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GROWTH AND SECTORAL INEQUALITY IN PAKISTAN: 2001-02 TO 2004-05

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Abstract. Existing work on inequality in Pakistan remains limited to analyzing inequality at regional and province level. Changes in inequality at sectoral level have not received attention. This paper examines within sector inequality and how changes in inequality are associated with growth using the most recent primary data of the two household surveys PIHS, 2001-02 and PSLM, 2004-05. The results show that the household head employed in Financing, Electricity, Manufacturing, and Community services appear to be more affluent than the other sectors' head. Financing sector turned out to be the most unequal distribution of consumption followed by Mining, Manufacturing and Community services sector. Between 2001-02 and 2004-05 inequality increased in most of the economic sectors, *i.e.* Agriculture, Manufacturing, Electricity, Construction, Wholesale and Retail Trade, Community and personal services and undefined sector. These sectors employed 87.5% of all head of households in 2004-05. In general, inequality increased in economic sectors, which witnessed a high economic growth. To reduce sectoral inequality, the government can focus policies to equalize the remuneration across sectors via tax and expenditure polices.

I. INTRODUCTION

The issue of income inequality has been central in Pakistan since the early 1960s when the country laid its foundation of development on the principle of rapid growth of GDP. Consequently, a number of authors examined the extent of income

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or expenditure inequality using the household income and expenditure survey data. The early attempts are based on published grouped data set of Household Income and Expenditure Surveys (HIES) conducted by the Federal Bureau of Statistics, Government of Pakistan. Later on, a number of authors/institutions used primary data when it became available and estimated income or consumption inequality in Pakistan. However, existing work is limited to examining inequality at regions and province level. Sectoral inequality has not received adequate attention in Pakistan. Sectoral inequality is important since it helps the policy maker to devise policies to improve extreme inequality at sectoral level. The paper address this issue and examines within sector inequality using the most recent primary data of the two household surveys namely Pakistan Integrated Household Survey (PIHS), 2001-02 and Pakistan Social and Living Standard Measurement Survey (PSLSM), 2004-05.

The organization of the paper is follows: The next section provides an overview of inequality and growth in Pakistan. Section III discusses the methodology and data used in this paper. Section IV presents the results for sectoral inequality. Concluding remarks are given in the final section.

II. AN OVERVIEW OF INEQUALITY AND GROWTH IN PAKISTAN

A number attempts have been made[1] to estimate extent of income inequality in Pakistan during the last four decades. These studies are based on published grouped data set of Household Income and Expenditure Surveys (HIES) conducted by the Federal Bureau of Statistics, Government of Pakistan. However, recently when primary data of HIES became available in the 1990s, a number of authors/institutions used the micro data to estimate the income or consumption inequality in Pakistan. These included FBS (2001), Word Bank (2003), Anwar (1997) and Anwar (2003, 2005).

A review of these studies suggests that after initially increasing rapidly in 1966-67, income inequality declined in the late 1960s in Pakistan (*see* Figure 1). However, income inequality seems to have increased in the 1970s which later on decline till the late 1980s. Income inequality increased rapidly in 1990 and then declined till 1996-97. However, inequality increased rapidly between 1996-97 and 1998-99, turning 1998-99 as the most unequal distribution in Pakistan.

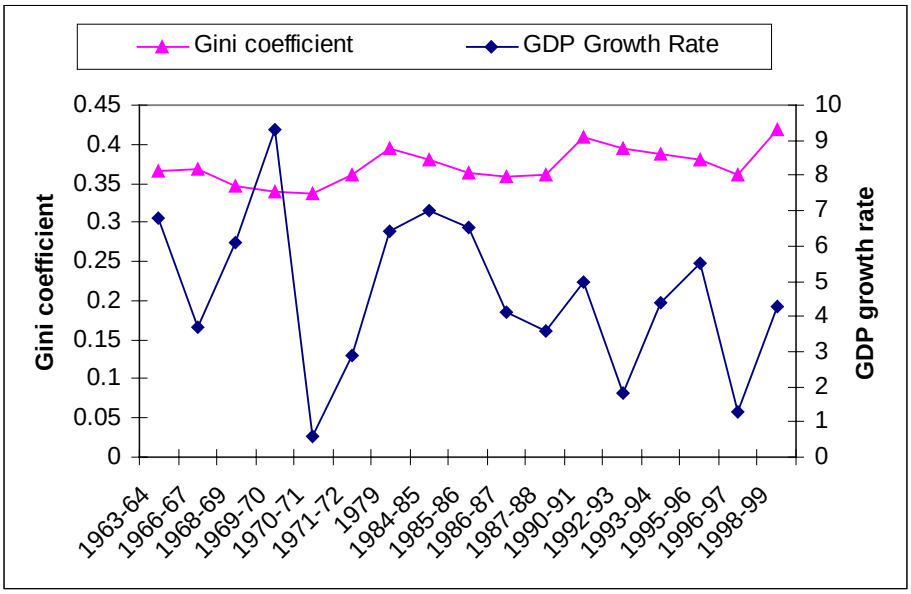
There seems to be no correlation between growth and inequality in Pakistan as the correlation coefficient is found to be very low at 0.003 during the whole period. This may be due to the fact that inequality declined during high growth period and increased during low growth period. For example, inequality declined in the 1960s which was the period of high economic growth rate. On the other hand, period of

[1]These include Bergen (1967), Azfar (1973), Khundkar (1973), Naseem (1973), Alauddin (1975), Chaudhry (1982), Mahmood (1984), Kruik and Leeuwen (1985), Ahmad and Ludlow (1989) and Malik and Shahnawaz (1992).

1970s is differentiated as low growth period but inequality increased during this period. However, the growth rates were respectably high to about 6.0 per annum during the 1980s but inequality decreased during this period. Later on, economic growth slowed down during the decade of the 1990s, which seems to have affected the income of the poorest segments of the population and led to higher inequality in Pakistan. Thus, it appears that while rapid growth narrowed the inequality during the 1960s and 1980s, the slow growth increased inequality in Pakistan at the end of the 1990s.

FIGURE 1

Growth and Inequality in Pakistan, 1963-64 and 1998-99



However, most of the work is limited to examining inequality at regions and province level. Sectoral inequality has not received attention in Pakistan. An investigation of inequality at sectoral level may help the policy maker to devise economic policies to reduce extreme inequality at sectoral level. To fill this gap, this paper examines within sector level of inequality as well changes in it using the most recent primary data of the two household surveys namely Pakistan Integrated Household Survey (PIHS), 2001-02 and Pakistan Social and Living Standard Measurement Survey (PSLSM), 2004-05.

TRENDS IN SECTORAL GDP GROWTH, 2001-02 TO 2004-05

Over the last few years, Pakistan's economy recovered from the low growth path of the late 1990s. The recovery began in 2003-04 and gained further momentum in 2004-05 with real GDP rising to 8.6 percent — the fastest in the last two decades.

On average real GDP growth rate was at 6.9 percent per annum spanning the period of two household surveys, 2001-02 and 2004-05 (*see* Table 1).

