, (1996)]. An alternative approach is to specify the links between openness and growth and examine them separately. Some studies associated openness strongly with greater wealth accumulation [Levine and Renelt (1992); and Tylor (1998)] and stronger growth, especially over relatively short periods. Tilat (2002) found that openness has no robust link with long term growth and suggested that short-run effects out-weigh the perceived benefits of globalization, which means an increase in poverty and a lower economic growth rate. To investigate the relationships between trade openness, growth and poverty one must first consider the effects on

[30] Recently, they have been subjected to criticism and re-working by Rodriguez and Rodrik (2001), who argued that their conclusions rest on very weak empirical functions such as flawed measures of openness and serious econometric shortcomings.

[31] Wei (2000), on the other hand, suggests that losses from corruption increase with openness, because corruption impinges disproportionally on foreign transactions, and as a result open economies have greater incentives to develop institutions.

[32] Thus for a developing country with a highly protected production structure, liberalization will result a rise in the relative price of unskilled labor-intensive products (since skilled-labor or capital intensive imports become relatively less expensive when trade barriers are removed). As the market for labor-intensive products expands, so demand for unskilled labor will rise leading to higher returns to unskilled labor generally. The Stolper-Samulson theorem with the poor being equated with unskilled labor is preferred by many economists for trade. But for a variety of reasons spelt out in Winters(2000a), this approach is not equated and it is concluded that effects of trade reforms on income distribution will not generally be predictable. So the S-S theorem refers to change in the functional distribution of income, which is not necessarily related to household income changes (Geoffrey and Thugge, 2001). Because in many countries the poor are not just connected to labor markets for which it is possible to do Stolper-Samulson exercises and those labor markets do not display the required inelasticity of supply (Winters, 2002).

total factor productivity [Winters, (2003)]. For sustained economic growth and development, improved productivity is necessary by universal agreement. It may not be sufficient and, because of its distributional implications, its beneficial effects on poverty could be less that those of growth emanating from other sources. For example, if higher productivity reflected declining inputs rather than increasing outputs, its short-run effects could be to reduce employment and exacerbate poverty.

Moreover, despite the strong presumption in modern growth theory, with its inferences to increased competition, access to new technologies, better intermediate goods and so on, the response of productivity to openness is ultimately ambiguous. A sceptical view of the early literature on this link is Pack (1988). An influential study by Coe, Helpman and Hoffmaister (1997), constructed an index of the total knowledge capital (measured by accumulated investment in R&D) in each industrial country. Using an import-weighted sum of industrial countries knowledge stocks to reflect developing countries access to foreign knowledge, they find that, interacted with importing countries openness, the latter has a significant positive effect on total factor productivity. Lumenga-Neso Ollarreaga and Schiff (2001), advance the theory that indirect knowledge flows offer a better explanation of TFP. Many studies show that reduction in trade barriers were followed by significant increases in TFP, generally because of increased import competition [Ferreira and Rosi (2001) in Brazil; Jonsson and Subramanian[33] (2001) for South Africa; Lee (1996) for Korea and Fatima *et al* (2003) for Pakistan]. While Begstien *et al* (2000) find a positive stimulus from exports to productivity in Africa, Karry (1997) obtain ambiguous results for China, while Aw, Chung and Roberts (1999) find little evidence for it in Latin America and Asia respectively. Historically, there has been significant debate about whether agricultural improvements are good for the poor, but recently the tendency has been on the optimistic side [see, for example, Datt and Ravallion (1998)].

Overall empirical evidence suggests that trade liberalization has a strong influence on productivity and its rate of change (Fatima *et al*, 2003). In many cases, the latter will be immediately and directly poverty-alleviating and in the long-run, they are a necessary part of any viable poverty reduction strategy. Also it is not difficult to imagine adverse short-run implications for jobs and poverty. Trade liberalization is usually associated with higher flows of foreign direct investment with attendant spillovers of technologies, new business practices and other effects in

[33] Johansson and Subramanian also conducted a time series exercise which links TFP positively to the openness ratio-exports+ imports/GDP.

domestic firms that increase the overall level of productivity and growth and also alleviate poverty levels [Hay (2001); Ferreira and Rosi (2001)]. A very important concern about openness is that it will reduce government revenues. The share of trade taxes in total revenue is negatively associated with the level of economic development, with many low-income countries earning half or more of their revenues from trade taxes[34]. Neither theory nor evidence suggests a simple link between trade liberalization and revenues, however in theory, a number of factors are important (Greenway and Milner, 1991). In the case of tariffs, revenues will increase with liberalization if the initial tariff level exceeds its revenue maximizing level[35]. Falvey (1994) explains that a Welfare Improving Revenue Enhancing (WIRE) tariff will always exist unless the compensated radial elasticities of all goods are the same. However, designing such as package is well beyond most governments' capabilities, especially since long and short-run responses may differ (e.g. Baven 2000). The alternative response to a fall in revenues is to cut public expenditures. There is a vast literature describing the effects of structural adjustment in developing countries on poverty and the impact felt through public expenditures and social sector expenditures in particular[36]. But evidence from adjustment resulting in cuts in social expenditures is mixed at best (Van der Gaag, 1991). Van der Gaag examines spending in the three years before and after donor financed adjustment programs began, and find, no pattern of increase or decrease in real total levels and social sector expenditures. Similarly, Sahn *et al* (1997) argued that, except in a few cases, those declines in social expenditures that have occurred have not been "part of the extended attempt to balance the government's fiscal position."

III. Model and Data

The model under consideration envisages an inverse relationship between openness and poverty levels, therefore various indices on openness are taken as independent variables (FDI, TRADE and Tax) while GDP per

[34] This reliance may reflect various factors, including difficulties in administering a tax system effectively and the relatively small share of the formal sector (Ebrill, Stotsky and Gropp, 1999).

[35] The revenue maximizing tariff will be $t = (\varepsilon_s - \varepsilon_d)/-\varepsilon_s(1+\varepsilon_d)$ where t is the ad valorem tariff rate, ε_s is the elasticity of import supply and ε_d is the elasticity of import demand (Ebrill, Stotsky and Gropp, 1999)

[36] Kellick (1995) provides an excellent brief review of the findings of such work; White (1997) provides comprehensive review of literature, while Squire (1991) and Van der Hoeven (1996) provide reviews of linkage between adjustment and poverty in the 1980s.

capita is included as a control variable for the basic specification of the model below;

$$Pov = \beta_{\circ} + \beta_1 FDI + \beta_2 TAX + \beta_3 TRADE + \beta_4 GDP_{PC} + \nu_t \qquad (1)$$

Where the dependent variable is the poverty index[37] (Head-Count). Amjad and Kemal (1997) explained poverty trends in Pakistan with the help of macroeconomic determinants. Using simple econometric techniques Akhter and Ahmad (1999) extended the work of Amjad and Kemal (1997) conceptually and explained poverty trends in the country. For the estimation of time series data, a simple interpolation technique is applied to take the decline or growth in trend between two points in time and fill the data gaps between successive observations (Jamal, 2004). Moreover, for international economic institutions such as the World Bank and government development agencies such as DFID, which are concerned with poverty in developing as well as in developed countries, the absolute measure is more appropriate than relative ones.

An indicator that has received only scant attention from economic theorists is the degree of openness [Harrison, (1996)]. For trade openness of an economy, we use (Import + Export) as share of GDP[38]. Foreign Direct Investment (FDI) is a proxy of financial openness which measures the medium and long-term ability of a country to attract investment from abroad[39] because FDI is an important source of capital, complements domestic private investment, is usually associated with new job creation and enhancement of technology transfer and boosts overall economic growth in host countries[40]. Globalization is not solely openness to international trade, although this is probably its most important feature.

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[37] Malik (1988) first generated five poverty observations during the period of 1963-64 to 1984-85 on the basis of household surveys using consistent indices to compute poverty lines for these particular years (defining the poverty line based on caloric requirement of 2250 plus basic needs of a person).

[38] The relevant question in the case of this indicator is not only what a country exports but also how it exports and imports in relation to its GDP.

[39] The most sceptical view of the openness process blames the liberalization of global financial markets for their allegedly negative effects in terms of increase in financial speculation, unemployment and poverty. For example, studies collected by Cornia and Lipumba (1999), show that, in the case of Africa, liberalization of financial markets has attracted large short-run speculative in flows which included large saving in nominal and real exchange rates. A major result of such speculative movements is a lack of adequate incentives to potential private investors in the tradable sector.

[40] For a comprehensive survey of the nexus between FDI and growth as well as for further evidence on the FDI-growth relationship see Mody and Murshid (2002). See Chakrabarti (2001) on the determinants of FDI.

The liberalization of financial markets has brought about a huge increase in capital inflows, particularly in the form of foreign direct investment. So FDI can be used to interpret financial openness (Figini *et al*, 2004)[41]. Tax revenue changes might have different impacts on poverty according to how progressiveness is modified and whether or not these changes take place in the framework of macroeconomic stabilization policies. To control for the latter, it is important to deal with the complementary measures that may have been implemented to tackle both macroeconomic instability and adverse effects of adjustments and stabilization programmes. Tax revenue is used as a proxy for the 'role of the state'. The data has been taken from the IFS (International Financial Statistics), WDI (World Development Indicators) and *Economic Survey of Pakistan* (various issues), for the period 1973-2003.

IV. Methodology

When testing time-series properties and co-integration evidence, the preliminary step in that analysis is concerned with establishing the degree of integration of each variable. The distinction between whether the levels of differences of a series is stationary leads to substantially different conclusions and hence, tests of non-stationarity[42] (that is unit roots) are the usual practice today. Engle-Granger (1987), define a non-stationary time series to integrated of order 'd' if it becomes stationary after being differentiated 'd' time. This notion is normally denoted by I(d).

The test for co-integration proceeds in two steps: first, the individual series are tested for a common order of integration. If the series are integrated and are of the same order, it would imply co-integration. Using the Augmented Dickey Fuller (ADF) test, the stationarity of the series is tested. The ADF test is a standard unit root test; it analyzes the order of integration of the data series. These statistics are calculated with a constant and a constant plus time trend and these tests have a null hypothesis of non-stationarity against an alternative of stationarity. The

[41] We also know that this measure does not fully account for both levels of financial openness: capital account liberalization and national treatment of foreign banks and other operations of entering in the local markets.

[42] Stationarity tests are of particular importance for at least two reasons: (i) the statistical theory underlying time-series analysis relies on the assumption of co-variance stationarity, an assumption that is, more of less than not, found to be violated in many economic time series; and (ii) failure to account for stochastic trends in the data series means mis-specifying the model. Clearly this can seriously affect statistical inferences and hypothesis tests.

ADF test to check the stationarity series is based on the equation of the form given below:

$$\Delta y_t = \beta_1 + \beta_2 t + \delta y_{t-1} + \alpha_i \sum_{t=1}^{m} \Delta y_{t-1} + \varepsilon_t \qquad (2)$$

Where ε_t is a pure white noise error term and

$$\Delta y_{t-1} = (y_{t-1} - y_{t-2}),\ \Delta y_{t-2} = (y_{t-2} - y_{t-3}),\quad \text{etc.}$$

These tests determine whether the estimates of δ are equal to zero. Fuller (1976) provided a cumulative distribution of the ADF statistics; if the calculated-ratio (value) of the coefficient δ is less than τ the critical value from the Fuller table, then Y is said to be stationary[43].

Consider for example two series X_t and Y_t both integrated of order (d). Engle and Granger have described that their linear combination will in general also be I(d).

It is an empirical fact that many macro economic variables appear to be integrated of order (d) [or I(d) in the terminology of Engle and Granger (1987)] so that their changes are stationary. Hence, if POV, TAX, FDI, TRADE and GDP per capita are each I(d), then it may be true that any linear combination of these variables will also be I(d). Having established that all of these variables are I(d), this study then proceeds to determine the order of integration of series for the analysis of long-run relationships between POV, TAX, FDI,TRADE and GDP per capita. For the purpose of examining the long-run relationship among the variables, they must be co-integrated. Two or more variables are said to be co-integrated if their linear combination is integrated to any order less than 'd'. The co-integration test provides the basis for tracing the long-run relationship. Two tests for co- integration have been given in the literature [Engle and Granger (1987) and Johansen and Juselius (1990)]. In the multivariate case, if the I(1) variables are linked by more than one co-integrating vector, the Engle–Granger procedure is not applicable. The test for co-integration used here is the likelihood ratio put forward by Johanseen and Juselius (1990), indicating that the maximum likelihood method is more appropriate in a multivariate system. Therefore, this study has used this method to identify the number of co-integrated vectors in the model. The Johansen and Juselius method has been developed in part

[43] 't' ratio of coefficient δ always has a negative sing.

by the literature available in the field and reduced rank regression, and the co-integrating vector 'r' is defined by Johansen as the maximum Eigen-value and trace test or statics. There are 'r' or more co-integrating vectors. Johansen (1988) and Johansen and Juselius (1990) proposed that the multivariate co-integration methodology could be defined as:

$$S_t = (\text{POV, FDI, TAX, TRADE and } GDP_{PC}) \quad (3)$$

which is a vector of $P = 5$ elements. Considering the following autoregressive representation:

$$S_t = \pi_\circ + \sum_{T=1}^{K} \pi_i S_{t-1} + \mu_t$$

Johansen's method involves the estimation of the above equation by the maximum likelihood technique, and testing the hypothesis H_o; $(\pi = \Psi\xi)$ of "r" co-integrating relationships, where r is the rank or the matrix $\pi(0 \angle r \angle \mathrm{P}), \Psi$ is the matrix of weights with which the variable enter co-integrating relationships and ξ is the matrix of co-integrating vectors. The null hypothesis of non-cointegration among variables is rejected when the estimated likelihood test statistic $\phi_i \{= -n \sum_{t=r+1}^{p} \ln(1 - \hat{\lambda}_i\}$ exceeds its critical value. Given estimates of the eigen-value $(\hat{\lambda}_i)$ the eigen-vector (ξ_i) and the weights (Ψ_i), we can find out whether or not the variables in the vector (S_t) are co-integrated in one or more long-run relationships among (POV, FDI, TAX, TRADE and GDP per capita). Having established the relationship among the variables, the question that remains is if in the short run there is disequilibrium or not. To find the effect of short-run changes of (FDI, TRADE, TAX and GDP per capita) on poverty, we used the following specification:

$$\Delta P = \gamma + \alpha\eta_{t-i} + \sum_{i=1}^{p} \beta_P \Delta P_{t-i} + \sum_{i=1}^{p} \beta_{TRADE} \Delta TRADE_{t-i} + \sum_{i=1}^{p} \beta_{FDI} \Delta FDI_{t-i}$$
$$+ \sum_{i=1}^{p} \beta_{TAX} \Delta TAX_{t-i} + \sum_{i=1}^{p} \beta_{GDPPC} \Delta GDPPC_{t-i} + \nu_t$$

Where ν_t is the error term and α is short run speed of adjustment,

Johansen and Juselius (1990) provide critical values for the two statistics. The statistical distribution depends on the number of non-stationary components in the model. To determine the non-stationary components, it is necessary to choose the lag length for the VAR portion of the model. To overcome this problem, this work determines the optimal lag length using Akaike's Information Criterion (AIC) and Schwartz Bayesian Criterion (SBC)[44]. The lowest values of AIC and SBC are used to select the lags and give the most desirable results.

V. Empirical Analysis

Since the present study is an initial attempt to identify the links between the evolution of poverty and trade liberalization (the phenomenon related to openness) in the case of Pakistan, we empirically estimated whether a statistically significant relationship exists between some measures of trade liberalization and poverty levels in the long-run as well as in the short-run. The preliminary step in this analysis is concerned with establishing the degree of integration of each variable. For this purpose, to get reliable results of equation 1, the implicit assumption is that variables in equation 1 are I(1) and co-integrated. We apply the test for the existence of a unit root in the level and first difference of each of the variables in our sample using the Augmented Dickey Fuller (ADF) test. ADF test statistics check the stationarity of series. The results presented in Table-1 reveal that all other variables are non-stationary in their level data. However, stationarity is found in the first differencing level of the variables Poverty, Foreign Direct Investment, Tax Revenue as share of GDP, Trade and GDP per capita.

[44] The distribution of the test statistic is sensitive to the order of lag used. If the lag order is used less than the true lag, then the regression estimates will be biased and the residual terms will be serially correlated. If the order of lag used exceeds the true order, the power of the test is to be reduced.

Table-1: Unit Root Estimation

	Level		1st Difference	
Variables	**Constant**	**Constant and Trend**	**Constant and Trend**	**Constant and Trend**
Poverty	-3.08	3.98**	3.98**	-5.59*
Trade	-2.35	-2.77	-2.77	-4.50*
Foreign Direct Investment	-1.80	-2.59	-2.59	-5.11*
Tax Revenue as share of GDP	-2.16	-1.85	-1.85	-4.76*
GDP per capita	0.29	-2.51	-2.51	-5.35*

Note: * significant at 1%

** Due to some problems in the data for poverty, the variable is stationary with a constant at lag (0) while with constant and trend becomes non-stationary so this variable is also stationary at 1st difference with lag (1).