TABLE 1

Real Sectoral GDP Growth Rates between 2001-02 to 2004-05 (%)

Sector	GDP Growth Rates (%)				
	2001-02	2002-03	2003-04	2004-05	2001-02 to 2004-05
COMMODITY PROD. SECTOR	1.3	4.3	9.2	9.2	7.6
Agriculture	0.1	4.3	2.3	6.7	4.4
Major Crops	–2.5	6.7	1.9	17.8	8.8
Minor Crops	–3.7	1.8	4.0	3.0	2.9
Livestock	3.7	3.0	2.5	2.3	2.6
Fishing	–12.3	3.4	2.0	2.2	2.5
Forestry	–4.4	11.1	–3.2	–30.4	–7.5
INDUSTRIAL SECTOR	2.6				
Mining and Quarrying	7.3	6.6	15.6	9.6	10.6
Manufacturing	4.5	6.9	14.0	12.6	11.2
Large Scale	3.5	7.2	18.1	15.6	13.6
Small & Household	7.5	7.5	7.5	7.5	7.5
Construction	1.6	4.0	–10.7	18.6	4.0
Electricity and Gas Distribution	–7.0	–11.7	56.8	3.5	16.2
SERVICES SECTOR	4.8	5.2	5.9	8.0	6.4
Transport, Storage and Communication	1.2	4.3	3.5	3.6	3.8
Wholesale & Retail Trade	2.8	5.9	8.4	11.1	8.5
Finance and Insurance	17.2	–1.3	9.0	29.7	12.5
Ownership of Dwellings	3.5	3.3	3.5	3.5	3.4
Public Admn. and Defence	6.9	7.7	3.2	0.6	3.8
Services	7.9	6.1	5.6	5.9	5.9
Real GDP (fc)	3.1	4.7	7.5	8.6	6.9

Source: *Economic Survey*, 2005-06. Finance Division, Islamabad

The growth was broad-based since each sub-sector witnessed robust growth. The acceleration in growth 2004-05 was aided by an exceptional performance in large-scale manufacturing, notable recovery in agriculture and a robust growth in services sector. After a four year of slow growth, Agriculture sector recovered and grew by 6.7 percent in 2004-05 on the back of an exceptional increase in the production of cotton and wheat crops. These two crops account for about 24 percent of the value added in this sector. On average, Agriculture sector grew by 4.4 percent over the household survey period.

Manufacturing sector which account for 18.3 percent of GDP, recorded an impressive growth of 12.5 percent in 2004-05 and 14.1 percent in 2003-04. The average growth rate for the Manufacturing sector was 11.2 percent between 2001-02 and 2004-05. Over the two surveys period Mining sector grew by 10.6 percent; Electricity and Gas sector grew by 16.2 percent; Construction sector by 4.0 percent.

Similarly, over the two surveys period the services sector which accounted for 52 percent of GDP record a growth of 6.4 percent; Of which Transport sector grew by 3.8 percent; Wholesale and Retail Trade grew by 8.5 percent; Financing sector grew by 12.5 percent' Public administration and Defence grew by 3.8 percent.

The high growth was supported by accommodative macroeconomic and financial sector policies which provided excessive credit to the private to generate domestic demand for consumer durable goods. Owing to lax monetary policy inflation accelerated to 9.3 percent in 2004-05. The overall inflation between the two-survey period was 21.5 percent mainly due to easy monetary policy and rising oil prices in the international market.

In this backdrop, it would be interesting to see how these sectoral growth rates of GDP translated in growth in household income or consumption expenditure. Does high growth in GDP resulted in higher growth in income or consumption of the households working in these sectors? How the increased sectoral growth affected the inequality of among households across economic sectors? The answers to these questions are addressed in the Section 4 of the paper.

III. METHODOLOGY, DATA AND VARIABLES

Although a number of inequality indices have been suggested[2] for the measurement of inequality, the Gini Coefficient is a well-known measure which is derived from the Lorenz curve, which plots the cumulative share of total income (or consumption), y_i earned by households or population, X_i ranked from bottom to top, where y_i are arranged in ascending order by their subscripts. It can be expressed as follows:

[2]For various inequality measures, *see* Kakwani (1980, 1990) and Culyer and Wagstaff (1997).

$$G = 1 - \sum_{i=0}^{k-1} (Y_{i+1} + Y_i)(X_{i+1} - X_i)$$

Where y_i are arranged in ascending order by their subscripts. The Gini coefficient is most sensitive to the middle part of distribution since it depends on the rank order weights of income recipients and on the number of recipients within a given range. It also satisfies some fundamental properties of an inequality measure. These included: (*a*) inequality aversion; (*b*) replication invariance and (*c*) anonymity.

To analyze changes in sectoral inequality, the most recent primary data of the two household surveys namely Pakistan Integrated Household Survey (PIHS), 2001-02 and Pakistan Social and Living Standard Measurement Survey (PSLSM), 2004-05 periodically conducted by the Federal Bureau of Statistics (FBS), Government of Pakistan Islamabad have been used in this study. The sample of PIHS 2001-02 consists of 14,705 households whereas sample of PSLSM, 2004-05 consists of 14,706 households both rural and urban in all the four provinces of Pakistan. These surveys provide information and data on income and consumption of all members of households. The collected data on consumption expenditure are based on more than 196 food and non-food items at household level during the survey period. These surveys also provide information on the economic sector of employment of household head. These information and data can be combined to measure the changes in sectoral inequality between 2001-02 and 2004-05.

To measure the sectoral inequality, an appropriate living standard indicator is required. Income is an indicator of living standard that most clearly determines both relative and absolute economic status of an individual in a society. While PIHS 2001-02 provide detailed information on household income, PSLM 2004-05 does not provide detailed information on household income due to changes in questionnaire and method of data collection in 2004-05. The household income definition of PSLM, 2004-05 is, therefore, not comparable with PIHS, 2001-02 and thus one cannot draw a trend in income inequality over this period. However, the consumption expenditure module and its method of data collection remained unchanged in both surveys and thus give an opportunity to draw a trend in inequality between two survey period. Thus, household consumption expenditure on non-durables is used as proxy for 'household income' for the measurement of inequality across sector of economic activities. To take an account of differences in needs and economies of scale in household consumption expenditure, this paper corrects the data for household size and composition using 1.0 for first adult and 0.8 for all family members.

IV. SECTORAL INEQUALITY IN PAKISTAN: THE RESULTS

The GDP grew at an average rate of about 7.0 per annum between 2001-02 and 2004-05. At sectoral level, the growth is supported by agriculture, industry and

services. This section examines how consumption expenditure of households grew at sectoral level over the period? Is growth in GDP also reflected in growth in consumption of household's head employed across economic sectors? And how this rising pattern of sectoral growth affected the inequality of consumption among households across economic sectors?

TABLE 2

Mean (Adult Equivalent) Monthly Expenditure and Population Share, 2001-02 and 2004-05

Sector of Economic Activity	Mean consumption expenditure		% change	Population share (%)	
	2001-02	2004-05		2001-02	2004-05
Agriculture, forestry, hunting, and fishing	876.7	1253.1	42.9	41.00	36.56
Mining and quarrying	1037.0	1623.8	56.6	0.22	0.41
Manufacturing	1138.6	1571.8	38.0	8.96	8.11
Electricity, gas and water	1191.0	1894.8	59.1	1.09	0.86
Construction	779.0	1176.0	51.0	8.73	7.32
Wholesale and retail trade and restaurant	1096.5	1582.6	44.3	14.4	16.2
Transport, storage and communication	1010.4	1344.6	33.1	6.86	5.36
Financing, insurance, real estate	2376.0	2991.9	25.9	0.86	0.49
Community, social and personal services	1130.6	1531.8	35.5	17.74	19.8
Activities not adequately defined	862.5	1622.5	88.1	0.15	4.89
Ratio of highest to the lowest mean consumption expenditure	3.05	2.54			
Overall	1018.6	1439.1	41.3	100	100

Source: Author's calculation based on Micro-data of PIHS 2001-02 and PSLM 2004-05.