Table-2

Orders of Lags	Akaike's Information Criteria	Schwartz Bayesian Criteria	Log Likelihood
1	5.3479	6.7491	-50.2187
2	-0.1216.11	2.4715	56.76332

Chow Break test (F statistic = 62.5824[45])

[45] F-value shows that we reject Null Hypothesis, indicating a structural change in the economy started in 1990s, especially the reforms in the financial sector and other sectors under SAP (Structural Adjustment Program approved by IMF to be implemented in Pakistan).

Table-3: Johansen-Juselius First Information Maximum Likelihood Test for Co-integration

Null-Hypothesis	Trace-Test values	5 Percent Critical Value	1 Percent Critical Value	Null-Hypothesis	Maximum Eigen values	5 Percent Critical Value	1 Percent Critical Value
$R = 0$	197.70*	87.31	96.58	$R = 0$	90.85*	37.52	42.36
$R \leq 1$	106.85*	62.99	70.05	$R = 1$	58.98*	31.46	36.65
$R \leq 2$	47.86**	42.44	48.45	$R = 2$	27.15**	25.54	30.34
$R \leq 3$	20.71	25.32	30.45	$R = 3$	13.87	18.96	23.65
$R \leq 4$	6.84	12.25	16.26	$R = 4$	6.84	12.25	16.26

Note: *(**) represent significant at 1% (5%), Johansen Co-integration test provides three Co-integrating equations at 1% and 5% significant levels.

After establishing that all the individual series under consideration are stationary, the traditional co-integration method is used to estimate the long-run relationship among the variables, particularly poverty, foreign direct investment, tax revenue as share of GDP trade, and GDP per capita. As mentioned above, Johansen's maximum likelihood approach is being applied for the co-integration test[46].

The results from the Johansen Co-integration analysis are summarized in Table-3, where both the maximum eigen value and trace-test value examine the null hypothesis of no co-integration against the alternative of co-integration. Starting with the null hypothesis of no co-integration ($R = 0$) among the variables, the trace-test statistics is 197.7, which is above the 1% and 5% critical values 96.58 and 87.31 respectively. Hence it rejects the null hypothesis $R \leq 0$ in favor of the general alternative $R = 1$. As is evident in Table-3, the null hypothesis of $R \leq 1$ can be rejected at the 1% level of significance, hence its alternative of $R = 2$ is accepted. Consequently, we conclude that there are three co-integrating relationships among poverty, foreign direct investment, tax revenue as share of GDP, trade as share of GDP and GDP per capita. Turning to the maximum eigen value test, the null hypothesis of no co-integration ($R = 0$) is rejected at the 1% level of significance in favor of the alternative, that is one co-integrating vector, $R = 1$. The test also rejected the null hypothesis of $R = 1$ in favor of the alternative $R = 2$. This is the confirmed conclusion overall that there are three co-integrating relationship amongst the five I(1) variables. Therefore,

[46] Optimal lag length is (2) selected using Akakie's information criterion (AIC) and Schwartz criterion (SIC) as shown in Table-2.

analysis of annual data from 1973 to 2003 appears to support the proposition that there exists a stable long-run relationship among foreign direct investment, tax revenue as share of GDP, trade as share of GDP, poverty, and GDP per capita in Pakistan. Once co-integration is established, then an Error Correction Method (ECM) can be estimated to determine the short-run behavior of trade liberalization (foreign direct investment, tax revenue as share of GDP, trade as share of GDP) and GDP per capita on the poverty rate. Results of the ECM are presented in Table-4.

Table-4: Short-Run Error Correction Model: Dependant variable = Poverty Index (Head-count Ratio)

Variables	Coefficients	t-Statistics
C	0.0045	10.40
DLPOV(-1)	1.0307	132.22*
DFDI(-1)	-0.0030	-1.46**
DTAX(-1)	0.0013	2.92*
DTRADE(-1)	0.00014	0.79
DGDPPC(-1)	-4.67E-05	-0.55
CE(-1)	-0.0176	-5.80*
R-squared = 0.99888	Adjusted- R squared = 0.99857	
ARCH LM Test		F = 2.373
Normality: Skewness and Kurtosis	JB Statistic = 1.4	

Note: *(**) represents the coefficients are statistically significant at 1% (and 10%) levels. Ramsey's test is for functional from Mis-specification and Jarque-Bara test for non-normality of errors.

Table-4 reports the results of the ECM (Error Correction Model) formulation of equation 4. According to Engle-Granger (1987), co-integrated variables must have an ECM representation. The ECM strategy provides an answer to the problem of spurious correlation, the short run dynamic relationship between trade liberalization and the poverty rate estimated from the ECM formulation. The long run dynamics appear in the set of regressors. Technically, ECM (Error Correction Term) measures the speed of adjustment back to co-integrated relationships. The ECM is posited to be a force returning the integrated variables to their long-run relation when they deviate from it and thus the longer the deviation, the greater would be the force tending to correct the deviation [Banerjee, *et al*, (1994)]. The coefficients of lagged values of ΔP , ΔFDI , ΔTAX , $\Delta TRADE$ and ΔGDP_{PC} are short run

parameters measuring the immediate impact of the independent variables on ΔP. In equation 4, the coefficients of lagged values of $\Delta TRADE$ and ΔGDP_{PC} are statistically insignificant showing no impact on the poverty rate in the short run. The coefficients of lagged values of ΔFDI and ΔTAX are statistically significant, indicating the immediate impacts on the poverty rate in short-run dynamics. Whereas the value of CE_{t-1} (Error Correction Term of the equation) is statistically significant at 1% suggesting powerful long run corrections in the model each year. Overall, our results support the hypothesis that trade liberalization alleviates poverty mostly in the long run. The short-run diagnostic test shows non-normality of errors, while the ARCH test shows no second order serial correlation in the short-run model.

Table-4 also shows that FDI has a negative sign with a statistically significant value i.e. FDI is associated with lower levels of poverty while the TAX (role of government or public intervention) variable has a positive and significant value which means that a tax increase is linked with a higher incidence of poverty in the long run as well as in the short run. FDI and TAX can be regarded as an argument in support of openness. The variable GDP_{PC} is included in the model as a control variable for the level of development in the country, which is negatively linked to poverty but not significant in the short run, which emphasizes that economic growth is not pro-poor.

While the variable TRADE[47] has a positive sign, it is not statistically significant in the short run which does not support the openness theory. This may be the result of the fact that our exports are cotton based and mainly depend on the climate. Therefore, increases in export prices in international markets do not have a significant impact on the incomes of peasants because of disguised unemployment and underemployment in the agricultural sector, a major contributor to GDP, and secondly, because of the unequal distribution of land holdings. Benefits are reaped by big landowners due to an increase in the price of cotton in national and international markets and the peasants remain poor, thus contributing to rural poverty.

VI: Conclusions and Policy Recommendations

In the present study we have focused on a key issue in the current debate on economic development: the effect of trade liberalization on poverty levels in the case of Pakistan. We empirically tested the relationship between trade liberalization and poverty levels both in the long run as well

[47] See Social Poverty and Development Center's Annual Report (2006).

as in the short run. To measure trade liberalization, we used standard indices of trade openness, financial openness and public intervention in the country, while head-count ratios were used for poverty measurement and GDP per capita was controlled for economic growth.

Our results imply that trade liberalization reduces poverty levels in the long run, while in the short run financial openness lowers poverty and the size of government (or public intervention) is associated with higher poverty levels, supporting the argument of openness. Neither trade openness nor GDP per capita has a significant relation with poverty in the short run. To achieve the major objective of reducing poverty, the government needs to design and implement an active development strategy not only to benefit from openness, but also to help counteract the negative effects of openness. Openness should not be viewed as a reliable substitute for a domestic development strategy but should be accompanied by improved trade-related infrastructure [Dollar and Kraay, (2001)]. Instead, the government needs to pursue more active trade liberalization and active domestic development policies which may benefit more poor people in the country. The government should focus on promoting foreign direct investment, which will be a complementary requirement for trade liberalization to be successful for the promotion of exports.

There is also a need to enhance the tax revenues of the state through better collection of revenues, and administrative reforms rather than expenditure cut backs, which can reduce the effectiveness of the public sector. The government needs to adopt a new approach of allocation of funds to social sectors so as to bring the issue of poverty reduction to the central stage of economic policy making. There is also the need for a realistic assessment of poverty for an effective poverty reduction strategy. More reforms in the banking sector are needed to enable the poor to get access to easy credit because the poor have small/few assets and are unable to meet their consumption needs during even short spells of unemployment. Thus, short run adjustment will not only increase poverty but also raise the intensity and severity of poverty among the poor. Trade policy reforms have the potential for improving growth and development and thus alleviating poverty in Pakistan with the adoption of some new distribution measures. Potential gains from trade liberalization are not automatic or guaranteed and trade reform policies do not alone reduce poverty. It is necessary to formulate macroeconomic policies, including trade reform policies, and introduce complementary options to create a paradigm shift in the right direction to empower more people with opportunities to eradicate poverty. Trade reforms must be pro-poor and geared to help the poorest of the poor.

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Testing for Market Efficiency in Emerging Markets: A Case Study of the Karachi Stock Market

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Abstract

This paper investigates the efficiency of the Karachi stock exchange (KSE) with corrections for thin trading and non-linearity as suggested by Miller, Muthuswamy and Whaley (1994). Daily, weekly, and monthly data on stock prices from December 1991 to May 2003 have been used, with three non-overlapping periods (December 1991 to May 1998; May 1998 to September 2001; and September 2001 to May 2003) and one combined period (May 1998 to May 2003). The results indicate that the Karachi Stock Market is efficient for the overall period, the three sub-periods, and the combined period in linear and non-linear behavior after making adjustments for thin trading. The same result is observed when the efficiency test is conducted on weekly and monthly data after adjusting for thin trading during the overall study period.

1. Introduction

The globalization of financial markets has increased the interest of investors in emerging markets. Many studies have commented on the predictability of returns in emerging markets e.g. (Urrutia, 1995; Ojah and Karemera, 1999; and Grieb and Reyes, 1999). However, different conclusions are drawn on market efficiency and the random walk hypothesis in these studies. Urrutia (1995) rejects the random walk hypothesis; however, he advocates for weak form efficiency. Ojah and Karemera (1999) indicated that equity returns in these markets follow a random walk. Branes (1986), Butler and Malaikah (1992), El-Erian and Kumar (1995) and Anotoniou and Ergul (1997) found inefficient behavior in the stock markets of Kuala Lumpur, Saudi Arabia, Turkey, Jordan, and Istanbul respectively. On the other hand, Butler and Malaikah (1992), Panas (1990) and Dickinson

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and Muragu (1994) found efficient stock markets in several emerging markets (Kuwait, Greece and Nairobi). Furthermore, investors in emerging markets are mostly concerned with losses as compared to gains, which leads to risk neutral behavior (Benartzi and Thaler 1995). Investors believe in their own forecasting, which leads to bias in prediction (Dabbs, Smith, and Procato, 1990). Investors are also less informed, which affects on trading behavior (Schatzberg and Reiber, 1992).

Infrequent trading behaviour, observed in most emerging markets, has two forms. Firstly, there is non-synchronous trading in which stocks trade every consecutive interval, but not necessarily at the close of each interval [Scholes (1976), Scholes and Williams (1977) and Muthuswamy (1990)]. The other form is infrequent trading in which stocks are not traded in every consecutive interval. Fisher (1996), Dimson (1979), Cohen, Maier, Schwartz, and Whitcomb, (1978), Cohen (1978, 1979) Lo and Mackinlay (1990), and Stoll and Whaley (1990b) focus on this infrequent trading. The key to distinguish between non-synchronous trading and infrequent trading is the interval over which price changes or returns are computed. In the literature it is observed that due to the problem of infrequent trading, the true prices may be contaminated as pointed out by Roll (1984) and developed by Stoll and Whaley (1990). They demonstrated that random bouncing of transaction prices between bid and ask, induces negative first-order autocorrelation in observed price changes even though price innovations are serially independent.

A number of studies have suggested ways to correct for infrequent trading. Stoll and Whaley (1990) suggested the residuals from an ARMA (p,q) regressions as a proxy for the true index. Bassett, France and Pliska (1991) used the Kalman filter to estimate a distribution of the true index. Miller, Muthuswamy and Whaley (1994) proposed to remove the effects of thin trading by using moving averages, which reflects the number of non-trading days, and then returns are adjusted accordingly. Butler and Malaikah (1992) ran tests to evaluate the weak form efficiency of the stock markets in Saudi Arabia and Kuwait. Al-Loughani (1995) suggested statistical techniques for the Kuwaiti market index and concluded that the series exhibited stationarity but did not conform to the random walk model. Most of these studies have attempted to correct for the problems associated with infrequent trading.

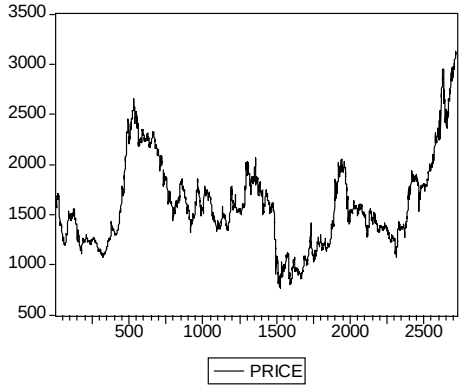
The Karachi stock market is one of the leading emerging markets. There are 659 companies listed in the Karachi stock exchange (KSE) with a total market capitalization of about $ 34.7 million, amounting to 25

percent of the GDP in Pakistan.[48] This feature of the KSE indicates a shallow market with high turnover, common features amongst emerging stock markets. The reasons for the shallowness of the market and high levels of turnover in emerging markets are poor information, insider trading, liquidity, and market manipulation. In general, the KSE has demonstrated significant fluctuations since reforms during 1990s (see figure 1). Only a few studies have looked at the behavior of the Karachi stock market. Hussain (1997) investigated the validity of the random walk model in the Pakistani equity market using daily data from January 1989 to December 1993. He found the presence of strong serial dependence in stock returns and suggested that the random walk model was not appropriate to describe stock returns behavior in the Pakistani equity market. However, his study did not take into consideration the special characteristics of the Karachi stock market as an emerging market. Nishat (1999, 2001) also pointed out the ARCH effect and non-synchronous effect in the Karachi stock market (also see Pakistan Economic Survey, 2005-6 pp. 108, which indicates that 62.4% trading volume are shared by 10 big companies listed with KSE). Moreover, researchers (Nishat, 1999; Nishat, 2000; Nishat and Mustafa, 2007) have identified a change in the behaviour of stock prices and a shift in the pattern of observed anomalies after the financial reforms of 1990s. These financial reforms provided depth and breadth in the Karachi stock market and a more competitive environment for investors in Pakistan (Nishat, 2001).

The aim of this study is to investigate the validity of the random walk model for the Karachi stock market taking into consideration the characteristics of emerging markets for the period December 1991 to May 2003. These characteristics are thin trading and non-linearity in the behavior of the stock market. The KSE has also been influenced by events such as sanctions on the Pakistani economy after the nuclear tests in May 1998 and 9/11, leading to a change in the price process of the stock market. The study also compares random walk model before and after nuclear tests (May 1998) and 9/11 (September 2001). The rest of the paper is organized as follows: The second section describes the econometric methodology and related issues followed by data in section three. The empirical findings and interpretation are presented in section four. Section five provides the concluding remarks.

[48] In developed markets, the market capitalization ratio to GDP is large and turnover is small. The Pakistan stock market stands in contrast to developed markets like the US, where the market capitalization to GDP ratio is 92 percent and turnover is 65 percent.

Figure-1



2. Econometric Methodology

To test for efficiency in the Karachi stock market, we use the methodology proposed by Miller, Muthuswamy and Whaley (1994) to check the efficiency of the stock market taking into consideration thin trading, non-linearity, and structural changes. Returns are calculated by the difference of two successive log daily price of the KSE-100 index:

$$R_t = \ln P_t - \ln P_{t-1} \qquad (1)$$

where P_t is the current KSE-100 index and P_{t-1} is the previous day's KSE-100 index.

Because thin trading, possibility of non-linearity, and structural changes are considered, making it difficult to identify the number of trading days, Miller (1990) has shown that it is equivalent to estimating an AR(1) model from which the non-trading adjustment can be obtained. The following equation is estimated:

$$R_t = \alpha_0 + \alpha_1 R_{t-1} + \varepsilon_t \qquad (2)$$

The regression of R_t on R_{t-1} shows the negative first order autocorrelation. In this situation, we expect that there is infrequent trading. This is dealt with by taking the residual from the regression to generate the innovations in the KSE-100 level. The returns are adjusted by using following equation suggested by Miller, Muthuswamy and Whaley (1994):

$$R_t^{adj} = \frac{\varepsilon_t}{1-\alpha_1} \tag{3}$$

where ε_t is the adjustment factor and R_t^{adj} is the adjusted return.

This adjustment reduces the negative correlations among the returns with the assumption that the non-trading adjustment is constant over time. However, this assumption is correct only for highly liquid markets, not for emerging markets. To correct for thin trading, we must estimate equation (3) recursively. In testing for efficiency, equation (2) is estimated using corrected returns calculated from equation (3). Moreover, efficiency will be examined using linear and non-linear models to see if the results of the two models are different. For this purpose the following equation is estimated:

$$R_t = \alpha_0 + \alpha_1 R_{t-1} + \alpha_2 R_{t-1}^2 + \alpha_3 R_{t-1}^3 + v_t \tag{4}$$

In the case of thin trading and non-linearity we estimate the following equation:

$$R_t^{adj} = \frac{v_t}{1-\alpha_1} \tag{5}$$

To correct for thin trading, equation 5 is run recursively. In testing for efficiency equation (6) is estimated using corrected returns calculated from equation (5):

$$R_t^{adj} = \alpha_0 + \alpha_1 R + \alpha_2 R_{t-1}^{adj} + \alpha_3 R_{t-1}^{adj} + u_t \tag{6}$$

3. Data

The data used in this study is daily KSE-100 index data from December 1991 to May 2003, taken from various issues of *Daily Business Recorder*. The return is calculated by the difference of log of two successive KSE-100 indexes by equation (1).

4. Empirical Results

The random walk models, taking into account thin trading and non-linearity, are estimated using OLS. Table-1 shows the test of the random walk model on daily data (without non-linearity) for uncorrelated returns of the KSE-100 index. We considered the full sample period from December 1991 to May 2003, three sub-sample non-overlapping periods (December

1991 to May 1998; May, 1998 to September, 2001; and September, 2001 to May 2003)[49], and one combined period (May, 1998 to May, 2003). In all periods and all sub-sample periods, the results indicate that the estimated coefficients are statistically significant. This shows that the Karachi stock was inefficient during the study period before adjustment for thin trading. It also implies that the Karachi stock market did not follow the random walk hypothesis. It also shows that the effects of thin trading are an important factor in the efficiency of Karachi stock market. However, results from the combined period (May 1998 – May 2003) gave evidence for the efficiency of the Karachi stock markets i.e. supported the random walk hypothesis. A possible reason is that information on the stock market had become more easily available due to the internet, cable, television and newspapers.

We also examined the random walk model by testing it on weekly and monthly data (with linearity) for uncorrelated returns at the KSE-100 index (see Table 5 and 9). The result is the same as we found in the daily data. However, unlike the daily data, we found a significant relationship between two successive prices in the combined period. This implies that the stock market does not follow a random walk in the weekly and monthly data. The reasons may be that monthly and weekly data adjust to new information more easily as compared to the weekly and daily data on stock market activity and it may falsely portray an efficient stock market. Jun and Uppal (1994) pointed out that monthly data can lead to spurious conclusions about the efficiency of markets due to adjustment of information.

To consider the impact of non-linear returns due to less informed investors, biased forecasts of investors, and neutral risk behaviour (that affects the efficiency of Karachi stock market), the non-linear model has been estimated on the basis of daily, weekly, and monthly data. The results are presented in Tables 3, 7 and 11, which indicate that the KSE is inefficient when tested with a non-linear model on daily and weekly data in the full sample period and two sub-sample periods. This implies that the Karachi stock market does not follow the random walk model even we consider the non-linear characteristic of emerging markets in these periods. However, in one sub-sample period and the combined period, the KSE-100 index is efficient and follows the random walk model. These two periods are related to the events of September 11, 2001. In these periods, there is a significant role for information on financial markets. In the case of monthly

[49] During the sample there are two events that had considerable impacts on the Pakistan's economy. These events were the May 1998 nuclear test and September 11, 2001. As a result Pakistan's economy went into depression.

data, it indicates that the stock market is efficient for the full sample period, the three sub-sample periods, and the combined period.

The results for model adjusted for thin trading in linear and non-linear model are presented in Table-2 and 4 for daily data, table 6 and 8 for weekly data and Table-10 and 12 for monthly data. After the adjustment for thin trading in the linear model on the basis of daily data, weekly data and monthly data, the results show that the KSE is efficient during the study period for the full sample as well as for three sub-sub sample periods. However, the KSE is inefficient after the nuclear test of May 28, 1998 in daily data only. The inefficiency is likely the effect of the nuclear test and 9/11/2001. The estimated coefficients obtained by both techniques are statistically not different from zero. This indicates that the KSE is efficient during the study period after adjustments for thin trading. It is evident that the coefficient of the non-linear term is insignificant in all three type data. This implies that the return generating process in KSE is non-linear. It concludes that when thin trading is adjusted in a non-linear model, the Karachi Stock exchange exhibits efficient behavior in daily data, weekly data, and monthly data.

5. Summary and Concluding Remarks

This study has empirically investigated the efficiency of the Karachi stock market. The random walk hypothesis was tested on daily, weekly and monthly data from December 1991 to May 2003 with three non-over-lapping periods and one combined period. The empirical results indicated that, without taking into consideration thin trading and non-linearity, the Karachi stock market was inefficient in all three types of data. This implies that the Karachi stock market did not follow the random walk model. However, when the returns were adjusted for thin trading and non-linearity, the Karachi stock market revealed efficient behavior and followed the random walk model for the full sample period (December 1991 to May 2003) and all sub-sample periods ((December 1991 to May 1998; May 1998 to September 2001; and September 2001 to May 2003), but not for the combined sample period (May 1998 to May 2003). This shows that when thin trading is adjusted for in a non-linear random walk model, the results show a greater degree of stock market efficiency than in the unadjusted specifications.

Table-1: Random Walk Model with out non-linearities for uncorrected returns for KSE-100 index on daily basis

$$R_t=\alpha_0+\alpha_1 R_{t-1}+\varepsilon_t$$

Periods	α_0	α_1	χ^{2a}	Q-stats	χ^{2b}
Dec. 14, 1991 to May 30, 2003	0.000 (0.66)	0.084 (4.39)	218.87	53	χ^2 = 39.29 F=19.76
Dec. 14, 1991 to May 28, 2003	-0.000 (-0.64)	0.219 (8.64)	86.24	25	χ^2 = 42.86 F=21.68
May 29, 1998 to Sept. 11, 2001	0.000 (0.29)	0.062 (1.77)	28.76	-	χ^2 = 8.55 F=4.27
Sept. 12, 2001 to May 30, 2003	0.002 (2.51)	-0.125 (-2.51)	98.90	-	χ^2 = 27.63 F=14.14
May 28, 1998 to May 30, 2003	0.000 (1.48)	0.006 (0.13)	99.80	-	χ^2 = 14.41 F=7.22

a. White test for hetroscedasticity. H_0 : is the series is homoscedastic. H_1.is other wise.

b. Ramsey RESET Test. H_0 : the functional form is correct. H_1: otherwise.

Table-2: Random Walk Model with out non-linearities for corrected returns for KSE-100 index on daily basis

$$R^{adj}_t=\alpha_0+\alpha_1 R^{adj}_{t-1}+\varepsilon_t$$

Periods	α_0	α_1	χ^{2a}	Q-stats	χ^{2b}
Dec. 14, 1991 to May 30, 2003	0.000 (0.00)	-0.015 (-0.78)	203.78	55	χ^2 = 34.04 F= 17.09
Dec. 14, 1991 to May 28, 2003	0.000 (0.00)	-0.015 (-0.58)	19.98	35	χ^2 = 42.99 F =21.75
May 29, 1998 to Sept. 11, 2001	-0.000 (0.21)	-0.019 (-0.55)	21.73	-	χ^2 = 8.11 F= 4.06
Sept. 12, 2001 to May 30, 2003	0.000 (0.10)	0.002 (0.06)	108.91	-	χ^2 = 28.60 F =14.66
May 28, 1998 to May 30, 2003	0.000 (0.02)	0.047 (1.76)	92.129	-	χ^2 = 3.20 F= 6.61

a. White test for hetroscedasticity. H_0 : is the series is homoscedastic. H_1.is other wise.

b. Ramsey RESET Test. H_0 : the functional form is correct. H_1: otherwise.

Table-3: Random Walk Model with non-linearities for uncorrected returns for KSE-100 index on daily basis

$$R_t=\alpha_0+\alpha_1 R_{t-1}+\alpha_2 R^2_{t-1}+\alpha_3 R^3_{t-1}+\varepsilon_t$$

Periods	α_0	α_1	α_2	α_3	χ^{2a}	χ^{2b}
Dec. 14, 1991 to May 30, 2003	-0.000 (-0.18)	0.161 (7.08)	0.904 (2.58)	-22.599 (-6.198)	245.144	χ^2=37.78 F=12.64
Dec. 14, 1991 to May 28, 2003	-0.000 (0.82)	0.341 (10.72)	-2.715 (-3.54)	-92.57 (-16.72)	38.70	χ^2=19.43 F =6.48
May 29, 1998 to Sept. 11, 2001	0.000 (0.28)	0.147 (3.23)	-0.131 (-0.225)	-21.166 (-2.92)	67.57	χ^2=5.01 F=1.66
Sept. 12, 2001 to May 30, 2003	0.002 (2.20)	-0.099 (-1.21)	-1.066 (-0.775)	21.305 (0.765)	51.62	χ^2=39.71 F=13.65
May 28, 1998 to May 30, 2003	0.000 (1.14)	0.101 (2.59)	-0.261 (-0.49)	-17.055 (-2.54)	116.66	χ^2=31.89 F=10.71

a. White test for hetroscedasticity. H_0 : is the series is homoscedastic. H_1.is other wise.

b. Ramsey RESET Test. H_0 : the functional form is correct. H_1: otherwise.

Table-4: Random Walk Model with non-linearities for corrected returns for KSE-100 index on daily basis

$$R^{adj}_{t}=\alpha_0+\alpha_1 R^{adj}_{t-1}+\alpha_2 R^{adj2}_{t-1}+\alpha_3 R^{adj3}_{t-1}+\varepsilon_t$$

Periods	α_0	α_1	α_2	α_3	χ^{2a}	χ^{2b}
Dec. 14, 1991 to May 30, 2003	0.000 (-0.09)	-0.021 (0.87)	-0.089 (-0.27)	1.47 (0.40)	58.95	χ^2=239.54 F=52.43
Dec. 14, 1991 to May 28, 2003	0.000 (0.25)	-0.016 (-0.49)	-0.339 (-0.65)	2.38 (-0.36)	26.81	χ^2=38.27 F =6.51
May 29, 1998 to Sept. 11, 2001	0.000 (0.208)	-0.050 (-1.11)	0.0015 (0.00)	3.079 (0.55)	8.71	χ^2=58.64 F=12.55
Sept. 12, 2001 to May 30, 2003	0.000 (0.14)	-0.009 (-0.118)	-0.090 (-0.06)	2.045 (0.06)	30.08	χ^2=44.33 F=9.78
May 28, 1998 to May 30, 2003	0.000 (0.052)	-0.0160 (-0.40)	-0.071 (-0.15)	1.296 (0.29)	10.71	χ^2=95.53 F=20.621

a. White test for hetroscedasticity. H_0 : is the series is homoscedastic. H_1.is other wise.

b. Ramsey RESET Test. H_0 : the functional form is correct. H_1: otherwise.

Table-5: Random Walk Model with out non-linearities for uncorrected returns for KSE-100 index on weekly basis

$$R_t=\alpha_0+\alpha_1 R_{t-1}+\varepsilon_t$$

Periods	α_0	α_1	χ^{2a}	Q-stats	χ^{2b}
Dec. 14, 1991 to May 30, 2003	0.004 (4.73)	0.196 (4.39)	221.17	53	χ^2 = 27.59 F=14.46
Dec. 14, 1991 to May 28, 2003	-0.001 (-0.71)	0.259 (4.23)	83.42	15	χ^2 = 13.70 F=7.15
May 29, 1998 to Sept. 11, 2001	0.000 (0.24)	0.097 (1.28)	26.67	-	χ^2 = 12.57 F=6.66
Sept. 12, 2001 to May 30, 2003	0.003 (1.67)	0.093 (1.47)	112.90	-	χ^2 = 16.38 F=8.65
May 28, 1998 to May 30, 2003	0.002 (1.51)	0.103 (1.68)	21.45	-	χ^2 = 17.25 F=9.12

a. White test for hetroscedasticity. H_0 : is the series is homoscedastic. H_1.is other wise.

b. Ramsey RESET Test. H_0 : the functional form is correct. H_1: otherwise.

Table-6: Random Walk Model with out non-linearities for uncorrected returns for KSE-100 index on weekly basis

$$R^{adj}_t=\alpha_0+\alpha_1 R^{adj}_{t-1}+\varepsilon_t$$

Periods	α_0	α_1	χ^{2a}	Q-stats	χ^{2b}
Dec. 14, 1991 to May 30, 2003	-0.000 (0.06)	-0.010 (-0.23)	218.87	53	χ^2 = 21.91 F=11.376
Dec. 14, 1991 to May 28, 2003	-0.000 (-0.07)	-0.000 (-0.15)	86.24	25	χ^2 = 9.652 F=4.95
May 29, 1998 to Sept. 11, 2001	-0.000 (-0.00)	-0.001 (-0.01)	28.76	-	χ^2 = 12.78 F=6.78
Sept. 12, 2001 to May 30, 2003	0.002 (2.51)	-0.014 (-0.22)	98.90	-	χ^2 = 14.97 F=7.87
May 28, 1998 to May 30, 2003	0.000 (0.00)	-0.007 (-0.15)	99.80	-	χ^2 = 15.88 F=8.35

a. White test for hetroscedasticity. H_0 : is the series is homoscedastic. H_1.is other wise.

b. Ramsey RESET Test. H_0 : the functional form is correct. H_1: otherwise.

Table-7: Random Walk Model with non-linearities for uncorrected returns for KSE-100 index on weekly basis

$$R_t=\alpha_0+\alpha_1 R_{t-1}+\alpha_2 R^2_{t-1}+\alpha_3 R^3_{t-1}+\varepsilon_t$$

Periods	α_0	α_1	α_2	α_3	χ^{2a}	χ^{2b}
Dec. 14, 1991 to May 30, 2003	0.002 (1.19)	0.302 (5.34)	-1.507 (-1.69)	-28.844 (-2.39)	139.45	χ^2=8.757 F=4.42
Dec. 14, 1991 to May 28, 2003	-0.001 (-0.67)	0.432 (5.35)	0.982 (0.68)	-49.603 (-2.96)	27.89	χ^2=2.175 F =1.885
May 29, 1998 to Sept. 11, 2001	0.002 (1.14)	0.246 (2.08)	-3.230 (-1.82)	-50.786 (-1.49)	65.67	χ^2=1.78 F=0.88
Sept. 12, 2001 to May 30, 2003	0.007 (2.49)	0.093 (0.48)	-3.463 (-0.88)	-9.602 (0.17)	56.08	χ^2=5.76 F=2.97
May 28, 1998 to May 30, 2003	0.004 (2.75)	0.197 (2.33)	-4.111 (-3.27)	-32.542 (-1.60)	113.90	χ^2=6.61 F=3.35

a. White test for hetroscedasticity. H_0 : is the series is homoscedastic. H_1.is other wise.

b. Ramsey RESET Test. H_0 : the functional form is correct. H_1: otherwise.

Table-8: Random Walk Model with non-linearities for uncorrected returns for KSE-100 index on weekly basis

$$R^{adj}_{t}=\alpha_0+\alpha_1 R^{adj}_{t-1}+\alpha_2 R^{adj2}_{t-1}+\alpha_3 R^{adj3}_{t-1}+\varepsilon_t$$

Periods	α_0	α_1	α_2	α_3	χ^{2a}	χ^{2b}
Dec. 14, 1991 to May 30, 2003	0.000 (0.00)	-0.030 (-0.52)	-0.089 (-0.14)	0.779 (0.14)	245.144	χ^2=7.28 F=3.67
Dec. 14, 1991 to May 28, 2003	-0.000 (-0.21)	-0.036 (-0.42)	-0.272 (-0.25)	-0.444 (-0.72)	38.70	χ^2=1.104 F =0.54
May 29, 1998 to Sept. 11, 2001	0.000 (0.09)	0.000 (0.00)	-0.246 (-0.16)	-0.752 (-0.32)	67.57	χ^2=1.65 F=0.819
Sept. 12, 2001 to May 30, 2003	0.007 (0.20)	-0.322 (-1.21)	0.176 (0.77)	20.21 (0.76)	51.62	χ^2=4.19 F=2.12
May 28, 1998 to May 30, 2003	0.001 (0.49)	-0.097 (-1.19)	-0.403 (-0.37)	6.155 (0.61)	116.66	χ^2=6.33 F=3.20

a. White test for hetroscedasticity. H_0 : is the series is homoscedastic. H_1.is other wise.

b. Ramsey RESET Test. H_0 : the functional form is correct. H_1: otherwise.