Table 2 present the mean consumption expenditure and the population share of population by economic sector of household head. In 2001-02, 41 percent household head were employed in Agriculture sector followed by 17 percent in Community services, 14.4 percent in Wholesale and Retail Trade Transport, 8.96 percent in Manufacturing, 8.73 percent in Construction and 6.86 percent in Transport sector. While some moderate changes occurred in sectoral composition of household head employment, the changes were more distinct in Agriculture sector between 2001-02 and 2004-05. The proportion of household head employed in Agriculture sector declined from 41 percent in 2001-02 to 36.5 percent in 2004-05. The declined in Agriculture sector is mostly absorbed by the urban-based economic sectors — Wholesale and Retail Trade, Community services sectors and undefined economic sector. While income differential between rural and urban regions is a key determinant of migration, the urbanization and urban growth may have been one of the factors for this rapid change in employment share.

TABLE 3

Gini Coefficient, 2001-02 and 2004-05

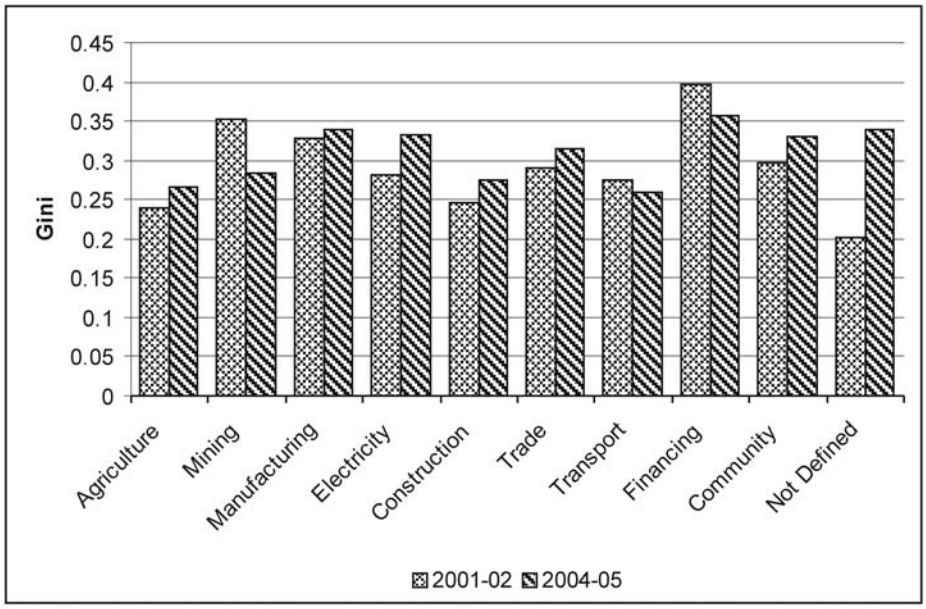
Sector of Economic Activity	Gini coefficient	% change in Gini coefficient	% change in mean consumption expenditure	
	2001-02	2004-05	2001-02 to 2004-05	
Agriculture, forestry hunting, and fishing	0.2396	0.2660	11.0	42.9
Mining and quarrying	0.3533	0.2833	–19.8	56.6
Manufacturing	0.3282	0.3384	3.1	38.0
Electricity, gas and water	0.2812	0.3325	18.3	59.1
Construction	0.2465	0.2748	11.5	51.0
Wholesale and retail trade and restaurant	0.2909	0.3140	8.0	44.3
Transport, storage and communication	0.2747	0.2592	–5.6	33.1
Financing, insurance, real estate	0.3974	0.3580	–9.9	25.9
Community, social and personal services	0.2980	0.3303	10.9	35.5
Activities not adequately defined	0.2012	0.3393	68.6	88.1
Overall	0.2933	0.3142	7.1	41.3

Source: Author's Calculation form Micro-data of PIHS 2001-02 and PSLM 2004-05.

The results indicate that the household head employed in Financing, Electricity, Manufacturing, and Community services appear to be more affluent than the other sectors' head. This is reflected by the highest mean consumption expenditure in 2001-02 was in Financing sector followed by Electricity, Manufacturing, and Community services. Finance and insurance was the richest sector whereas Construction was the poorest sector in terms of level of mean consumption expenditure. Nevertheless, the gap between the highest to lowest mean consumption expenditure in these sectors seems to have narrowed. This is reflected by the changes in the ratio of the highest to lowest mean consumption expenditure across sectors, which declined from 3.05 in 2001-02 to 2.54 in 2004-05. Between 2001-02 and 2004-05, the most rapidly growing sector as measured by consumption expenditure were Not defined3 sector (88%) followed by Electricity (59%), Mining (56%), Wholesale and Retail (44%), Manufacturing (38%), Community services (35%) and Transport sectors (33%).

FIGURE 2

Sectoral Inequality in Pakistan, 2001-02 and 2003-04



The results relating to sectoral consumption inequality as measured by Gini coefficient rank Financing sector as the most unequal distribution of consumption followed by Mining, Manufacturing sector and Community services sector (*see*

[3]The rapid gain in mean consumption expenditure may be attributable to a substantial change in population share which increased from 0.15 percent in 2001-02 to 4.89 percent in 2004-05.

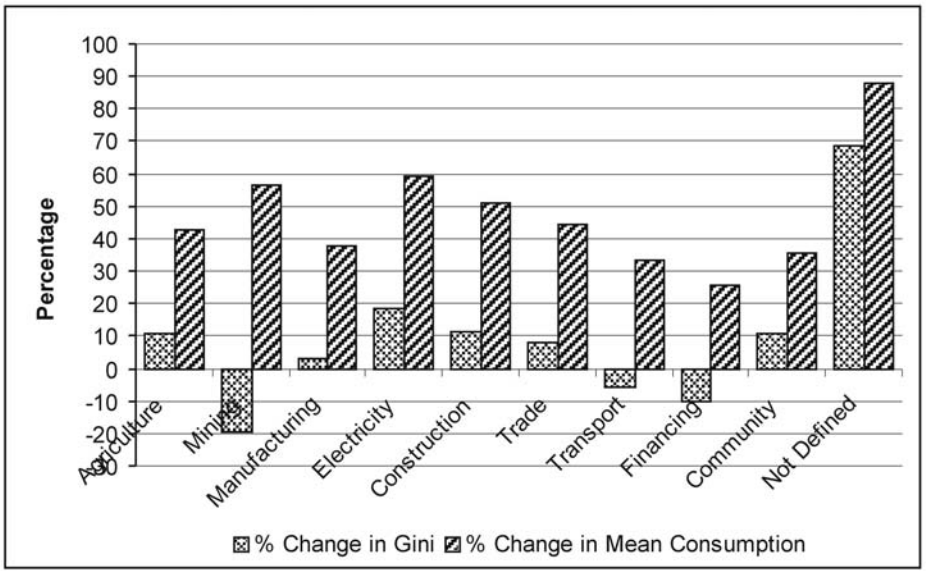
Table 3 and Figure 2). It is noteworthy that household head employed in Financing sector comprised of those working in financial institutions, insurance, real estate and business. The household head employed in Manufacturing sector comprised of those working in various industries such as food, beverages and tobacco, textile, wearing apparel and leather, wood paper, and paper products chemicals, petroleum, non-metallic mineral products, basic metal, fabricated metal products, machinery and equipment industries. On the other hand, the household head employed in Community sector included of those working in mainly public administration and defense services, social and community services.

CHANGES IN SECTORAL INEQUALITY

The results show that consumption inequality as measured by Gini Coefficient has increased across sectors in Pakistan between 2001-02 and 2004-05 (*see* Table 2). Except few, most of the sectoral consumption distributions reflect an increase in inequality over the period. Financing, Mining and Transport sectors were the exception. While the Financing and Mining sectors have very small share in population, the results may be biased due to sampling error. The growth in Transport sectors was not enough compared to other sectors which observed an increase in Inequality over the period. However, inequality increased in most of the economic sectors, *i.e.* Agriculture, Manufacturing, Electricity, Construction, Wholesale and Retail Trade, Community and personal services and undefined sector. These sectors employed 87.5% of all head of households in 2004-05.

FIGURE 3

Changes in Growth and Inequality Across Sectors, 2001-02 and 204-05



It is noteworthy that GDP grew rapidly by about 7 percent per annum between 2001-02 and 2004-05. Consequently, inequality increases were more rapidly in those sectors where consumption increases was larger over the period. In other words, higher growth in consumption led to a rise in inequality at sectoral level over the period. For example, changes in Gini coefficient were high in undefined sector, followed by Electricity, Construction, Agriculture and Community services sectors. Thus, changes inequalities are consistent with growth in mean expenditure in these sectors (*see* Figure 3). These results suggest that inequality increased in most the economic sectors which witnessed a high economic growth and rich households seem to have benefited from high economic growth between 2001-02 and 2004-05. These trends are not desirable as concentration of income among the richest, influential and powerful groups is likely to undermine political stability and economic and social reform process.

V. CONCLUDING REMARKS

The paper examined level as well as the changes in sectoral inequality in Pakistan using two most recent household surveys data for 2001-02 and 2004-05. The results suggest the Financing sector as the most unequal distribution of consumption followed by Mining, Manufacturing sector and Community services sector. It may be noted that the household head employed in Financing sector are those working in financial institutions, insurance, real estate and business. The household head employed in Manufacturing sector comprised of those working in various industries whereas the household head employed in Community sector included of those working in mainly public administration and defense services, social and community services. It may be due to the fact that these sectors are skilled based and remuneration is generally higher in these sectors relative to others.

The results show that except few, inequality increased in most of the sectors 2001-02 and 2004-05. Financing, Mining and Transport sectors were the exception. It may be due to the fact that Financing and Mining sectors have very small share in population and the sample size is also small which may not be sufficient to capture the changes in inequality in these sectors. However, inequality increased in most of the economic sectors, *i.e.* Agriculture, Manufacturing, Electricity, Construction, Wholesale and Retail Trade, Community and personal services and undefined sector. These sectors employed 87.5% of all head of households in 2004-05. The higher growth in mean consumption expenditure led to a rise in inequality at sectoral level over the period. Thus, changes inequalities are consistent with growth in mean expenditure in these sectors.

It is noteworthy that inequality also increased in those sectors where most of the poor work such as Agriculture, Construction and Wholesale and Retail Trade sectors. These changes may not be pro-poor, if examines by the definition of Kakwani and Pernia (2000), and Datt and Ravallion (1992) who argue that growth is pro-poor when growth lowers inequality.

These changes are not desirable as rising inequality tend to reinforce the existing sectoral inequality and exclude the poor from opportunities that others enjoy such as a better education, access to loans, which are essential to develop their productive potentials. It is thus imperative to reduce income inequality to reduce poverty. Thus, if government aims to reduce absolute poverty via its growth accelerating strategy, it should focus primarily on policies to equalize the remuneration across sectors to reduce inequality via tax and expenditure polices which not only generate employment but also reduce poverty.

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TESTING WAGNER'S LAW FOR PAKISTAN: 1972-2004

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Abstract. This paper is an attempt to test the existence of Wagner's Law in Pakistan. In this connection the Johansen and Juselius (1990) Cointegration approach has been used to test the long-run relationship between government expenditures and its determinants for Pakistan. Short-run dynamics are estimated by using the Error Correction Mechanism (ECM), various diagnostics and the stability tests are used to examine the existence of the relationship between variables. We find a long-run relationship between government expenditures and the determinants like per capita income, openness of Pakistan's economy, and the financial development. The existence of this relationship has far reaching implication for policy makers in designing the expenditures policy of the government in Pakistan as well as for other developing countries like Pakistan.

I. INTRODUCTION

The relative size of public sector has shown promising growth in both developing and developed countries of the world. After the World War II every country had tried to achieve rapid economic growth and a sharp increase in public expenditures as well as in GDP had been recorded over the past few decades. The positive relationship between public expenditure and GDP has attracted a lot of attention from researchers. Furthermore, the recent advances in time series techniques have also encouraged the researchers to re-examine the long-run relationship between variables.

The Economic literature remained deprived from model of determination of public expenditure for a long period; although a few classical economists address

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the tendencies found in the long-term behaviour of public expenditure but did not present these tendencies in the form of specific theory (Tarschys, 1975). However, a century before, Adolph Wagner presented a simple model formulated for the determination of public expenditure. He also used this model for empirical purposes and formulated a law based on his empirical findings which presented a relationship between government activities and its expenditure for 'progressive nation' (Bird, 1971). As a result, Wagner became the first economist who showed a positive correlation between the level of country's development and size of its public sector.

Wagner's Law has received considerable attention from economists and practitioners of public finance for well over 100 years. Since then, and particularly in recent decades, a variety of empirical studies have sought to test the validity of Wagner's law. These studies have utilized a variety of models and tests to compare the growth of government expenditure against various indicators of economic development.

Wagner's Law gained popularity in academic circles after the publication of English translation of Wagner's work in 1958. Afterwards, it has been analyzed and tested by many researchers for developing and developed countries, for example, Musgrave (1969), Bird (1971), Mann (1980), Sahni and Singh (1984), Abizadeh and Gray (1985), Ram (1986, 1987), Khan (1990), Henrekson (1992), Murthy (1993), Oxley (1994), Ansari *et al.* (1997) and Chletsos and Kollias (1997).[1] Following the existing economic literature some researchers used ordinary least squares (OLS) for regression analysis, while some tried to apply causality test, and some also carried out cointegration analysis. A considerable variation is found among these researchers results for various countries from period to period (Safa, 1999). This study is an attempt to examine the Wagner's Law for Pakistan by employing annual time series data over the period 1972-2004.

The study is divided into five sections. Section I is the introduction of the study and literature review. Section II presents model specification. In section III methodology and data are discussed, whereas section IV presents empirical results, and section V concludes the study.

II. MODEL SPECIFICATION

In econometrics a variety of models have been employed and several proxies have been utilized for the Wagnerian variables (Bird, 1971; Gandhi, 1971; Michas, 1975; Abizadeh, 1988). Wagnerian argument suggests that government expenditures as a percentage of GDP is function of real per capita GDP (Michas, 1975). Quantitatively, it has been postulated that

$$\frac{GE}{GDP} = f\left(\frac{RGDP}{POP}\right) \qquad (i)$$

[1]For detail, see Chang (2002).