Table-9: Random Walk Model with out non-linearities for uncorrected returns for KSE-100 index on monthly basis

$$R_t=\alpha_0+\alpha_1 R_{t-1}+\varepsilon_t$$

Periods	α_0	α_1	χ^{2a}	Q-stats	χ^{2b}
Dec. 14, 1991 to May 30, 2003	0.025 (1.60)	-0.424 (-7.85)	205.17	15	χ^2 = 128.46 F=1133.41
Dec. 14, 1991 to May 28, 2003	0.026 (1.06)	-0.447 (-6.68)	93.89	4	χ^2 = 73.16 F=1433.21
May 29, 1998 to Sept. 11, 2001	0.002 (0.104)	-0.053 (-0.37)	23.16	-	χ^2 = 4.357 F=2.26
Sept. 12, 2001 to May 30, 2003	0.073 (1.97)	-0.491 (-2.50)	108.90	-	χ^2 = 0.32 F=0.14
May 28, 1998 to May 30, 2003	0.002 (1.25)	-0.255 (-2.17)	18.14	-	χ^2 = 3.25 F=1.63

a. White test for hetroscedasticity. H_0 : is the series is homoscedastic. H_1.is other wise.

b. Ramsey RESET Test. H_0 : the functional form is correct. H_1: otherwise.

Table-10: Random Walk Model with out non-linearities for uncorrected returns for KSE-100 index on monthly basis

$$R^{adj}_t=\alpha_0+\alpha_1 R^{adj}_{t-1}+\varepsilon_t$$

Periods	α_0	α_1	χ^{2a}	Q-stats	χ^{2b}
Dec. 14, 1991 to May 30, 2003	-0.001 (-0.07)	0.362 (5.51)	198.87	46	χ^2 = 54.44 F=44.60
Dec. 14, 1991 to May 28, 2003	-0.012 (-1.06)	0.456 (5.70)	93.41	21	χ^2 = 46.07 F=58.56
May 29, 1998 to Sept. 11, 2001	-0.000 (-0.08)	-0.003 (-0.19)	22.17	-	χ^2 = 4.56 F=2.38
Sept. 12, 2001 to May 30, 2003	-0.003 (-0.13)	-0.084 (-0.361)	103.90	-	χ^2 = 0.74 F=0.32
May 28, 1998 to May 30, 2003	0.046 (1.21)	-0.281 (-1.24)	98.85	-	χ^2 = 0.522 F=0.22

a. White test for hetroscedasticity. H_0 : is the series is homoscedastic. H_1.is other wise.

b. Ramsey RESET Test. H_0 : the functional form is correct. H_1: otherwise.

Table-11: Random Walk Model with non-linearities for uncorrected returns for KSE-100 index on monthly basis

$$R_t=\alpha_0+\alpha_1 R_{t-1}+\alpha_2 R^2_{t-1}+\alpha_3 R^3_{t-1}+\varepsilon_t$$

Periods	α_0	α_1	α_2	α_3	χ^{2a}	χ^{2b}
Dec. 14, 1991 to May 30, 2003	-0.002 (-0.15)	-0.072 (-0.52)	0.479 (1.46)	-1.52 (-1.28)	245.144	χ^2=1.59 F=0.77
Dec. 14, 1991 to May 28, 2003	-0.014 (-1.04)	0.092 (0.48)	0.850 (1.56)	-4.18 (-1.96)	38.70	χ^2=1.25 F =0.61
May 29, 1998 to Sept. 11, 2001	-0.002 (-0.08)	-0.359 (-1.48)	0.724 (0.68)	5.403 (0.40)	67.57	χ^2=0.70 F=0.33
Sept. 12, 2001 to May 30, 2003	0.052 (1.15)	-0.511 (-1.15)	0.6176 (0.92)	0.249 (0.09)	51.62	χ^2=0.66 F=0.29
May 28, 1998 to May 30, 2003	0.014 (0.68)	-0.155 (-0.75)	0.285 (0.64)	-0.769 (-0.48)	116.66	χ^2=2.04 F=1.00

a. White test for hetroscedasticity. H_0 : is the series is homoscedastic. H_1.is other wise.

b. Ramsey RESET Test. H_0 : the functional form is correct. H_1: otherwise.

Table-12: Random Walk Model with non-linearities for uncorrected returns for KSE-100 index on monthly basis

$$R^{adj}_t=\alpha_0+\alpha_1 R^{adj}_{t-1}+\alpha_2 R^{adj2}_{t-1}+\alpha_3 R^{adj3}_{t-1}+\varepsilon_t$$

Periods	α_0	α_1	α_2	α_3	χ^{2a}	χ^{2a}
Dec. 14, 1991 to May 30, 2003	0.002 (0.15)	0.030 (0.23)	-0.222 (-0.39)	-0.815 (-0.41)	143.14	χ^2=1.54 F=0.76
Dec. 14, 1991 to May 28, 2003	-0.000 (-0.01)	0.016 (0.080)	0.028 (0.04)	0.132 (0.05)	23.98	χ^2=1.71 F =0.84
May 29, 1998 to Sept. 11, 2001	-0.006 (-0.39)	0.215 (0.68)	1.099 (0.86)	-13.255 (-0.97)	68.16	χ^2=3.65 F=1.85
Sept. 12, 2001 to May 30, 2003	0.006 (0.20)	-0.088 (-0.03)	-1.088 (-0.42)	-2.930 (-0.31)	59.80	χ^2=0.52 F=0.23
May 28, 1998 to May 30, 2003	0.001 (0.07)	0.008 (0.042)	-0.067 (-0.08)	-1.789 (-0.62)	121.60	χ^2=0.68 F=0.23

a. White test for hetroscedasticity. H_0 : is the series is homoscedastic. H_1.is other wise.

b. Ramsey RESET Test. H_0 : the functional form is correct. H_1: otherwise.

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Analysis of Economic Efficiency and Competitiveness of the Rice Production Systems of Pakistan's Punjab

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Abstract

The Policy Analysis Matrix (PAM) methodology was used to determine the level of economic efficiency and competitiveness in the production of rice crops in Pakistan's Punjab. The methodology was also used to assess the effect of policy intervention on the production of Basmati and IRRI rice crops. The results indicate that an expansion of the production of Basmati rice can lead to an increase in exports. The production of IRRI in Pakistan's Punjab is characterized by a lack of economic efficiency implying inefficient use of resources to produce the commodity. On the other hand, both Basmati and IRRI rice production in the Punjab demonstrate a lack of competitiveness at the farm level for the period under analysis. The analysis shows that the prevailing incentive structure affected farmers negatively. A negative divergence between private and social profits implies that the net effect of policy intervention is to reduce the farm level profitability of both rice production systems in Punjab. The results highlight the need for removing existing policy distortions in the structure of economic incentives to enhance economic efficiency and to attain farm level competitiveness in rice production.

1. Introduction

Agriculture is the mainstay of Pakistan's economy. It also contributes substantially to Pakistan's exports and is an important food cash crop. It is the second largest agricultural export item of the country and accounts for 6.1 percent of the total value added in agriculture and 1.3 percent of GDP. In Pakistan's Punjab, basmati and IRRI rice are two varieties cultivated, consumed and exported. Basmati has a lower yield and a higher production cost than IRRI rice, but these are offset by higher prices. Using guaranteed price supports for both varieties, the government encourages farmers to

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produce exportable surpluses, particularly of Basmati, where Pakistan has a comparative advantage and is the dominant supplier of the world's premier non- gluteus long grain aromatic rice in the international market (Davidson, 1996).

As with most agricultural commodity markets, the rice market also suffers from the cobweb phenomenon, where price fluctuations are caused by the time lag between making the decision to cultivate the crop and the ultimate selling of the crop. To decrease the risk faced by farmers from fluctuating prices, the government has set support prices for various varieties of rice (Ahmed, *et al*., 2000).

The Agreement on Agriculture (AOA) of the World Trade Organization (WTO) has set targets for future world trade such as trade liberalization, non-intervention by governments and elimination of trade barriers. This would greatly improve world trade volumes and benefit the countries following free trade regimes, since trade is beneficial to those countries which have a comparative advantage in a particular commodity and is mutually advantageous to countries importing cheap raw materials. The literature shows that Pakistan is likely to benefit more in producing commodities where there is a comparative advantage than any developing country under full reform conditions (Hussain *et al*., 2006).

Governments intervene in agriculture and influence output and input markets. Frequently, the measures used include tariffs, quotas and subsidies designed for trade protection or enhancement, and price supports designed to increase farm income. The impact of policy distortions is particularly evident when Pakistan's high level of agricultural disprotection is compared with other countries that pursued different policies (Faruqee 1995). Faruqee (1995) quoted the example of high performing East Asian economies which had lower levels of disprotection of agriculture. He further argued that in the presence of past pricing distortions, output losses were huge in Pakistan, to the tune of 10 percent a year for cotton and 6 percent a year for wheat for the mid-1980s (Faruqee 1995). He also reported that Pakistan has a comparative advantage in the production of Basmati rice, wheat and cotton, whereas coarse rice and sunflower production are marginally inefficient. Analyses of resource use efficiency through DRC and incentives in production were used to gain insight into the economic efficiency and the effects of policy interventions in the rice production systems of Pakistan's Punjab. The use of economic efficiency analysis through comparative advantage deals not only with on-farm production but incorporates whole commodity systems and thus provides an analysis of the entire commodity chain (Slinger, 1997).

In most developing countries with distorted markets and trade barriers, domestic resources are costlier than traded inputs and distortions lead to the misallocation of resources (Gonzales, 1984, and Gonzales et al., 1993). In developing countries, due to distortions in factors and output markets, externalities and government policy interventions, social or economic profitability deviates from private profitability. This allows a wide gap between competitiveness and comparative advantage, and failure to measure and account for market distortions might lead to biases. Comparative advantage indicates whether it is economically advantageous for a country to expand production and trade of a specific commodity, while competitiveness indicates private commercial performance of individual firms (Warr, 1994). Warr further argued that the two concepts are not the same and any attempt to portray them as being the same, or at least similar, is misleading. In this situation a crop can be profitable for farmers but its production may not be an efficient use of national resources and vice versa. The divergence between private and social values stem from the varying interest of the growers and society (Khan, 2001).

2. Research Methodology

2.1 Nature and Source of data

This study is based on secondary data from different national sources. The main sources of the data were the Agricultural Prices Commission (APCOM), Economic Advisors Wing, Finance Division, Economic Wing MINFAL, Central Board of Revenue (CBR) and National Fertilizer Development Centre (NFDC). Some specific documents were Support Price Policy for Rice (paddy), Agricultural Statistics of Pakistan, CBR Yearbook, and Pakistan Fertilizer Related Statistics (various issues). The most important source of data was Support Price Policy Reports which contained extensive information on the cost of different operations performed by average farmers including tractor operations, labor usage for different tasks, seed and seed treatment, irrigation, fertilizer expenses, land rent and management charges, etc. They can be grouped categorically as follows: (1) Technical input-output coefficients were used at the farm level (2) Domestic farmgate prices (procurement prices adjusted for marketing costs) for output and domestic market prices for inputs and other resources were used (3) International farmgate prices (export/import unit value) for outputs and inputs adjusted for the shadow exchange rate, internal cost of marketing, processing, transport and handling were used. In order to calculate the social prices of non-tradable inputs for this study a standard format was utilized, as suggested by Appleyard (1987).

2.2 Method of Analysis

The method of analysis utilized to measure the economic efficiency and competitiveness of rice production systems was the Policy Analysis Matrix (PAM) (Table-1). This framework was developed by Monke and Pearson (1989), and augmented by recent developments in price distortion analysis by Masters and Winter-Nelson (1995). PAM is a tool that allows us to examine the impact of policy by constructing two enterprise budgets, one valued at market prices and the other valued at social prices. The PAM, once assembled, provides a convenient method of calculating the measure of policy effects and measures of competitiveness and economic efficiency/ comparative advantage. A wide range of government policies have influences on protection/disprotection of agricultural production, which can be measured by using nominal and effective protection rates as indicators. This framework is particularly useful in identifying the appropriate direction of change in policy (Gonzale *et al*., 1993). In the present study particular attention is given, however, to competitiveness and economic efficiency in domestic resources by using a PAM framework. These methods have the same foundation, but differ in their capacity to interpret the results. Many recent studies have utilized a PAM framework to evaluate competitiveness and comparative advantage and policy effects in Pakistan for different crops, some of which are Salman and Martini (2000), Khan (2001), Khan and Rana (2004). The impact of policy is then assessed as the divergence between private and social valuation. The assessment of competitiveness and economic efficiency of rice crop production at the farmgate level of Pakistan's Punjab was undertaken using the data for the period 1995-96 to 2004-05, and the necessary indicators were derived to explain the private profitability, social profitability and divergence for the entire period.

Table-1: Framework of Policy Analysis Matrix (PAM)

	Revenue	**Costs**		**Profits**
		Tradable Inputs	**Domestic Factors**	
Valued at Private prices	A= $P_{id} * Q_i$	B= $P_{jd} * Q_j$	C= $P_{nd} * Q_n$	D
Valued at Social prices	E= $P_{ib} * Q_i$	F= $P_{jb} * Q_j$	G= $P_{ns} * Q_n$	H
Divergence	I	J	K	L

Source: Based on Monke and Pearson (1989)
Private profit: D=*A*– (*B*+*C*); Social profit: H=E– (*F*+*G*); Output transfer: I=*A*– *E*; Input transfer: J=*B*– F
Factor transfer: K=*C*– G, Net policy transfer: L= D– H

Where: P_{id} = *domestic price of output i*

P_{jd} = *domestic price of tradable input j*

P_{ib} = *international price of output i*

P_{jb} = *international price of tradable input j*

P_{nd} = *market price of non-tradable input n*

P_{ns} = *shadow price of non-tradable input n*

Q_i = *quantity of output*

Q_j = *quantity of tradable input.*

Q_n = *quantity of non-tradable input.*

The indicator in the first row of Table-1 provides a measure of private profitability (D), or competitiveness, and is defined as the difference between observed revenue (*A*) and costs (*B*+*C*). Private profitability demonstrates the competitiveness of the agricultural system, given current technologies, prices for inputs and outputs, and policy interventions and market failures. The second row of the matrix calculates the measure of social profitability (H) defined as the difference between social revenue (E) and costs (F+G). Social profitability measures economic efficiency/ comparative advantage of the agricultural system.

2.3 Ratio Indicators

The PAM framework can also be used to calculate important indicators for policy analysis. The computation of the following measures for Pakistan were established by Appleyard (1987), Salman and Martini (2000), Chaudhry and Kayani (1999):

a) Nominal Protection Coefficient on Output (NPCO)

This ratio shows the extent to which domestic prices for output differ from international reference prices. If NPCO is greater than 1, the domestic farm gate price is greater than the international price of output and thus the system receives protection. On the contrary, if NPCO is less than 1, the system is disprotected by policy. NPCO is expressed as:

$$NPCO = (A)/(E) = (P_{id} * Q_i)/(P_{ib} * Q_i) \quad (1)$$

b) Nominal Protection Coefficient on Input (NPCI)

This ratio shows how much domestic prices for tradable inputs differ from their social prices. If NPCI exceeds 1, the domestic input cost is greater than the comparable world prices and thus the system is taxed by policy. If NPCI is less than 1, the system is subsidized by policy. Using the PAM framework, NPCI is derived as:

$$NPCI = (B)/(F) = (P_{jd} * Q_j)/(P_{jb} * Q_j) \quad (2)$$

c) Effective Protection Coefficient (EPC)

EPC is the ratio of value added in private prices (A-B) to value added in social prices (E-F). An EPC value of greater than 1 suggests that government policies provide positive incentives to producers, while values less than 1 indicate that producers are disprotected through policy interventions on value added. EPC is expressed as:

$$EPC = (A-B)/(E-F) = \{(P_{id} * Q_i)-(P_{jd} * Q_j)\}/\{(P_{ib} * Q_i)-(P_{jb} * Q_j)\} \quad (3)$$

d) Domestic Resource Cost (DRC) Ratio

The DRC was brought into common use by Bruno (1972) specifically for the purpose of measuring comparative advantage. According to Bruno (1972) and Krueger (1966 and 1972), the economic efficiency in domestic resource use of a commodity system can be assessed by using this ratio. Since minimizing the DRC is equivalent to maximizing social profits, if the DRC ratio is less than 1, the system uses domestic resources efficiently. If the DRC ratio is greater than 1, then the system shows inefficiency in domestic resource use and possesses a comparative disadvantage. The method of calculating the DRC ratio in the PAM framework is given as:

$$DRC = (G)/(E-F) = (P_{ns} * Q_n)/\{(P_{ib} * Q_i) - (P_{jb} * Q_j)\} \quad (4)$$

e) Private Cost Ratio (PCR)

PCR is the ratio of factor costs (C) to value added in private prices (A-B). This ratio measures the competitiveness of a commodity system at the farm level. The system is competitive if the PCR is less than 1. Using the PAM framework the PCR can be expressed as:

$$PCR = (C)/(A-B) = (P_{nd} * Q_n)/\{(P_{id} * Q_i)-(P_{jd} * Q_j)\} \quad (5)$$

3. Results and Discussion

The empirical results of the study first describe the level of economic efficiency through economic profitability and DRC ratios and competitiveness through private profitability and PCR ratio of Basmati and IRRI rice production systems of the Punjab, during the 1995-96 to 2004-05 period using average farmer cost of production data..

The completed Policy Analysis Matrix in (Table 2) shows the effects of policies on the relative competitiveness of Basmati rice. A negative divergence between private and social profit implies that the net effect of policy intervention is to reduce profitability of Basmati production in Pakistan's Punjab. A removal of policy distortions would substantially increase profitability. The negative output transfers in Basmati production were caused mainly by disprotection by the government's prevailing policies. Basmati rice farmers receive lower revenue than they would have done in the absence of policy distortions. With a minor adjustment in the nominal rates of protection it can be produced with positive private returns and the Basmati production system would become competitive.