Where *GE* represents nominal government expenditure, *POP* denotes total population, and *GDP* and *RGDP* are nominal and real national output, respectively. However, some other studies in testing Wagner's law utilized the following formulation (Goffman and Mahar, 1971; Musgrave, 1969).

$$GE = f(GDP) \qquad (ii)$$

GE and *GDP* are either real or nominal. As per the relationship the elasticity value of *GE* with respect to *GDP* is being expected to exceed unity to validate Wagner's law, postulating a faster rate of increase of government expenditure than national output. Another formulation is, for example, by Gupta (1967).

$$\frac{GE}{POP} = f\left(\frac{GDP}{POP}\right) \qquad (iii)$$

GE and *GDP* are in constant prices. Two more formulations have been suggested and empirically tested by Mann (1980):

$$GE = f\left(\frac{GDP}{POP}\right) \qquad (iv)$$

$$\frac{GE}{POP} = f(GDP) \qquad (v)$$

Wagner's Law is valid if the elasticity values in relation (*iv*) exceeds unity and exceeds zero in relation (*v*) respectively.

Our model is the modified version of the Abizadeh and Gray (1985) as:

$$LGE_t = \beta_0 + \beta_1 LPY_t + \beta_2 LOP_t + \beta_3 LFD_t + \varepsilon_t \qquad (vi)$$

Where *L* is used as the variables are used in log form.

GE = Government expenditure ratio: total government expenditures in year *t* divided by *GDP* in year *t*, both in current value terms

PY = Real per capita *GDP* in Pak Rupees.

OP = Openness: (Exports + Imports) divided by *GDP*, both in current value terms.

FD = Financial Development: M_2 divided by *GDP*

To measure the growth of government spending over time we adopted the dependent variable the Government expenditure ratio: total government expenditures in year *t* divided by *GDP* in year *t*, both in current value terms. It is a reasonable and accepted measure of Wagner's Law of expanding state expenditures. It allows comparison of the growth of government expenditure relative to the growth of the economy.

Real per capita *GDP* is included as an independent variable measuring both the level and trend of economic development in the country. It is also widely used in other tests of Wagner's Law. A positive relationship is hypothesized.

The Openness of the economy, measured by the ratio of Exports plus Imports to *GDP*, reflects the development and diversification of the economy. It has also been used successfully in other studies. A positive relationship is hypothesized.

Financial development in the economy is defined by the ratio of M_2 to *GDP*, as development progresses; there will be less reliance on cash balances for transaction purposes. Thus, a negative relationship is hypothesized.

In this study the annual data from 1972 to 2004 on variables including: Gross Domestic Product (*GDP*), Government Expenditures, Exports and Imports, M_2, population and prices are used. Data have been taken from International Financial Statistics (IFS) various issues.

III. METHODOLOGY AND DATA

UNIT ROOT TESTS

Before testing for cointegration, we first need to determine whether the individual series are integrated of order one, *i.e. I* (1). Since it is a necessary, but not sufficient condition for a set of variables to be cointegrated. We will use Augmented Dicky-Fuller test (ADF) for a unit root (Dicky and Fuller, 1979). This is a test for stochastic non-stationarity. It is also possible that the non-stationarity in individual series results from a deterministic process such as time trend. Therefore, we estimate the following regression using ordinary least squares (OLS).

$$\Delta x_t = C + \delta_1 t + \delta_2 \times_{t-1} + \sum_{i=1}^{n} \alpha_i \Delta x_{t-1} + \varepsilon_t$$

Where x_t is individual time series, t is linear time trend and Δ is first difference operator, *i.e.* $\Delta x_t = x_t - x_{t-1}$, ε_t is a serially uncorrelated random term, and C is a constant, the terms Δx_{t-1}, $i = 1, 2, \ldots, n$ are included to ensure that ε_t is white noise.

First we test the hypothesis:

H_0: $\delta_2 = 0$

H_1: $\delta_2 < 0$ series contains a unit root

Second the Hypothesis that H_0: $(\delta_1\ \delta_2) = (0, 0)$, *i.e.* non-stationarity does not in addition result from a linear time trend. If we cannot reject the second Hypothesis we re-estimate the equation without time trend and again test the first hypothesis.

Cointegration techniques are used to find the long-run relationship between variables if they are integrated of order one, *i.e. I* (1). Johansen approach will be used to examine the existence of cointegration between government expenditures

and its determinants. The validity of the estimated model is tested using the standard diagnostic tests — the Jarque and Bera (1980) test for normality, the Brush and Godfrey (1981) Lagrange Multiplier (LM) test for serial correlation. The White (1980) heteroskedasticity test and Cusum and Cusum of Squares test (Brown, Durbin and Evans, 1975) of stability are also applied.

IV. EMPIRICAL RESULTS

At the first step, the individual series are tested for their order of integration by Augmented Dicky-Fuller (ADF) test. This test confirmed the order of integration of the individual series. The ADF test is performed on level as well as on first difference of the series. The results are presented in Table 1.

TABLE 1

Augmented Dickey-Fuller Test Results for Unit Roots

Variables Level	ADF stats	Variables First Difference	ADF stats	Result
LGE	–1.6283	Δ *LGE*	–5.7376*	*I* (1)
LFI	–2.0675	Δ *LFI*	–4.2573*	*I* (1)
LOP	–3.4239	Δ *LOP*	–5.4620*	*I* (1)
LPY	–1.5003	Δ *LPY*	–4.8512*	*I* (1)

NOTE: * denotes significance at 5 percent, *I* (1) indicates unit root in levels and stationary after first differencing.

THE LONG-RUN GOVERNMENT EXPENDITURES FUNCTION: A COINTEGRATION ANALYSIS

We have investigated the number of cointegrating vectors by applying the likelihood ratio test that is based on the maximal eigen values and trace statistics of the stochastic matrix of the Johansen (1988) procedure. The results from the Johansen cointegrated test (both the Eigen values and the trace test) are presented in Table 2. All the variables included for the test have the same order of integration.

The likelihood ratio (LR) test indicates one cointegrating equation at 5 percent level of significance in each case. The null hypothesis of zero cointegrating vector is rejected against the alternative of one cointegrating vector. Consequently we can conclude that there is one cointegrating relationships among the variables, specified in the model.

TABLE 2

Johansen Test for Cointegration

Maximum Eigen Value Test

Null Hypothesis	Alternative Hypothesis	Test Statistic
$r = 0$	$r = 1$	30.23894*
$r = 1$	$r = 2$	19.86597
$r = 2$	$r = 3$	9.408874
$r = 3$	$r = 4$	0.307602

Trace Test

Null Hypothesis	Alternative Hypothesis	Test statistic
$r = 0$	$r \geq 1$	59.82138*
$r = 1$	$r \geq 2$	29.58247
$r = 2$	$r \geq 3$	9.716508
$r = 3$	$r \geq 4$	0.307615

NOTE: 1. * indicates significant at the 5 percent level.

2. Variables included in the cointegrating vector: *LGE*, *LFI*, *LOP* and *LPY*.

The long-run private investment function presented here is obtained by normalizing the estimated cointegrated vector on the government expenditures (LGE). So the results of estimated long-run government expenditure function are reported in the Table 3.

TABLE 3

Normalized Coefficients of Johansen Test on *LGE*

Variables	Coefficients	Standard Error	T-value
LPY	2.393672*	0.23444	10.2102
LOP	–0.331420*	0.12744	–2.600596
LFI	0.433083*	0.03845	11.2635
Constant	11.45022	–	–

NOTE: * represents significance at 5% critical values.

The estimated coefficients of *LPY*, *LOP* and *LFI* have expected signs and are significant. The estimated equation indicates that the government expenditures are mainly determined by the per capita income, openness of the economy and financial developments having elasticities of 2.39, –0.33 and 0.43 respectively.

THE SHORT-RUN DYNAMIC MODEL OF GOVERNMENT EXPENDITURES: THE ERROR CORRECTION APPROACH

After establishing the Cointegration relationship an error correction model (ECM) is established to determine the short-run dynamics of the regression model. The following error correction model (ECM) is established to determine the short-run dynamics of the regression model.

$$\Delta LGE = \beta_0 + \beta_1 \Delta LGE(-1) + \beta_2 \Delta LPY + \beta_3 \Delta LPY(-1) + \beta_4 \Delta LOP + \beta_5 \Delta LOP(-1) + \beta_6 \Delta LFI + \beta_7 \Delta LFI(-1) + \beta_8 EC(-1)$$

After estimating this model, we gradually eliminate the insignificant variables. The results suggested that out of these regressors only five are establishing short-term relationship with the government expenditures significantly. All others insignificant variables are dropped from the ECM. The following ECM is found to be the most appropriate and fits the data best.

$$\Delta LGE = \beta_0 + \beta_2 \Delta LPY + \beta_4 \Delta LOP + \beta_5 \Delta LOP(-1) + \beta_6 \Delta LFI + \beta_8 EC(-1)$$

The results of final estimated parsimonious dynamic error correction model are given in Table 4.

TABLE 4

Error Correction Model Estimates Dependent Variable Δ *LGE*

Variables	Coefficients	Standard Error	T-value
Δ *LPY*	1.114827	0.548161	2.033759
Δ *LOP*	–0.293870	0.119796	–2.453084
Δ *LOP*(–1)	0.235198	0.099251	2.369728
Δ *LFI*	0.434153	0.161852	2.682407
EC(–1)	–0.878597	0.166452	–5.278395
Constant	0.031127	0.024095	1.291808
R-square = 0.720460 F (6, 30) = 12.37109			

The error correction coefficient carries negative expected sign which is highly significant, indicating that in Pakistan government expenditure ratio, real per capita GDP, openness and financial development are cointegrated. Furthermore, the estimated coefficient of error correction indicates that approximately 88 percent of the disequilibrium is corrected immediately, *i.e.* in the next year.

Diagnostic Test

The validity of the estimated model is tested using the standard diagnostic tests. The residual passed the diagnostic test of no autocorrelation and no heteroskedasticity. The parameter stability of any estimated function has been the more crucial test, this stability in the model is confirmed by the CUSUM and CUSUM SQUARES.

Graphical presentation of CUSUM and CUSUM SQUARES are provided in Figures 1 and 2.

FIGURE 1

CUSUM

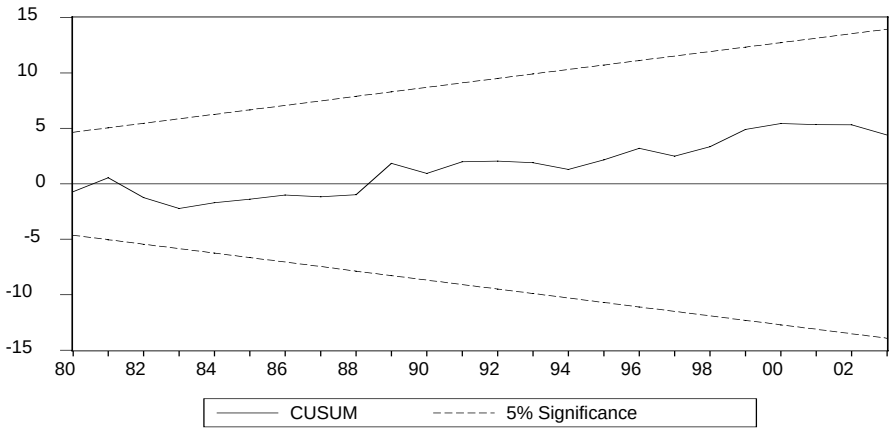
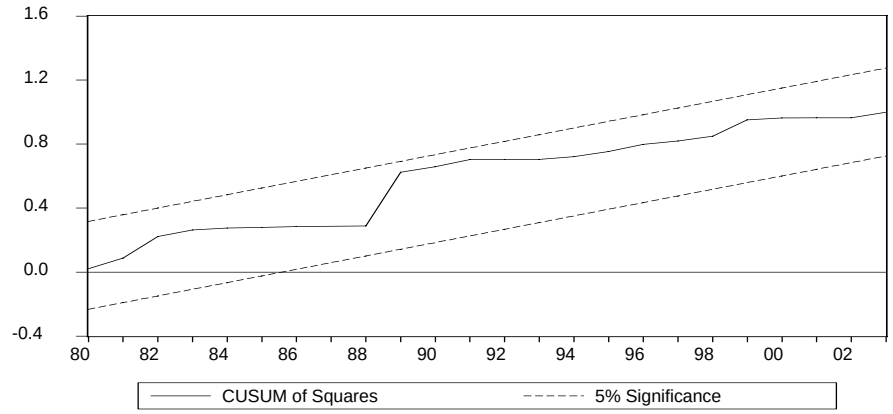


FIGURE 2

CUSUM SQ



It can be seen, the plots of these two tests do not cross the critical value line, indicating a stable long-run relationship between government expenditure ratio, real per capita GDP, openness and financial development. Thus, it can be concluded that the results are appropriate for policy implications.

There is no movement outside the critical lines in both tests that shows the coefficients are stable and no instability in the model.

V. CONCLUSIONS

Finally we can conclude that per capita income, openness of the economy and financial developments are the major determinants of the government expenditures in Pakistan. Moreover, we have found a long-run relationship between government expenditures and above stated determinants, and the existence of this relationship has far reaching implications for policy makers in designing the governmental expenditure policies in Pakistan as well as for other developing countries.

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ECONOMIC COMPETITIVENESS AND HUMAN RESOURCE DEVELOPMENT An FDI Perspective

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Abstract. Integration of global markets has highlighted the issue of economic competitiveness, the base line to attract the foreign direct investment. In this increasingly globalized and interdependent world economy, knowledge and skills of workforce will be the key competitive weapons of nations and thus should be focused for enhancement of the economic competitiveness (Thurow, 1994). The current study focuses on the role of human resource management as a tool to improve the economic competitiveness of South Asian region in general and Pakistan in particular and hence attracting the foreign capital inflow to boost the economic growth.

I. INTRODUCTION

Globalization has posed serious challenges to the developing countries, lacking in knowledge and skills, which undoubtedly form the basis of productivity and competitiveness in the ever-increasing integrated world economy. The integration of global markets and emergence of international trade bodies like World Trade Organization (WTO) has channelized Foreign Direct Investment (FDI) from developed to developing and underdeveloped countries. This paper argues that the key to improve the economic competitiveness of South Asian region, particularly Pakistan, lies in enhancing the human resource capabilities by making appropriate capital investment in education and professional training which could further improve their ability to innovate and adapt to the new technologies. Moreover, the study suggests some policy implications for creating economic competitiveness by managing and developing human resources of Pakistan.