Table-2: Results of Policy Analysis Matrix for Basmati Rice Production System

	Revenue	Costs		Profits
		Tradable Inputs	Domestic Factors	
Valued at Private prices	7320	2735	5236	-651
Valued at Social prices	14228	2921	6266	5041
Divergence	-6908	-185	-1031	-5693

At the margin, positive social profit and the DRC ratio were less than unity implying that the Basmati production system uses scarce resources efficiently (Table-3). The DRC for the Basmati rice Production system was 0.56. This indicates that Basmati production systems had strong economic efficiency in the use of domestic resources which exhibit comparative advantage and indicated that the crop is potentially very beneficial to Pakistan in term of DRC per unit of foreign exchange earned. On the other hand in the PAM table, the competitiveness of a system is measured by the private profitability (D) or Private Cost Ratio (PCR). Based on information given in Table-3, the PCR of Basmati production was 1.14, which implies that system lacks competitiveness at the current level of

technology and policy intervention. The ratio formed to measure output transfers is called the Nominal Protection Coefficient on Output (NPCO). The NPCO and EPC for Basmati were 0.52 and 0.41, respectively, on an average for the entire period under analysis. Low or less than unity NPCO and EPC indicates that the price structure discriminates or provides relative disincentives for growing this crop, and this conclusion is reinforced by negative private profitability for average farmers in Pakistan's Punjab. In term of policy implications, the estimates of NPC, EPC and DRC reveal that with the removal of distortions in output and input markets under trade liberalization, the growers of basmati rice are likely to gain and the country is likely to benefit more in producing Basmati rice. The Nominal Protection Coefficient on Input (NPCI) for the Basmati production system was less than 1 (0.94) which indicates that the policies reduce input costs. This indicates that the Basmati production system was slightly subsidized by the policy on tradable inputs but this does not offer any important offset to the overall disprotection for Basmati rice production as the result demonstrates that Effective Protection Coefficient (EPC) remained substantially less than unity (0.41). These results imply that there was significant disprotection from the state to the Basmati production system on value added.

Table-3: Competitiveness and Economic Efficiency Indicators for Basmati Production System

Indicators	Average 1995-96 to 1999-00	Average 2000-01 to 2004-05	Average 1995-96 to 2004-05
Nominal Protection Coefficient (NPCO) on Output	0.50	0.53	0.52
Nominal Protection Coefficient (NPCI) on Input	0.94	0.96	0.94
Effective Protection Coefficient (EPC)	0.42	0.41	0.41
Domestic Resource Cost (DRC)	0.51	0.61	0.56
Private Cost Ratio (PCR)	1.03	1.25	1.14

The Policy Analysis Matrix in Table-4 shows the effects of policies on relative competitiveness of IRRI production in Pakistan's Punjab. A negative divergence between private and social profit implies that the net effect of policy intervention is to reduce profitability of IRRI production at the farm level. A removal of policy distortions would increase profitability to some

extent. The negative output transfers were caused mainly by disprotection policies.

Table-4: Results of Policy Analysis Matrix for IRRI Rice Production System

	Revenue	Costs		Profits
		Tradable Inputs	Domestic Factors	
Valued at Private prices	5709	2553	4365	-1209
Valued at Social prices	6981	2963	4568	-550
Divergence	-1272	-410	-202	-660

Based on the information in Table-5, average economic efficiency indicators for the IRRI rice production system was 1.20 for the whole period under review. In other words, the IRRI production system shows negative social profits: a DRC of 1.20 indicates that IRRI production lacks economic efficiency in the use of domestic resources and IRRI production in Pakistan's Punjab seems to be in a situation of comparative disadvantage. The determination of profit actually received by farmers is a straightforward and important initial result of the PAM approach. In the PAM Table-5, the competitiveness of a system is measured by the private profitability (D) or Private Cost Ratio (PCR). The IRRI production system demonstrates a lack of competitiveness at the current level of technology and prices prevailing at the farmer level because the PCR remained greater than unity (Table-5).

The ratio formed to measure output transfers is called the Nominal Protection Coefficient on Output (NPCO). The average NPCO for the entire period under analysis for IRRI rice was 0.82, which indicates that IRRI rice farmers received lower prices than they would have received facing world prices or that the system was disprotected.

The Effective Protection Coefficient (EPC) shows the joint effect of policy transfers affecting both tradable inputs and tradable outputs. The EPC for IRRI production systems was 0.82, which implies that there was overall disprotection from the policy on value added. On the input side, the average Nominal Protection Coefficient on Input (NPCI) was less than 1 (0.87) for the IRRI production system. This shows that the policy regime favors farmers and reduces the cost of tradable inputs to some extent, but this does not offer any important offset to the overall disprotection that exists for the IRRI production system of Punjab. The results imply that

Punjab must strive to increase competitiveness and economic efficiency of the IRRI production system through increasing productivity, farm level profitability and resource use efficiency by adequate policy incentives.

Table-5: Competitiveness and Economic Efficiency Indicators for IRRI Production System

Indicators	Average 1995-96 to 1999-00	Average 2000-01 to 2004-05	Average 1995-96 to 2004-05
Nominal Protection Coefficient (NPC) on Output	0.69	0.96	0.82
Nominal Protection Coefficient (NPC) on Input (I)	0.87	0.87	0.87
Effective Protection Coefficient (EPC)	0.59	1.06	0.82
Domestic Resource Cost (DRC)	0.88	1.51	1.20
Private Cost Ratio (PCR)	1.38	1.44	1.41

4. Conclusions

A mixed picture arises from analyzing the competitiveness and economic efficiency in the rice sector of Pakistan's Punjab through the period under analysis. The Basmati production system was economically efficient and maintained a comparative advantage, but the prevailing price structure discriminates against growing this crop as shown by negative private profitability showing a lack of competitiveness at the farm level. It also expresses the need for the removal of policy distortions to increase the incentives for growers to expand production of an economically advantageous export commodity. Since trade liberalization implies that the market will determine output prices, both basmati growers and the country can benefit.

The IRRI rice production system also exhibits a lack of competitiveness at the farm level because of negative private profitability, An analysis of economic efficiency though DRC implies that the system is not economically efficient in the use of scarce domestic resources which indicates a situation of comparative disadvantage. The estimates of IRRI rice reveals that under trade liberalization, the prospect of IRRI being a major export crop seems to be somewhat gloomy for Pakistan's Punjab. To attain

economic efficiency in IRRI rice and to sustain its traditional status as an export item of the country, there is an urgent need to increase crop productivity and minimize costs of production. Costs of production can be reduced by decreasing exports incidentals and processing costs incurred from farmgate to export destinations, through adequate policy incentives. Output transfers in the production systems of both IRRI and Basmati were negative and considerably different. The extent of the policy distortion is higher in Basmati production as compared to IRRI rice production.

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Sustainability of Feed-based Aquaculture in Bangladesh[50]

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Abstract

Six carp and carp based culture technologies were selected to examine the sustainability of supplementary feed-based aquaculture through availability of domestic feeds compared to the total requirement in Bangladesh. The study covered seven districts of Bangladesh with a sample size of 376. It was found that farmers used a good number of feeds (more than 35) for the selected technologies but they maintained no standard doses for them. There were important differences among the prices of different feeds and other inputs used for different technologies in different parts of the country. Prices of all inputs were found to be increasing and this increase has been greater in recent years as compared to previous years. Though all the technologies were found to be profitable, the feed situation was not satisfactory. Except for rice polish, the supplies of other local feeds were unable to meet the national demand. If this situation persists and no measures are taken to secure the local feed supply, the present development of supplementary feed-based aquaculture will become dependent on imported feeds and would not be sustainable in the future. This study strongly suggests that the authorities should handle the matter with proper attention, considering its significant impact in the economy of the country.

Keywords: Profitability, Composition, Availability, Sustainability

Introduction

Fish and fisheries have been an integral part of the life of the people of Bangladesh from time immemorial. This sector contributes about 6 percent of GDP, 16 percent of gross agricultural product and

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about Tk. 20 billion (10 percent) of export earnings, of which frozen shrimp constitutes 82 percent while the rest are fish and other aquatic products (BBS, 2000). Total fish production in Bangladesh in 1998-99 was reported to be 1.552 million metric tons (MT) of which 0.65 million MT (42 percent) was from inland open waters, 0.593 million MT (38 percent) from inland closed waters and 0.309 million MT (20 percent) from marine fisheries. The largest three contributors to total inland production (including capture and culture) are ponds (32 percent), flood lands (26 percent) and rivers and estuaries (10 percent). The overall growth rate of fish production of Bangladesh for the period 1984-85 to 1997-98 was 5.02 percent. These figures display several important features. First, although inland open water fisheries are still the largest contributors to total fish production, their share has declined from 62 percent in 1983-84 (471,595 MT) to only 42 percent (649,418 MT) in 1998-99, while the contribution from inland closed waters (culture) fisheries has increased from 16 percent (117,025 MT) in 1983-84 to 38 percent (593,202 MT) in 1998-99. During this period, the share of marine fisheries fell from 24 to 20 percent. Almost all the growth of culture fisheries occurred since 1989-90; and since then, total production nearly doubled by 1997-98, led by aquaculture in inland closed waters which increased output at a remarkable rate of 13 percent per year (BBS, 2004). As the contribution of inland open water fisheries is declining and the contribution of marine fisheries is growing slowly, it is necessary to think of culture fisheries as the appropriate means to increase fish production for the growing population.

Culture fisheries have already shown their dominance in total fish production over the last 15 years or so. Pond fish farming, shrimp farming and culture-based baors are now the most promising sources for additional fish production. Thus its potential has to be utilized. In fish farming and shrimp/golda farming, pangus farming, cage and pen farming, the use of supplementary feed is very important as far as the achievement of full potential yield is concerned. Supplementary feed is also being used in carp poly cultures by many promising fish farmers and entrepreneurs. Those using supplementary feed produce higher yields per hectare. The Government of Bangladesh and the Department of Fisheries (DoF) are also encouraging fish farming. New agricultural lands are now being converted into fish ponds. Cage and pen cultures are also being encouraged to increase the country's fish production.

The interest in increasing aquaculture yields has necessarily turned attention to the use of supplemental or complete feeds to enhance production. But imported feed ingredients are too expensive and demanding

of scarce foreign exchange to be practical in Bangladesh. Though the farmers use their feeds economically (especially high valued imported feeds) they are anxious about feed prices and feed availability. Various small-scale local feed milling has been attempted with some promising results but no comprehensive study has been done regarding the availability of local ingredients, their costs and returns as required to support expanded feed-based aquaculture production systems.

Some studies related to this research are Islam and Dewan (1986), Islam (1987), Rahman (1995), Rana (1996), Hossain *et al.* (1997), Das (2005), Nurunnahar (2005) and Islam (2006). Islam and Dewan (1986) carried out a study on resource use and economic returns in pond fish culture, in which they identified that pond fish production was mainly based on stocking fish seed, use of fertilizer and feed and human labor for different operations and management. They also observed that net return was positively influenced by price of output and economic use of both material inputs and labor. Islam (1987) made efforts to estimate the effects of seven factors on pond fish output using a Cobb-Douglas production function and found that fish seed, fertilizer and artificial feed, human labor, farm size, age of pond and number of pond owners were significant in explaining the variation in pond fish output, but the results varied across the different locations. Rahman (1995) explored the contributions of key variables to the production process of pond fish farming. He observed that ownership of pond, number of species and human labor had a negative impact on pond fish output, while depth of pond water, farm size, fish seed, fertilizer and artificial feed were found to be responsible for explaining the variation in pond fish output. He also identified higher feed prices as one of the major problems of pond fish production in the study area. Rana (1996) worked to find the influencing variables for pond culture and found that pond size and stocking of fingerlings had negative effects and pond ownership, feed, fertilizer and human labor had positive effects on pond fish production. In analyzing the relationship between supplementary feed and fish production, Hossain *et al.* (1997) showed that the average production of carp of 2133.30 kg/ha would be obtained in 105 days in a mixed culture system using supplementary feed (rice bran and mustard oil cake in a ratio of 1:1) at 5% of total fish body weight daily in two installments. During this research work, the respondents opined that sometimes feeds were not sufficiently available to them and feed prices went beyond their ability to pay. Das (2005) determined the profitability and effects of specific factors on fingerling production under non-government organization (NGO) supervision. She found that producing fingerling in a nursery pond was highly profitable and pond size, cost of spawn stocked, material cost, feed

cost, human labor cost and management cost had significant impacts on nursery operations. Nurunnahar (2005) observed net return and resource use efficiency of carp poly culture in the Kushtia district of Bangladesh. She found carp poly culture to be a profitable business and other than human labor, inputs were used in an efficient manner. She also found that the poly culture farmers expected higher fish prices as production costs were higher due to higher prices of inputs, especially fish feeds. Islam (2006) worked on the profitability and technical efficiency of hatchery operation and observed hatchery farms to be highly profitable. Education, experience and training received by the hatchery operators were found to be the most important factors explaining technical efficiency.

It is clear that there is no specific study emphasizing sustainability/ feasibility of feed-based aquaculture, especially in Bangladesh. It is in this backdrop that a study on the economics of aquaculture, based on local as well as supplementary feed ingredients, is necessary. Results of this study might be helpful for researchers, extension workers, NGOs and policy makers to make present modern aquaculture as a sustainable means of improving the livelihood of the rural people of Bangladesh.

Objectives of the study

(i) to determine the profitability of the selected aquaculture technologies using supplementary feeds;

(ii) to examine the compositional variation of fish feeds across different fish farming practices;

(iii) to estimate the demand for, and availability of, local feed ingredients for feed-based aquaculture;

(iv) to study the price movements of local supplementary fish feeds; and

(v) to assess the sustainability of fish culture on the basis of findings of the study for expansion of feed-based future fresh water fish culture.

2. Methodology of the Study

This study used both primary and secondary data to achieve its objectives. Primary data were collected from the fish farmers, fish entrepreneurs (those provided pond and capital but were not directly related), feed manufacturers, feed dealers and feed retailers. The survey collected information on cost, return, price, catch and feed composition of fish culture. On the other hand, secondary data comprised time series information on production of rice, wheat and other mother/original feed produces. Primary data were collected through direct interviews while secondary data were collected from different issues of Bangladesh Bureau of Statistics (BBS) and unpublished but reliable documents of different feed companies. Six fish culture technologies were selected to assess the sustainability of feed-based aquaculture: carp-pangus, carp poly, carp-golda, pangus mono, golda mono and nursery. The sample was selected on the basis of the concentration of farmers where supplementary feed use in aquaculture was relatively widely practiced. On the basis of this criterion, seven districts, i.e., Mymensingh, Bogra, Noakhali, Comilla, Jessore, Khulna and Bagerhat were tentatively selected, from where samples were chosen for the study. Here, carp-pangus and carp-golda imply the simultaneous culture of two fishes in same pond in the same time. On the other hand, pangus mono and golda mono refer to the culture of one fish in one pond only. Moreover, carp poly is the culture of different species of carp and finally nursery refers to fingerling raising ponds. The distribution of the sample is shown in Table-1.

The number of respondents under carp-pangus, carp poly, carp-golda, pangus mono, golda mono and nursery technologies were 55, 100, 65, 51, 50 and 55 respectively (Table-1). Thus the total sample size for the study stood at 376. Moreover, the sample respondents were selected from 22 upazilas (sub-districts) comprising four, three, two, one, three, eight and one upazila from Mymensingh, Bogra, Noakhali, Comilla, Jessore, Khulna and Bagerhat respectively. Data were collected for the period of September, 2001 to March, 2002.

Table-1: Distribution of Samples of the Selected Technologies

District / Technology	Number of respondents/fish farmers							
	Mymen-singh	Bogra	Noakhali	Comilla	Jessore	Khulna	Bagerhat	All districts
Carp-pangus	33 (60.00)	20 (36.36)	2 (3.64)	-	-	-	-	55 (100)
Carp poly	27 (27.00)	10 (10.00)	30 (30.00)	27 (27.00)	6 (6.00)	-	-	100 (100)
Carp-golda	2 (3.08)	-	-	-	25 (38.46)	29 (44.62)	9 (13.85)	65 (100)
Pangus mono	12 (23.53)	39 (76.47)	-	-	-	-	-	51 (100)
Golda mono	-	-	-	-	1 (2.00)	47 (94.00)	2 (4.00)	50 (100)
Nursery	20 (36.36)	12 (21.82)	-	-	23 (41.82)	-	-	55 (100)
All technologies	94 (25.00)	81 (21.54)	32 (8.51)	27 (7.18)	55 (14.63)	76 (20.21)	11 (2.93)	376 (100)
Upazila surveyed (No.)	4 (18.18)	3 (13.64)	2 (9.09)	1 (4.55)	3 (13.64)	8 (36.36)	1 (4.55)	22 (100)

Figures within the parentheses indicate percentages of total

Source: Field Survey (2002).

Simple statistical techniques (average, percentage, etc.) were employed to analyze the collected data. Moreover, a moving average technique based on current price was followed to smooth the fluctuations in feed prices and thus examine the price movements of the major local feed items used for the selected fish culture technologies (Puri, 1984).

3. Result and Discussion

3.1 Profitability of the Feed-based Aquaculture

3.1.1 Fingerling cost of the selected technologies

It was found that, except for pangus and golda mono technologies, the others used several types of fingerling for fish culture. Among them carp-golda technology used 10 types while each of the rest used 11 types of fingerling (Table-2). Moreover, in the nursery technology, fingerling was purchased on the basis of both number and weight. Though the selected technologies experienced several fingerling costs, only five major cost items

of each technology are discussed below. The residual fingerling items constituted minimum shares in total fingerling cost for each of the selected technologies.

In the case of carp-pangus technology, the highest amount of fingerling used was pangus (88.12 percent) while it was ruhi (20.24 percent) for carp poly culture and golda (89.75 percent) for carp-golda poly culture technologies. In terms of number, the nursery technology used magur fingerling in the highest quantity (31.11 percent) and in terms of weight it was the pangus (95.72 percent). The mono culture technologies used only one type of fingerling, i.e., pangus mono culture used pangus fingerling and golda mono culture used golda fingerling only.

In carp-pangus technology, the highest cost was incurred for pangus fingerling (93.46 percent) and it was followed by ruhi (2.15 percent), silver carp (1.63 percent), catla (1.48 percent) and silver barb (0.66 percent) fingerlings.

The highest fingerling cost was incurred for ruhi fingerling (23.81 percent) for carp poly technology. The second, third, fourth and fifth highest cost for this technology were silver carp (15.79 percent), catla (14.44 percent), mrigel (14.09 percent) and mirror carp (11.97 percent) fingerlings.

Among the 10 species of fingerling used by carp-golda technology, the sequence of the five major fingerling costs was golda, catla, ruhi, grass carp and silver carp with respective shares in total fingerling cost of 94.79, 1.30, 1.29, 0.81 and 0.77 percent.

For the nursery technology, pangus contributed the highest cost (65.13 percent) in total fingerling cost (comprising number and weight costs together) followed by magur (12.57 percent), mirror carp (4.62 percent), ruhi (4.38 percent) and mrigel (3.48 percent).

In the case of pangus and golda mono culture technologies, where only one type of fish was cultured, fingerling cost for pangus and golda fingerling was Tk. 128602.30 and 57505.26 respectively.

Table-2: Per Hectare Fingerling Cost of the Selected Technologies

Sl. No.	Name of the finger-ling	Technology												
		Carp-pangus		Carp poly		Carp-golda poly		Pangus mono		Golda mono		Nursery		
		No.	Cost (Tk)	No.	Cost (Tk)	No.	Cost (Tk)	No.	Cost (Tk)	No.	Cost (Tk)	No.	Weight (kg)	Cost (Tk)
1	Pangus	45616.85 (88.12)	89304.30 (93.46)	-	-	-	-	35639.46 (100)	128602.30 (100)	22004.71 (100)	57505.26 (100)	250336.82 (21.91)	37.56 (95.72)	77473.27 (65.13)
2	Ruhi	1733.36 (3.35)	2050.28 (2.15)	3674.87 (20.24)	3045.27 (23.81)	329.60 (1.59)	618.55 (1.29)	-	-	-	-	62914.07 (5.51)	0.24 (0.61)	5212.03 (4.38)
3	Catla	960.63 (1.86)	1413.59 (1.48)	2009.99 (11.07)	1847.01 (14.44)	294.92 (1.42)	624.47 (1.30)	-	-	-	-	57025.05 (4.99)	0.06 (0.15)	3938.26 (3.31)
4	Mrigel	281.96 (0.54)	259.59 (0.27)	2553.99 (14.07)	1801.47 (14.09)	93.14 (0.45)	96.57 (0.20)	-	-	-	-	66026.52 (5.78)	0.05 (0.13)	4140.15 (3.48)
5	Silver carp	1829.91 (3.53)	1558.14 (1.63)	3460.33 (19.06)	2019.61 (15.79)	540.87 (2.60)	369.39 (0.77)	-	-	-	-	72534.08 (6.35)	0.41 (1.04)	3601.26 (3.03)
6	Silver barb	867.69 (1.68)	628.79 (0.66)	2683.72 (14.78)	988.57 (7.73)	603.35 (2.90)	112.69 (0.24)	-	-	-	-	68198.14 (5.97)	-	1700.74 (1.43)
7	Telapia	135.92 (0.26)	85.41 (0.09)	445.42 (2.45)	209.03 (1.63)	15.38 (0.07)	7.69 (0.02)	-	-	-	-	149.03 (0.01)	-	10.43 (0.01)
8	Mirror carp	135.82 (0.26)	85.41 (0.09)	1762.27 (9.71)	1530.38 (11.97)	126.87 (0.61)	272.97 (0.57)	-	-	-	-	177252.01 (15.52)	0.63 (1.61)	5490.29 (4.62)
9	Calbaus	94.94 (0.18)	119.80 (0.13)	180.85 (1.00)	128.75 (1.01)	10.91 (0.05)	5.82 (0.01)	-	-	-	-	227.28 (0.02)	0.03 (0.08)	328.28 (0.28)
10	Big head	101.32 (0.20)	38.70 (0.04)	65.63 (0.36)	71.88 (0.56)	-	-	-	-	-	-	-	0.10 (0.25)	606.06 (0.51)
11	Grass carp	9.09 (0.02)	5.68 (0.01)	901.23 (4.96)	845.05 (6.61)	115.83 (0.56)	388.01 (0.81)	-	-	-	-	32337.96 (2.83)	0.16 (0.41)	1500.78 (1.26)
12	Bagna	-	-	415.00 (2.29)	301.89 (2.36)	-	-	-	-	-	-	-	-	-
13	Golda	-	-	-	-	18657.90 (89.75)	45440.07 (94.79)	-	-	-	-	-	-	-
14	Magur	-	-	-	-	-	-	-	-	-	-	355403.42 (31.11)	-	14957.72 (12.57)
All	-	51767.59 (100)	95549.69 (100)	18153.30 (100)	12788.91 (100)	20788.77 (100)	47936.23 (100)	35639.46 (100)	128602.30 (100)	22004.71 (100)	57505.26 (100)	1142404.34 (100)	39.24 (100)	118959.27 (100)

Figures within the parentheses indicate percentages of total

Source: Field Survey (2002).

3.1.2 Feed Cost of the selected technologies

A huge number of feeds (more than 35) was used for fish production under the selected technologies in the study area, and the farmers followed no standard doses to apply them. Among them the major five feed items (in terms of quantity and cost) are discussed below. The other feed items are excluded from the discussion because of their small shares in total feed amount and cost.

The highest amount of feed used for carp-pangus technology was rice bran (24.90 percent) which was followed by wheat bran (16.31 percent), oil cake (12.82 percent), rice polish (8.76 percent) and litter (8.49 percent). But in terms of cost, meat bone ranked the highest (16.15 percent) followed by rice bran (15.89 percent), fish meal (14.56 percent), oil cake (12.00 percent) and wheat bran (11.59 percent) (Table-3).

In the case of carp poly technology, the highest feed amount of 26.13 percent was associated with rice polish. The other feed items were oil cake, grass, azola and wheat bran comprising percentages of 16.94, 11.42, 11.37 and 9.14 respectively. On the basis of cost, this order was found to be oil cake, wheat bran, rice polish, rice bran and poultry dropping with respective shares of 40.05, 20.12, 17.53, 10.61 and 2.59 percent.

Carp-golda technology used mussel meal in the highest amount (51.84 percent), while the other feed items were wheat bran (6.22 percent), saudi bangla (6.08 percent), wheat (4.07 percent) and rice polish (3.37 percent). On cost basis, the maximum expenditure was incurred for mussel meal (33.76 percent) and was followed by saudi bangla (15.23 percent), niribili (7.39 percent), fish meal (6.63 percent) and wheat bran (5.74 percent).

In the case of pangus mono technology, the maximum quantity of feed used was rice bran having relative share of 29.57 percent in total feed quantity. The next four feed items were found to be wheat bran, poultry dropping, rice polish and oil cake with their respective shares of 27.81, 24.12, 5.67 and 4.71 percent in total feed quantity. When the feed cost was considered, the order of the five maximum used feed items appeared to be rice bran, wheat bran, meat bone, fish meal and poultry dropping contributing 28.93, 28.23, 8.91, 6.63 and 6.61 percent in total feed cost respectively.

Table-3: Per Hectare Feed Cost of the Selected Technologies

Sl. No.	Name of feed	Technology											
		Carp-pangus		Carp poly		Carp-golda		Pangus mono		Golda mono		Nursery	
		Quantity (Kg)	Cost (Tk)	Quantity (Kg)	Cost (Tk)	Quantity (Kg)	Cost (Tk)	Quantity (Kg)	Cost (Tk)	Quantity (Kg)	Cost (Tk)	Quantity (Kg)	Cost (Tk)
1	Rice bran	8981.71 (24.90)	60737.03 (15.89)	375.01 (5.94)	2463.90 (10.61)	151.87 (2.96)	1081.49 (2.57)	16556.32 (29.57)	109706.13 (28.93)	214.76 (7.65)	1569.30 (4.36)	1101.91 (20.76)	7845.05 (16.44)
2	Rice polish	3159.60 (8.76)	14466.11 (3.78)	1648.16 (26.13)	4073.54 (17.53)	172.73 (3.37)	590.96 (1.41)	3172.82 (5.67)	17114.66 (4.51)	9.64 (0.34)	51.48 (0.14)	436.97 (8.23)	1236.20 (2.59)
3	Rice	-	-	-	-	152.81 (2.98)	1543.30 (3.67)	-	-	435.66 (15.52)	4398.35 (12.22)	-	-
4	Wheat bran	5883.66 (16.31)	44323.99 (11.59)	576.42 (9.14)	4673.17 (20.12)	319.07 (6.22)	2413.04 (5.74)	15566.73 (27.81)	107076.70 (28.23)	154.36 (5.50)	1074.08 (2.98)	530.08 (9.99)	3723.44 (7.81)
5	Wheat flour	1571.58 (4.36)	14983.40 (3.92)	20.09 (0.32)	214.82 (0.94)	20.81 (0.41)	182.52 (0.43)	784.96 (1.40)	7032.23 (1.85)	7.72 (0.28)	65.36 (0.18)	177.55 (3.35)	1626.96 (3.41)
6	Wheat	-	-	-	-	208.94 (4.07)	1722.60 (4.10)	-	-	9.50 (0.34)	82.49 (0.23)	-	-
7	Oil cake	4623.41 (12.82)	45880.88 (12.00)	1068.51 (16.94)	9304.31 (40.05)	159.65 (3.11)	1405.11 (3.34)	2638.53 (4.71)	24659.65 (6.50)	174.69 (6.22)	2091.25 (5.81)	1042.92 (19.65)	9443.18 (19.79)
8	Fish meal	2132.10 (5.91)	55673.13 (14.56)	3.98 (0.06)	116.00 (0.50)	138.11 (2.69)	2786.13 (6.63)	911.70 (1.63)	25138.45 (6.63)	19.78 (0.70)	743.95 (2.07)	103.28 (1.95)	2372.40 (4.97)
9	Meat bone	2784.29 (7.72)	61759.49 (16.15)	5.84 (0.09)	127.18 (0.55)	2.18 (0.04)	42.49 (0.10)	1534.22 (2.74)	33777.23 (8.91)	1.33 (0.05)	32.00 (0.09)	289.51 (5.45)	6365.65 (13.34)
10	Salt	233.26 (0.65)	2116.41 (0.55)	2.19 (0.03)	12.67 (0.05)	0.83 (0.02)	5.69 (0.01)	175.47 (0.31)	1225.23 (0.32)	0.83 (0.03)	3.86 (0.01)	-	-
11	Molasses	105.57 (0.29)	1216.31 (0.32)	-	-	-	-	-	-	-	-	-	-
12	Soybean meal	921.72 (2.55)	12229.74 (3.20)	0.71 (0.01)	10.71 (0.05)	54.08 (1.05)	730.83 (1.74)	679.95 (1.21)	11698.87 (3.08)	51.82 (1.85)	668.46 (1.86)	15.91 (0.30)	206.82 (0.43)
13	Vitamin premix	178.87 (0.50)	31224.50 (8.17)	0.29 (0.01)	39.72 (0.17)	0.07 (0.01)	7.69 (0.02)	77.40 (0.14)	12704.38 (3.35)	0.13 (0.01)	20.00 (0.06)	3.63 (0.07)	691.01 (1.45)

14	Litter	3062.28 (8.49)	5279.19 (1.38)	-	-	-	-	-	-	-	-	-	-
15	Oyster shell	534.44 (1.48)	4358.40 (1.14)	-	-	2.74 (0.05)	14.65 (0.03)	35.58 (0.06)	142.53 (0.04)	3.07 (0.11)	12.67 (0.04)	19.09 (0.36)	110.00 (0.23)
16	Maize polish	651.16 (1.80)	7005.17 (1.83)	-	-	0.38 (0.01)	8.46 (0.02)	212.66 (0.38)	1949.32 (0.51)	18.92 (0.67)	175.38 (0.49)	209.17 (3.94)	1923.86 (4.03)
17	Saudi bangla	65.83 (0.18)	1398.60 (0.37)	-	-	311.95 (6.08)	6401.13 (15.23)	-	-	195.45 (6.96)	4079.70 (11.34)	248.41 (4.68)	5459.01 (11.44)
18	Quality	852.66 (2.36)	15790.76 (4.13)	1.23 (0.02)	22.22 (0.10)	39.82 (0.78)	907.42 (2.16)	-	-	243.97 (8.69)	5111.30 (14.20)	-	-
19	Peleted	167.83 (0.47)	2349.65 (0.61)	-	-	152.04 (2.97)	1738.45 (4.14)	-	-	317.43 (11.31)	4183.86 (11.62)	636.74 (12.00)	5746.97 (12.05)
20	Poultry dropping	-	-	515.09 (8.17)	600.69 (2.59)	89.79 (1.75)	86.14 (0.20)	13503.45 (24.12)	25068.16 (6.61)	-	-	436.61 (8.23)	407.82 (0.85)
21	Grass	-	-	720.48 (11.42)	429.11 (1.85)	-	-	-	-	-	-	-	-
22	Helanchi	-	-	64.29 (1.02)	96.43 (0.42)	-	-	-	-	-	-	-	-
23	Azola	-	-	717.21 (11.37)	240.29 (1.03)	-	-	-	-	-	-	-	-
24	Khudipana	-	-	173.06 (2.74)	173.06 (0.74)	-	-	-	-	-		-	-
25	Mussel meal	-	-	-	-	2658.17 (51.84)	14186.54 (33.76)	68.81 (0.12)	828.91 (0.22)	309.90 (11.04)	2035.74 (5.66)	-	-
26	Niribili	-	-	-	-	156.45 (3.05)	3107.18 (7.39)	-	-	206.64 (7.36)	4219.41 (11.72)	-	-
27	Chira	-	-	-	-	68.53 (1.34)	905.96 (2.16)	-	-	188.22 (6.71)	2275.47 (6.32)	-	-
28	Semai	-	-	-	-	12.87 (0.25)	196.65 (0.47)	-	-	8.33 (0.30)	150.27 (0.42)	-	-
29	Buter dal	-	-	-	-	56.54 (1.10)	848.21 (2.02)	-	-	89.49 (3.19)	1301.15 (3.62)	-	-
30	Khesari dal	-	-	-	-	65.37 (1.27)	876.91 (2.09)	-	-	50.80 (1.81)	703.83 (1.96)	-	-

31	Potato	-	-	-	-	9.27 (0.18)	95.87 (0.23)	-	-		-	-	-
32	Kochu	-	-	-	-	121.77 (2.37)	121.77 (0.29)	-	-		-	19.55 (0.37)	309.09 (0.65)
33	Bason	-	-	-	-	0.77 (0.02)	13.85 (0.03)	-	-		-	7.91 (0.15)	150.00 (0.31)
34	Egg	-	-	-	-	-	-	-	-		-	28.01 (0.53)	88.03 (0.18)
35	Others	165.66 (0.46)	1516.21 (0.40)	415.85 (6.59)	633.68 (2.73)	-	-	66.21 (0.12)	1117.40 (0.29)	94.24 (3.36)	941.34 (2.62)	-	-
All	-	36075.63 (100)	382308.97 (100)	6308.41 (100)	23231.50 (100)	5127.61 (100)	42021.04 (100)	55984.81 (100)	379239.85 (100)	2806.68 (100)	35990.70 (100)	5307.25 (100)	47705.49 (100)

Others include cow viscera, cod liver oil, sweet gourd, etc.
Figures within the parentheses indicate percentages of total
Source: Field Survey (2002).

The most used five feed items for golda mono technology were rice (15.52 percent), peleted feed (11.31 percent), mussel meal (11.04 percent), quality feed (8.69 percent) and rice bran (7.65 percent). On the other hand, the maximum expenditure incurred for five feed items of this technology were quality feed (14.20 percent), rice (12.22 percent), niribili (11.72 percent), peleted feed (11.62 percent) and saudi bangla (11.34 percent).