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Development of the dynamic economies and the enhancement of economic competitiveness are at the forefront of global discussion at the moment. A majority of nations of the world are striving to improve the international economic competitiveness of their countries rather than trying to avoid global competition behind protective walls. Presently, the economic competition between the countries is not on the basis of nuclear power or large army base rather developing the competitive economies. According to the World Competitiveness Report of International Institute for Management Development (1995), competitiveness of companies and nations is influenced by eight major factors:

- "A competitive domestic economy that brings higher value-added productivity and prosperity to the country.
- Outward-looking economic policies that increase economic activities and improve the country's economic performance; higher integration with the international economy, more productive resource allocation and higher living standards.
- Less government intervention; government policies concentrating on creating a competitive environment for enterprises and providing macroeconomic and social conditions to minimize external risks.
- Internationally integrated financial sector that supports competitiveness.
- A well-developed infrastructure with availability of natural resources; a functional business system, information technology, transport, communication and an educated skilled labour force that promotes competitive business environment in a country.
- Managerial ability that provides long-term orientation to adapt to changes in the competitive environment; a level of entrepreneurship and skills for integration of business activities.
- Capability for efficient and innovative application of existing technologies that bring competitive advantage. Investment in research and innovative activities for acquiring new knowledge.
- A knowledge-based society and skilled labour force that increases a country's productivity and competitiveness."

Exploiting the trade opportunities for the country and attracting foreign capital inflow eventually create globally competitive economy. However, the researchers have different opinions on the role of government in the creation of economic competitiveness. One group argues for complete elimination of barriers to trade since they believe that economic growth is inversely related with excessive rules and regulations (Dollar, 1992; Sachs and Warner, 1996). Whereas, the other school of thought favors the government involvement on the pretext that the state support improves the country's competitive position and inflow of capital. According to Rodrik (2002), creating economic competitiveness may be a function of the degree

to which governments are engaged in market supporting activities including the infrastructure and human resource development.

II. ECONOMIC COMPETITIVENESS AND HUMAN RESOURCE DEVELOPMENT

Economic competitiveness of selected countries is reported in Table 1, which reflects that Pakistan lies among the poor performers based on the competitiveness ranking indices by World Economic Forum. In contrast, India has somewhat better ranking at different indices of economic competitiveness even superceding China at the technology, business competitiveness and global competitiveness fronts.

TABLE 1

Economic Competitiveness Rankings

Country	Tech-nology Index	Macro-economic Environ-ment Index	Business Competi-tiveness Index	Global Competi-tiveness Index	Growth Competi-tiveness Index
Finland	2	4	2	2	1
USA	1	23	1	1	2
Israel	12	48	22	23	27
Korea	7	25	24	19	17
Ireland	31	7	19	21	26
Malaysia	25	19	23	25	24
China	64	33	57	48	49
India	55	50	31	45	50
Turkey	53	87	51	71	66
Pakistan	80	69	66	91	83

Source: World Economic Forum, *Global Competitive Index* (2006)

Human resource development of economy general and professionals in particular has not grasped much intention of researchers in literature; however, creating economic development and competitiveness, the role of competent professionals is of strategic importance (Debrah and Ofori, 2006). Human resource development is the essential precondition for developing a knowledge-based economy, reducing skills mis-matches in the labour market, and creating a country's international competitiveness by promoting social and economic development as well being of the people (Khan, 2005). Health care, nutrition, population welfare

and employment and reducing poverty are important ingredients of human resource development (Muqtada and Hildeman, 1993). Improved and better quality education at various levels from basic literacy to advanced science and technology is the essential precondition for raising the industrial and agricultural productivity, sustaining the substantial growth of manufactured and service exports, better health and nutrition facilities, peaceful law and order situation, political stability, quality of governance and elimination of poverty. The focus of human resource development policies of developed countries has been on promoting knowledge and skills through quality education and proper training, and thus enhancing the employability; improving access and equality for all to live and work in a knowledge and information based society (Yussif and Ismail, 2002; ILO, 2001). Cho and McLean (2004) explored recently developed concept of National Human Resource Development (NHRD) at government level and looked into various emerging models of NHRD, *i.e.* centralized NHRD, transitional NHRD, government-initiated NHRD, decentralized or free market NHRD, and small-nation NHRD. India was the first country in history to rename its Ministry of Education to Ministry of Human Resource Development (HRD) in 1985 to focus on the development of skilled workforce through quality education and training (Rao, 2004).

In this increasingly globalized and interdependent world economy, the knowledge and skills of workforce will be the key competitive weapons of nations (Thurow, 1994). Low cost of production and level of value addition to goods and services would be the main factors that would decide the capacity of a country to compete in the global markets (Reich, 1991). The competition among corporations will be intense on the basis of quality of their human systems and the process of their products and services (Meister, 1994). Therefore, countries with relevant knowledge and skills acquired through increased and effective investment in human resource development, learning and training would benefit more from the emerging environment.

III. FOREIGN DIRECT INVESTMENT

The positive role of FDI is well documented in literature. The economic growth of the country is positively associated with the level of FDI inflows and FDI tends to be directed to those countries and sectors that enjoy actual and potential comparative advantage. Pakistan has witnessed a steady growth in FDI during past few yeas. This growth in FDI may be attributed mainly to political stability and macroeconomic reforms by the government (Khan, 2005). The most attractive sectors for foreign investors have been oil and gas exploration, telecommunication and financial services (BOI, 2006). The deregulation policy regarding telecom sector attracted huge foreign investment accounting for 55% of total FDI in the year 2005-2006 (Table 2).

However, as the recipients of FDI, Pakistan's position, in comparison with other counties of the world, is weak. Pakistan has performed better in last few years

and received more than double inward FDI flows in 2005 as compared to 2000, however, this performance is much lower than the other developing and developed countries of the world.

TABLE 2

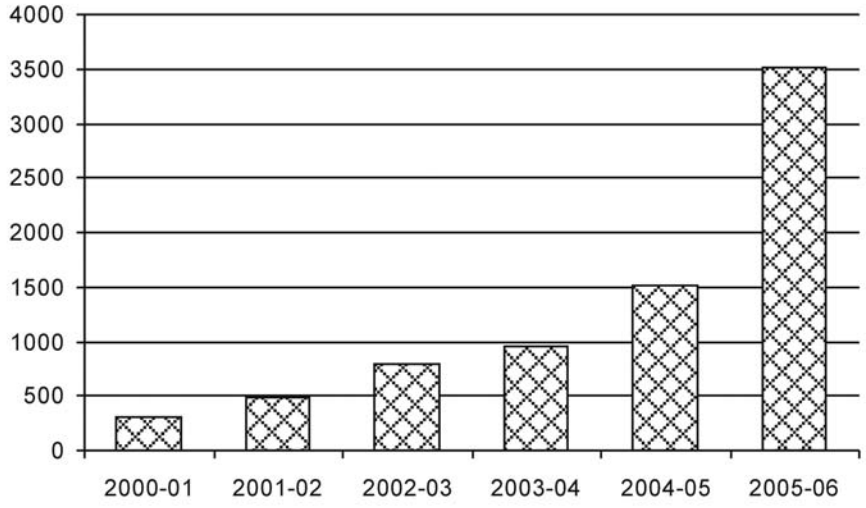
Sector-Wise FDI in Pakistan

Sector	2005	%age	2004	%age	2003	%age	2002	%age
IT & Telecom	1937.7	55	518	34	222	23.4	208	18
Financial Business	329.2	9.3	269	17.7	242	25.5	208	26
Oil and Gas	312.7	8.9	218	14.3	273	28.8	187	23.41
Trade	118	3.4	52.1	3.4	35.6	3.7	39.1	4.9
Power	320.6	9.1	73.3	4.8	35.4	3.7	32.8	4.11
Construction	89.5	2.5	51	3.3	32	3.4	32.8	4.11
Others	413.3	11.1	343	22.5	109	11.5	158	19.47
Total	3,521.0	100	1524	100	949	100	798	100

Source: Board of Investment Pakistan, 2006.