In the case of nursery technology, rice bran was the most important feed item (20.76 percent), followed by oil cake (19.65 percent), peleted feed (12.00 percent), wheat bran (9.99 percent) and rice polish and poultry dropping (each 8.23 percent). If expenditures for the feed items is considered, the five highest cost feed items were found to be oil cake (19.79 percent), rice bran (16.44 percent), meat bone (13.34 percent), peleted feed (12.05 percent) and saudi bangla (11.44 percent).

From above discussion it is clear that in terms of quantity used, rice bran appeared to be the largest feed item for carp-pangus, pangus mono and nursery technologies while rice polish, rice and mussel meal were the largest feed items for carp poly, golda mono and carp-golda technologies respectively. On the other hand, in terms of cost incurred, oil cake was found to be the major feed item for carp poly and nursery technologies while meat bone, mussel meal, rice bran and quality feed were major feed items for carp-pangus, carp-golda, pangus mono and golda mono technologies respectively.

3.1.3 Other input cost of the selected technologies

Inputs like fertilizer, manure, labour (human), machine, water and lease were considered as other inputs for the selected technologies for the present study. There were four types of fertilizer used by the selected technologies (Table-4). Among them carp-pangus, carp poly, carp-golda and nursery technologies used three types (urea, TSP and MP), pangus-mono used four types (urea, TSP, MP and zypsum) and golda mono used only two types (urea and TSP) of fertilizer. Except carp-golda, other technologies used urea more as compared to other fertilizers followed by TSP, MP and zypsum. Carp-golda technology used TSP the most followed by urea and MP. The only manure item, cow dung, was used by all the technologies and its quantity was greater than the quantities of fertilizers used. Lime was also used by all technologies and, except for carp-pangus, other technologies used poison for their culture operations.

Human labor was used for pond preparation, intercultural operation and harvesting of fish from ponds. Machine charges and water costs were incurred for adding/irrigating water to the ponds. Moreover, the lease cost was the lease value of the pond area under operation.

In terms of cost incurred for using other inputs, labor for intercultural operation was the major cost item for all technologies except carp poly culture. The next largest input cost item for carp poly technology was labor for harvesting which constituted 36.20 percent of total other input cost. The second largest cost item was machine charge (22.16 percent) for carp-pangus technology while it was labor for intercultural operation for carp poly (25.67 percent), labor for harvesting for carp-golda (22.79 percent), golda mono (21.04 percent) and nursery (23.89 percent) and lease cost for pangus mono (17.46 percent) technologies. Moreover, Table-4 shows that machine charge and zipsum cost were the cost items experienced only by carp-pangus and pangus mono technologies respectively.

Table-4: Per Hectare Other Input Cost of the Selected Technologies

Sl. No.	Name of input	Technology											
		Carp-pangus		Carp poly		Carp-golda		Pangus mono		Golda mono		Nursery	
		Quantity	Cost (Tk)	Quantity	Cost (Tk)	Quantity	Cost (Tk)	Quantity	Cost (Tk)	Quantity	Cost (Tk)	Quantity	Cost (Tk)
1	Urea (kg)	114.07	683.92 (0.84)	123.53	756.32 (3.06)	45.96	284.86 (1.08)	262.93	1507.72 (1.95)	27.24	174.41 (0.54)	156.64	965.11 (2.55)
2	TSP (kg)	83.97	1058.70 (1.30)	113.33	1492.92 (6.05)	49.76	610.88 (2.31)	241.17	2849.15 (3.68)	5.93	67.10 (0.21)	128.52	1675.23 (4.42)
3	MP (kg)	15.43	151.24 (0.19)	1.20	11.20 (0.05)	4.07	39.37 (0.15)	20.17	257.02 (0.33)	-	-	14.36	139.23 (0.37)
4	Zipsum (kg)	-	-	-	-	-	-	12.79	51.15 (0.07)	-	-	-	-
5	Cow dung (kg)	1181.10	1181.10 (1.45)	3822.65	1728.61 (7.01)	419.32	201.06 (0.76)	4104.49	2823.90 (3.65)	324.49	90.89 (0.28)	1051.71	477.25 (1.26)
6	Lime (kg)	228.35	1406.87 (1.73)	133.46	868.45 (3.52)	136.86	808.63 (3.06)	370.47	2127.17 (2.75)	124.95	738.61 (2.28)	189.39	1085.82 (2.87)
7	Poison (kg)	-	-	0.61	110.79 (0.45)	0.64	147.30 (0.56)	0.63	162.54 (0.21)	1.21	221.76 (0.68)	1.80	430.50 (1.14)
8	Labor for pond preparation (man-day)	17.13	1140.65 (1.40)	21.11	1201.46 (4.87)	21.43	1702.95 (6.43)	29.23	1758.26 (2.27)	33.18	2927.85 (9.03)	17.80	1107.91 (2.93)
9	Labor for intercultural operation (man-month)	28.80	24720.04 (30.36)	16.57	6334.84 (25.67)	14.18	10114.97 (38.22)	29.47	37008.75 (47.86)	12.84	16481.40 (50.85)	27.60	13504.11 (35.65)
10	labor for harvesting	-	11905.53 (14.62)	-	8932.20 (36.20)	-	6032.67 (22.79)	-	10704.16 (13.84)	-	6819.39 (21.04)	-	9049.10 (23.89)
11	Machine charge	-	18042.02 (22.16)	-	-	-	-	-	-	-	-	-	-
12	Water cost		5788.36 (7.11)	-	1053.61 (4.27)	-	753.40 (2.85)	-	4582.61 (5.93)	-	204.20 (0.63)	-	4976.05 (13.14)
13	Lease cost		15205.73 (18.67)		2185.95 (8.86)	-	5769.11 (21.80)	-	13501.48 (17.46)	-	4683.14 (14.45)	-	4465.72 (11.79)
All		-	81429.34 (100)	-	24676.35 (100)	-	26465.21 (100)	-	77333.91 (100)	-	32408.75 (100)	-	37876.03 (100)

Figures within the parentheses indicate percentages of total

Source: Field Survey (2002).

3.1.4 Profitability of the selected technologies

Total return was the value of fingerling harvested via the nursery technology while it was the value of fish harvested for other technologies. Table-5 indicates that the highest total return of Tk. 967530.24 was obtained in carp-pangus technology and was followed by pangus mono (Tk. 873758.67), nursery (Tk. 856954.55), carp-golda (Tk. 238654.66), golda mono (Tk. 231985.23) and carp poly (Tk. 166315.02) technologies.

Fingerling cost was the largest for pangus mono technology (Tk. 128602.30) and the second largest fingerling cost was experienced by the nursery technology (Tk. 118959.27). In terms of fingerling cost, these technologies were followed by carp-pangus (Tk. 95549.69), golda mono (Tk. 57505.26), carp-golda (Tk. 47936.23) and carp-poly (Tk. 12788.91).

Feed cost was found to be the highest for carp-pangus technology which was Tk. 382308.97 and it was followed by pangus mono, nursery, carp-golda, golda mono and carp poly technologies which had expenditures of Tk. 379239.85, 47705.49, 42021.04, 35990.70 and 23231.50 respectively. The ranking of the technologies for other input costs was carp-pangus, pangus mono, nursery, golda mono, carp-golda and carp poly with respective cost of Tk. 81429.34, 77333.91, 37876.03, 32408.75, 26465.21 and 24676.35.

Total cost, comprising all cost items, was found to be the highest for pangus mono technology and it was Tk. 585176.06. It was followed by carp-pangus (Tk. 559288.00), nursery (Tk. 204540.79), golda mono (Tk. 125904.71), carp-golda (Tk. 116422.48) and carp poly (Tk. 60696.76) technologies under study.

Net return was derived by subtracting total cost from total return. It is evident from Table-5 that the highest net return per hectare of Tk. 652413.74 was achieved by the nursery technology. The second highest net return technology was carp-pangus yielding a net return of Tk. 408242.24. The other technologies in terms of net return were pangus mono, carp-golda, golda mono and carp poly experiencing net returns of Tk. 288582.61, 122232.18, 106080.52 and 105618.26 respectively. So, nursery was the most profitable technology followed by carp-pangus, pangus mono, carp-golda, golda mono and carp poly technologies.

Table 5. Per Hectare Returns and Profitability of the Selected Technologies

Sl. No.	Technology	Returns			Costs				Net return (Tk/ha)
		Quantity of fish/fingerling harvested (kg/ha)	Number of fish/fingerling harvested (No./ha)	Total return (Tk/ha)	Fingerling cost (Tk/ha)	Feed cost (Tk/ha)	Other input cost (Tk/ha)	Total cost (Tk/ha)	
1	Carp-pangus	18899.20	-	967530.24	95549.69	382308.97	81429.34	559288.00	408242.24
2	Carp poly	3422.07	-	166315.02	12788.91	23231.50	24676.35	60696.76	105618.26
3	Carp-golda	1565.88	-	238654.66	47936.23	42021.04	26465.21	116422.48	122232.18
4	Pangus mono	16389.05	-	873758.67	128602.30	379239.85	77333.91	585176.06	288582.61
5	Golda mono	767.09	-	231985.23	57505.26	35990.70	32408.75	125904.71	106080.52
6	Nursery	755.41	777896.18	856954.53	118959.27	47705.49	37876.03	204540.79	652413.74
	All	41798.70	777896.18	3335198.35	461341.66	910497.55	280189.59	1652028.80	1683169.55
	Average	6966.45	129649.36	555866.39	76890.28	151749.59	46698.27	275338.13	280528.26

Source: Field Survey (2002).

3.2 Composition of Feed Items under Different Technologies

In the study area, more than 35 feed items were used by the respondents using different technologies. Among them, the largest number of feeds (27) was used by carp-golga technology (Table-6). The second and third highest feed using technologies were golda mono (24) and carp-pangus (18) respectively. Each of the carp poly and nursery technologies used 17 feed items and ranked fourth while the lowest number of feeds (14) was used by pangus mono technology. So, carp-golda technology was the maximum feed-use technology and pangus mono technology was the minimum feed-use technology under study.

In terms of the frequency of the respondents and consideration of maximum used five feed items, wheat bran was the most commonly cited feed item by the carp-pangus respondents (90.91 percent), followed by oil cake (85.45 percent), rice bran (83.64 percent), vitamin premix (67.27 percent) and salt (61.82 percent). This ranking for carp poly technology was oil cake (96.00 percent), rice polish (70.00 percent), wheat bran (56.00 percent), grass (28 percent) and poultry dropping (23.00 percent). For carp-golda technology it was mussel meal (76.92 percent), oil cake (63.08 percent), wheat (46.79 percent), saudi bangla (46.15 percent) and wheat bran and rice bran (each of 43.08 percent). The ranking of the five common feed items for pangus mono technology was wheat bran, rice bran, oil cake, vitamin premix and salt having corresponding percentages of total respondents of 98.01, 96.08, 68.63, 62.75 and 56.86 percent. For golda mono technology, it was rice (62.00 percent), oil cake (56.00 percent), chira (50.00 percent), saudi bangla (40.00 percent) and niribili and semai (each of 34.00 percent).

Among the five feed items used by the largest number of nursery respondents, oil cake was the most common feed item (87.27 percent) followed by rice bran (49.09 percent), meat bone (43.64 percent), wheat flour (34.55 percent) and wheat bran (32.73 percent). So, rice was the most commonly used feed item by the respondents of golda mono technology, wheat bran for carp pangus and pangus mono technologies, oil cake for carp poly and nursery technologies and mussel meal for carp golda technology.

The last column of Table-6 shows the frequency of technologies using different feed items for supplementary feed-based aquaculture in Bangladesh. It appears from the table that among 35 feed items, 9 items were used by all 6 technologies, followed by 3 items by 5 technologies, 4 items by 4 technologies, 2 items by 3 technologies, 9 items by 2 technologies and 8 items by 1 technology. The highest and most general nine feed items used by all technologies were rice bran, rice polish, wheat flour, wheat polish, oil cake, fish meal, meat bone, soybean meal and vitamin premix.

Table-6: Composition of Feeds under Different Technologies

Sl. No.	Name of feed	Technology													
		Carp-pangus		Carp poly		Carp-golda		Pangus mono		Golda mono		Nursery		Technology practiced	
		Respon-dent (No.)	%	Respon-dent (No.)	%	Respon-dent (No.)	%	Respon-dent (No.)	%	Respon-dent (No.)	%	Respon-dent (No.)	%	Techno-logy (No.)	%
1	Rice bran	46	83.64	17	17.00	28	43.08	49	96.08	16	32.00	27	49.09	6	100.00
2	Rice polish	24	43.64	70	70.00	16	24.62	13	25.49	2	4.00	19	34.55	6	100.00
3	Rice	-	-	-	-	24	36.92	-	-	31	62.00	-	-	2	33.33
4	Wheat bran	50	90.91	56	56.00	28	43.08	50	98.04	6	12.00	18	32.73	6	100.00
5	Wheat flour	30	54.55	3	3.00	14	21.54	9	17.65	4	8.00	19	34.55	6	100.00
6	Wheat	-	-	-	-	31	46.79	-	-	4	8.00	-	-	2	33.33
7	Oil cake	47	85.45	96	96.00	41	63.08	35	68.63	28	56.00	48	87.27	6	100.00
8	Fish meal	29	52.73	3	3.00	21	32.31	27	52.94	8	16.00	15	27.27	6	100.00
9	Meat bone	31	56.36	2	2.00	4	6.15	27	52.94	1	2.00	24	43.64	6	100.00
10	Salt	34	61.82	7	7.00	6	9.23	29	56.86	2	4.00	-	-	5	83.33
11	Molasses	7	12.73	-	-	-	-	-	-	-	-	-	-	1	16.67
12	Soybean meal	16	29.09	1	1.00	10	15.38	9	17.65	10	20.00	2	3.64	6	100.00
13	Vitamin premix	37	67.27	3	3.00	1	1.54	32	62.75	1	2.00	15	27.27	6	100.00
14	Litter	20	36.36	-	-	-	-	-	-	-	-	-	-	1	16.67
15	Oyster shell	10	18.18	-	-	5	7.69	5	9.80	2	4.00	2	3.64	5	83.33
16	Maize polish	9	16.36	-	-	1	1.54	5	9.80	4	8.00	14	25.45	5	83.33
17	Saudi bangla	2	3.64	-	-	30	46.15	-	-	20	40.00	11	20.00	4	66.67
18	Quality	2	3.64	1	1.00	12	18.46	-	-	8	16.00	-	-	4	66.67
19	Peleted	1	1.82	-	-	6	9.23	-	-	11	22.00	6	10.91	4	66.67

20	Poultry dropping	-	-	23	23.00	9	13.85	-	-	-	-	9	16.36	3	50.00
21	Grass	-	-	28	28.00	-	-	-	-	-	-	-	-	1	16.67
22	Helanchi	-	-	1	1.00	-	-	-	-	-	-	-	-	1	16.67
23	Azola	-	-	8	8.00	-	-	-	-	-	-	-	-	1	16.67
24	Khudipana	-	-	4	4.00	-	-	-	-	-	-	-	-	1	16.67
25	Mussel meal	-	-	-	-	50	76.92	5	9.80	15	30.00	-	-	3	50.00
26	Niribili	-	-	-	-	13	20.00	-	-	17	34.00	-	-	2	33.33
27	Chira	-	-	-	-	16	24.62	-	-	25	50.00	-	-	2	33.33
28	Semai	-	-	-	-	15	23.08	-	-	17	34.00	-	-	2	33.33
29	Buter dal	-	-	-	-	14	21.54	-	-	11	22.00	-	-	2	33.33
30	Khesari dal	-	-	-	-	8	12.31	-	-	5	10.00	-	-	2	33.33
31	Potato	-	-	-	-	3	4.62	-	-	-	-	-	-	1	16.67
32	Kochu	-	-	-	-	5	7.69	-	-	-	-	3	5.45	2	33.33
33	Bason	-	-	-	-	1	1.54	-	-	-	-	2	3.64	2	33.33
34	Egg	-	-	-	-	-	-	-	-	-	-	5	9.09	1	16.67
35	Others	5	9.09	13	13.00	-	-	3	5.88	11	22.00	-	-	4	66.67

Others include cow viscera, cod liver oil, sweet gourd, etc.

Source : Field Survey (2002)

3.3 Demand for Local Feed Items

An attempt was made to determine the present demand for local feed items per hectare on the basis of the current pattern of feed use/requirement by the respondents under the selected technologies. Table-7 reveals the requirement of six local feed items. Among them rice bran appeared with a maximum requirement of 8981.71, 16556.32, 214.76 and 1101.91 kg per hectare for carp-pangus, pangus mono, golda mono and nursery technologies while rice polish (1648.16 kg) and wheat bran (319.07 kg) were the largest requirement for carp poly and carp-golda technologies respectively. The table also reveals the average pond sizes of selected 6 technologies under study. The average pond sizes for carp-pangus, carp poly, carp-golda, pangus mono, golda mono and nursery technologies were found to be 0.32, 0.26, 0.64, 0.36, 0.60 and 0.29 ha respectively. Thus the average pond size for all the technologies stood at 0.41 ha.

Table-7: Per Hectare Demand/Requirement of Local Feed Items

Sl. No.	Feed item	Technology						Average	
		Carp-pangus (kg)	Carp poly (kg)	Carp-golda (kg)	Pangus mono (kg)	Golda mono (kg)	Nursery (kg)	Kg	MT
1	Rice bran	8981.71	375.01	151.87	16556.32	214.76	1101.91	4563.60	4.56
2	Rice polish	3159.60	1648.16	172.73	3172.82	9.64	436.97	1433.32	1.43
3	Wheat bran	5883.66	576.42	319.07	15566.73	154.36	530.08	3838.39	3.84
4	Wheat flour	1571.58	20.09	20.81	784.96	7.72	177.55	430.45	0.43
5	Oil cake	4623.41	1068.51	159.65	2638.53	174.69	1042.92	1617.95	1.62
6	Maize polish	651.16	-	0.38	212.66	18.92	209.17	182.05	0.18
Pond size (ha)		0.32	0.26	0.64	0.36	0.60	0.29	0.41	-

Source: Field Survey (2002).

Taking all technologies together, the average per hectare requirement of the local feed items, i.e., rice bran, rice polish, wheat bran, wheat flour, oil cake and maize polish amounted to 4.56, 1.43, 3.48, 0.43, 1.62 and 0.18 MT respectively. So, rice bran is the major feed item for feed based aquaculture in Bangladesh as its requirement was the highest (4.56 MT/ha) among all feed items.

3.4 Availability of Local Feed Items

Different feed mills and companies were surveyed regarding the percentages of the above-mentioned six feed items (data on other feed items was not available) in the mother/original output/produce during the time of study. According to them, the overall percentages of rice bran, rice polish, wheat bran, wheat flour, oil cake and maize polish in mother/original output were estimated to be 2.08, 22.50, 14.00, 3.50, 63.50 and 97.00 percent respectively. So, these percentages were multiplied with the respective original output to determine the availability of local feed items. Thus availability of local feed items appeared to be 479793.60, 5190075.00, 287973.00, 71993.25, 172085.00 and 3880.00 MT for rice bran, rice polish, wheat bran, wheat flour, oil cake and maize polish respectively.

Table-8: Availability of Local Feed Items

Sl. No.	Source		Feed availability					
	Name	Quantity	Rice bran (2.08%) (MT)	Rice polish (22.50%) (MT)	Wheat bran (14%) (MT)	Wheat flour (3.5%) (MT)	Oil cake (63.5%) (MT)	Maize polish (97%) (MT)
1	Rice	23067000	479793.60	5190075.00	-	-	-	-
2	Wheat	2056950	-	-	287973.00	71993.25	-	-
3	Mustard and Til	271000	-	-	-	-	172085.00	-
4	Maize	4000	-	-	-	-	-	3880.00

Source: BBS (2004) and Field Survey (2002).

3.5 Local Feed Prices

An attempt was made to understand the movement of local feed prices for culture fisheries of the country. For this, draft documents of different feed companies were investigated. Remarkable variations were noted among the feed prices of different places. The average prices of local feed items for five years were collected which are shown in Table-9. The table indicates that the highest cost feed item was maize polish followed by wheat flour, oil cake, wheat bran, rice bran and rice polish. The corresponding prices per quintal for the year 1996 were found to be Tk. 695.00, 542.00, 389.00, 218.00, 211.00 and 111.00.

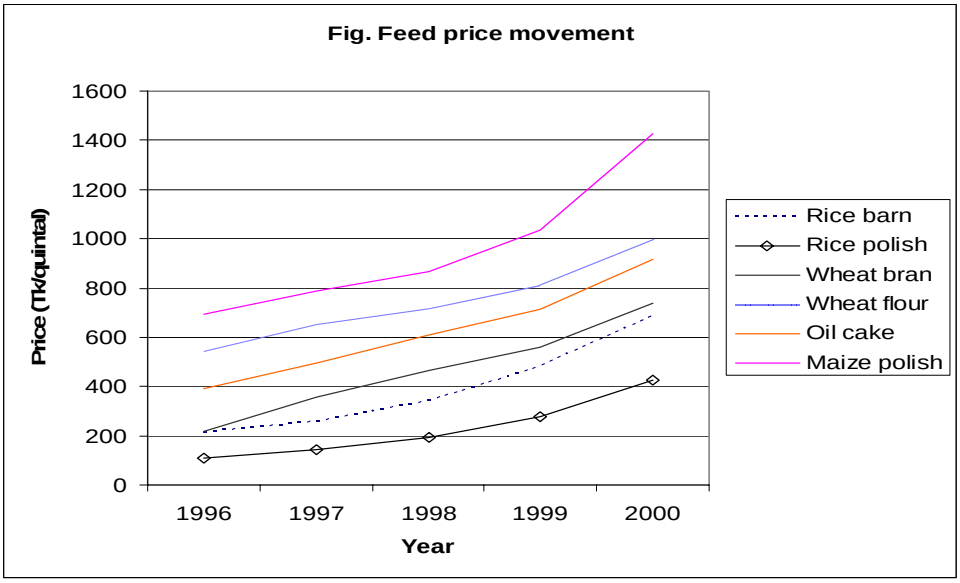
Figure 1 shows the three year moving average of price movements of the selected local feed items. It is evident from both the table and figure

that local feed prices are increasing over time. Moreover, Figure 1 clearly shows that the rate of increase is going to be higher in succeeding years as feed based aquaculture incorporates more and more areas under its operation. So, proper steps (increasing land under feed production, introducing local feed processing technologies, extension services to the feed growers, etc.) need to be undertaken immediately to ensure the supply of local feeds to maintain feed prices within the purchasing ability of the fish farmers on one hand and make feed based aquaculture sustainable on the other.

Table-9: Local Feed Prices

Sl. No.	Feed item	Price (Taka/quintal)					Three yearly moving average (Taka/quintal)				
		1996	1997	1998	1999	2000	1996	1997	1998	1999	2000
1	Rice bran	211	258	343	479	682	-	270.67	360.00	501.33	-
2	Rice polish	111	146	194	278	427	-	150.33	206.00	299.67	-
3	Wheat bran	218	357	468	562	738	-	347.67	462.33	589.33	-
4	Wheat flour	542	650	712	805	995	-	634.67	722.33	837.33	-
5	Oil cake	389	495	610	714	917	-	498.00	606.33	747.00	-
6	Maize polish	695	788	867	1035	1231	-	783.33	896.67	1044.33	-

Source: Field Survey (2002) (unpublished documents of different feed companies).



3.6 Sustainability of Feed-based Aquaculture in Bangladesh

Sustainability of feed based aquaculture with respect to local feed availability was studied. At present, the total pond and ditch area of Bangladesh is 305025 ha (DoF, 2005). Because of the absence of secondary data, senior officials and scientists of different research institutions were asked about the share of feed based aquaculture in the total pond and ditch area of Bangladesh. According to their responses, it was found that at least 75% of total pond and ditch area is currently under feed based aquaculture. Moreover, they stated that the area under feed based aquaculture is increasing day by day. The sustainability of feed based aquaculture is assessed in Table-10 with respect to 75%, 85% and 95% of total pond and ditch area of the country.

Table-10 clearly shows that, except rice polish, all five local feed items reveal a domestic production deficit irrespective of percentage of area under feed based aquaculture. Moreover, this deficit increases with the increase in area under operation. Among the deficits, the maximum deficit was associated with wheat bran (590499.00 MT) followed by rice bran (563391.90 MT), oil cake (198520.38 MT), maize polish (37298.38 MT) and wheat flour (26377.38 MT) considering 75% of total area under feed-based aquaculture. These deficits are currently being met by importing feeds from abroad (importing the same feed items or other feeds to supplement the local feeds). As more and more area is being used for culture fisheries, the deficits are widening and feed based aquaculture is going to become a highly import dependent technology in Bangladesh. So, if this situation continues, feed based aquaculture will not be a sustainable income generating activity for the improvement of the livelihoods of the rural people of Bangladesh.

Table-10: Sustainability of Feed-based Aquaculture with Respect to Local Feed Availability

Sl #	Feed item	Availability (MT)	75% of pond and ditch area		85% of pond and ditch area		95% of pond and ditch area	
			Require-ment (MT)	Surplus/deficit (+/-) (MT)	Require-ment (MT)	Surplus/deficit (+/-) (MT)	Require-ment (MT)	Surplus/deficit (+/-) (MT)
1	*2*	*3*	*4*	*(5=3-4)*	*6*	*(7=3-6)*	*8*	*(9=3-8)*
1	Rice bran	479793.60	1043185.50	(-)563391.90	1182276.90	(-)702483.30	1321368.30	(-)841574.70
2	Rice polish	5190075.00	327139.31	(+)4862935.69	370757.89	(+)4819317.11	414376.46	(+)4775698.54
3	Wheat bran	287973.00	878472.00	(-)590499.00	995601.60	(-)707628.60	1112731.20	(-)824758.20
4	Wheat flour	71993.25	98370.56	(-)26377.31	111486.64	(-)39493.39	124602.71	(-)52609.46
5	Oil cake	172085.00	370605.38	(-)198520.38	420019.43	(-)247934.43	469433.48	(-)297348.48
6	Maize polish	3880.00	41178.38	(-)37298.38	46668.83	(-)42788.83	52159.28	(-)48279.28

Total pond and ditch area of Bangladesh= 305025 ha (DoF, 2005).

4. Conclusion and Policy Implication

4.1 Conclusion

The following conclusions can be drawn from the above study:

(i) Average pond sizes for the carp-pangus, carp poly, carp-golda, golda mono, pangus mono and nursery technologies were found to be 0.32, 0.26, 0.64, 0.60, 0.36 and 0.29 ha respectively.

(ii) There were 14 types of fingerling used for the selected technologies. In the case of nurseries, fingerling was purchased both in weight and number basis.

(iii) More than 35 feed items were found to be used for the selected six technologies in different parts of the country. Among them were rice bran, rice polish, wheat bran, wheat flour, oil cake, fish meal, meat bone, soybean meal and vitamin premix- and these 9 feed items were used by all the technologies.

(iv) Among the local feed items, rice bran, rice polish, wheat bran, wheat flour, oil cake and maize polish were the most used feeds for the technologies under study.

(v) On average, per hectare feed requirements for the local feed items were estimated to be 4.56, 1.43, 3.84, 0.43, 1.62 and 0.18 MT for rice bran, rice polish, wheat bran, wheat flour, oil cake and maize polish respectively.

(vi) Availability of local feed items mentioned above amounted to 479793.60, 5190075.00, 287973.00, 71993.25, 172085.00 and 3880.00 MT respectively for the year 1999-2000.

(vii) On the basis of the above requirements and availability estimates, except rice polish, all the local feed items required imports to run culture fisheries in the country. As culture fisheries capture more and more areas under its operation, it is going to become an import dependent practice if the feed situation prevails without any measures to address it.

(viii) As culture fisheries are an important source of income and employment, they have a significant livelihood impact on the economy of Bangladesh. Therefore, proper policy and other measures

are suggested to be taken by both the government organizations and NGOs to improve the local fish feed situation of the country.

4.2 Policy Implications

(i) BBS, DoF and other concerning organizations should record feed and other fisheries related data regularly.

(ii) The government and NGOs should come forward to establish local feed mills to cater to the feed requirement of the growing and promising fish culture industry.

(iii) Intensive research programs should be undertaken immediately by both GOs and NGOs for quality innovation.

(iv) Farmers/users should be trained so that they can use the feed and other inputs more efficiently.

(v) Capital should be supplied to the farmers who suffer from a lack of sufficient capital to use/purchase feeds from the market in a timely fashion.

(vi) A monitoring system should be developed to check the adulteration of fish feed in the country.

(vii) A subsidy/duty reduction package can be launched for imported feed ingredients (which cannot be produced domestically) so that supplementary fish culture can be sustained with lower costs of production.

4.3 Livelihood Implications

This project found a great livelihood impact of supplementary feed-based aquaculture in Bangladesh. This practice provides vast opportunities to the unemployed and self-employed rural youth of the country. Moreover, many people have already found ways to earn a living in feed processing and marketing. The nutritional and other values of supplementary fish culture are also worth mentioning. So, supplementary feed–based aquaculture should be made sustainable with local feed ingredients to explore its potential for poverty alleviation as well as economic development.

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Book Review

Inayatullah, Rubina Saigol, Pervez Tahir (Eds), *Social Science in Pakistan: A Profile*, Council of Social Science Pakistan (COSS), Islamabad, 2005, pp 512, Price Pak Rs. 500, US $ 20.

Social scientists study various facets of human society. Historically, societies were understood and explained through religious and philosophical texts. History, Philosophy and Politics also developed as independent disciplines. One thinks of Plato's **Republic**, Chanakya's **Arthashastra**, and histories by various Greek, Roman, Arab, Persian, Turk, Chinese and Indian writers. One notable contribution to the study of societies is by Ibn Khaldun, the 14th century Tunisian, considered the first sociologist of the world.

However, it is the advent of the Industrial Revolution – first in England and later its spread to the rest of Europe and North America - that gave rise to a new type of society, the like of which had no precedent in history. This new industrial society had totally new characteristics not observed in earlier ones. New sciences of sociology, economics, psychology, and anthropology were developed. Advances were made in the older disciplines of philosophy, political science and history. Europeans who had colonized the Americas and Oceania in the 16th- 18th centuries completed the colonization of the rest of the world by the first decade of the 20th century. They introduced newly developed knowledge along with new institutions for governance, control and exploitation during the colonial rule. The British introduced a new educational system with schools, colleges and universities in the 19th century. The Punjab University was one of the first five universities established in the sub-continent in the last quarter of the 19th century. Science and social science disciplines, developed in Europe, were introduced in the colonies. Newer disciplines like anthropology, ethnography, and linguistics that helped understand the newly subjugated societies were developed.

The book under review takes stock of the state in which various disciplines of the social sciences exist in Pakistan. It consists of twenty essays, seventeen of which describe the state of Economics, History, Pakistan Studies, Political Science, International Relations, Peace and Conflict Resolution, Area Studies, Strategic Studies, Sociology, Public Administration,

Linguistics, Journalism and Mass Communication, Philosophy, Psychology, Anthropology, Women's Studies and Education. One essay assesses the contribution of NGOs to social science research in Pakistan, while another looks at the quantitative development of the social sciences. Inayatullah has contributed an introduction, while Rubina Saigol has provided a conclusion. All contributors hold senior positions in universities and research establishments. All essays evaluate the state of their discipline, quantitatively as well as qualitatively. They also try to identify the factors that have helped or hindered the development of their respective disciplines.

Pakistan inherited the colonial state and other affiliated institutions, the schools, colleges and the Punjab University. At that time only traditional disciplines such as economics, political science, history and philosophy were taught at undergraduate levels in colleges. The practice continued in the earlier years after independence. Since Pakistan became a US ally in the Cold War soon after independence, American influence replaced the earlier British colonial perspective in the study of various subjects. With American assistance, newer disciplines were introduced: Public Administration in 1955, Sociology, Social Work, Applied Psychology in the 1960s, Anthropology, Area Studies, Strategic Studies, International Relations in the 1970s and Peace and Conflict Studies and Women's Studies in the 1990s. A significant development of the late 1970s has been the decline of the discipline of History and the introduction of the subject of Pakistan Studies as a compulsory subject up to the undergraduate level. This has made the teachers of this new subject the largest group among college teachers.

All contributors have noted that, despite impressive growth in the numbers of teachers and institutions, the state of social science in Pakistan is very unsatisfactory. Hardly any significant research has emerged from these institutions despite a large number of theses churned out by post-graduates.

The book is successful in its endeavour of giving the reader a comprehensive picture of the state of development of various disciplines of the social sciences. However, except for a very few, most articles are descriptive rather than analytical. They shed little light on the reasons for the sad state of the social sciences in Pakistan.

Rubina Saigol notes in her concluding essay, "overwhelming ideological orientation of teachers across the disciplinary spectrum revolves around religious and nationalist thinking.....so deeply rooted are the teachers and students in the hegemonic version of state and society that even the social sciences, which are tasked to produce alternative visions, fail

to do so." "The absence of debate and controversy, discussions and contention, makes most of the universities very dull and insipid places where received knowledge from old books is transmitted from generation to generation in the same unchanging way".

This book is a wake up call for all thinking individuals as well as social scientists in Pakistan, as it highlights the dismal state of the social sciences in Pakistan. Social scientists have failed to study and understand the contours and the dynamics of their own society, leaving the task to foreign governments and academics. That is not enough or even appropriate. Pakistan, though a new country, is peopled by the descendents of one of the oldest civilizations. It has witnessed the interaction and intermingling of indigenous people with those from the West and North. It has been the birth place of Hinduism, Buddhism, Jainism, Sikhism and it has welcomed Muslims, Christians, Jews, and Zoroastrians. So many influences have gone into the making of the personality and psyche of her people. Pakistani social scientists should study and explore their society so that they can identify the problems and suggest their solutions to help the people to transform themselves into a prosperous, peaceful and humane nation.

Lahore School of Economics Dr. Anis Alam
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