FIGURE 1

FDI Growth for the Period 2000-2006



Source: Board of Investment Pakistan, 2006

Although the ranking of Pakistan on FDI performance ranking index in year 1990 was 78 for the inward FDI performance (Table 3), yet, this ranking is continuously declining, as growth in FDI inflows is low. India, during 2000, with 119th ranking in the performance index, however, showed a steady growth in FDI inward flows from US $ 1705 millions in 2000 to US $ 6958 millions in 2006 (Table 4). The growing technological capabilities of Indian firms, particularly in information technology services and pharmaceuticals, are driving the FDI growth (UNCTAD, 2006). Access to marketing, distribution networks, foreign technology and strategic assets such as brand names, are the main motivators.

TABLE 3

Inward FDI Performance Index Rankings, 1990-2005

Countries	1990	2000	2004	2005
Bangladesh	109	110	119	116
Bhutan	–	–	–	–
India	101	119	112	119
Maldives	–	–	–	–
Nepal	100	131	136	135
Pakistan	78	118	109	102
Sri Lanka	72	108	96	106

Source: UNCTAD, *World Investment Report* 2006

TABLE 4

FDI Flows for Selected Countries and Regions in Millions of US $

Countries	1990-2000	2002	2003	2004	2005
Bangladesh	190	328	350	460	692
Bhutan	2	–	1	1	1
India	1705	5627	4585	5474	6598
Maldives	9	12	14	15	14
Nepal	11	6	15	–	5
Pakistan	463	823	534	1118	2183
Sri Lanka	159	197	229	233	272
China	30104	52743	53505	60830	72408
South Asia	2533	8982	5729	7301	9765

Source: UNCTAD, *World Investment Report* 2006

IV. HUMAN RESOURCE COMPETITIVENESS AND FDI INFLOWS

Researchers have discussed free flow of capital, goods, resources, technology and services through the new communication and transport technologies as driving forces of economic globalization (Beynon and Dunkerley, 2002) and capitalist economic system as catalyst to economic activity (Ghai, 1997; Walters, 1995). The two-pronged effects of globalization process would, at one hand create new opportunities for developing nations, and on the other hand, expose them to new global competition. With the wide spread adoption of new technologies, improved production capabilities and economies of scale, we can predict greater global competition and surplus for countries and companies. Specifically, this competition and commercialization will create new opportunities for value added products and services. These opportunities can be exploited by improving quality standards of value added production facilities. Improved living standard is expected to boost up the demand for competitive services in commercial and social sectors such as information technology, telecommunication, energy, financial, entertainment and tourism.

The emerging economies would be facing labour shortages due to major shifts in labour markets and millions of new immigrants which would further induce skilled manpower and outsourcing services from the developing countries to the countries with better infrastructure, ease of doing business and better production facilities. This process would also promote free flow of capital and investment in all forms, helping capital rich countries in making optimal investment decisions.

Increased demand of qualified and trained professionals for managing the technical, managerial and professional positions is the requirements of a skilled and knowledge based society. Human resource development is necessary but not the sufficient condition to ensure the sustainable social and economic development or solve the general unemployment problem in the country. Supply side policies like science and technology, education and training and development and industrial policies should be coalesced with the policies that expand aggregate demand in the economy such as macroeconomic and other measures. Although, there are various factors that may affect the Foreign Direct Investment (FDI) inflows to a country, yet our focus here will only be on the factors related to human resource development.

HUMAN RESOURCE DEVELOPMENT

South Asia is the largest developing as well as the poorest and the most illiterate region in the world. The region remained a backward area in spite of its natural and human resources and has not fully provided materialistic benefits to more than 1.4 billion inhabitants. The South Asian region is amongst the low quality of life on the human development index scale and remained a region where the infant mortality rate is one of the highest and the number of poor people is more than 500 million. The total population of the region represents 23 percent of the world population but

shares only 2 percent of the total GNP of the world whereas the average per capita income of the region is US $ 450, as compared to the world average of US $ 5,080 (Khan, 2005).

From the human development indicators perspective, the South Asian region is still the second worst region although some progress in education, healthcare and gender equality has been witnessed from the last few years. The regional ranking for the Human Development Index (HDI), Human Poverty Index (HPI), Gender Development Index (GDI) and Gender Empowerment Measures (GEM) are low as a whole. Table 5 shows that the rankings are above 100 in the Human Development Index for all South Asian countries except Sri Lanka and Maldives.

TABLE 5

Human Development in South Asia

Countries	Human Development Index		Human Poverty Index		Gender Development Index		Gender Empowerment Measures	
	Rank	Index	Rank	Index	Rank	Index	Rank	Index
Bangladesh	139	0.520	86	44.1	105	0.514	79	0.218
Bhutan	134	0.536	–	–	–	–	–	–
India	127	0.602	58	31.3	98	0.586	–	–
Maldives	96	0.745	37	16.6	–	–	–	–
Nepal	136	0.526	74	38.7	106	0.511	–	–
Pakistan	135	0.527	68	37.1	107	0.508	71	0.379
Sri Lanka	93	0.751	42	18.0	66	0.747	72	0.370

Source: UNDP, *Human Development Report* 2006

The major obstacle in the human resource development of Pakistan remains the existence of disparities in access to the quality education and relevant training and development. There is a considerable gap and mismatch between available skills and existing education and training programs (Planning Commission, 2005). The basic education has been more relevant to local development and labour market needs since the devolution of power to the grassroots level in 2000. The basic education includes the work orientation elements to meet the needs of young people to work in the industry whereas the contributions by the communities and parents remain low, although the basic education and training is the responsibility of the local government.

EDUCATIONAL ACHIEVEMENT

Human resource development and government's investment in country's education system are critical in dealing with the developmental challenges of globalization (Scotland, 2004). The basic education level is of crucial importance to ensure the supply of skilled manpower to be a globally competitive economy. The data in Table 6 shows some important indicators, which reveal the basic educational achievements of South Asian countries including Pakistan. In terms of government educational expenditures as percentage of its respective GDP on education of people, only Maldives and Sri Lanka are spending a sufficient percentage of their total GDP on basic education of the people. The rest of the countries are spending relatively less amount on general education of people. Pakistan has a provision of only 2% of gross domestic product on education, which is the minimum percentage in all of the South Asian countries. Keeping in view the expenditure on education, Maldives has highest adult literacy rate in the region of 96.3% followed by Sri Lanka, *i.e.* 90.7%. Pakistan is second last in the region terms of literacy rate. Moreover, in terms of the combined tertiary enrollment ratios, Pakistan is at the lowest position in comparison to the other countries of the region. It is evident from table 6 that sufficient allocation of financial resources is required to achieve adequate quality of education at different levels and to gain economic competitiveness through human resource development.

TABLE 6

Government Expenditures on Education and Performance

Countries	Public Expenditure on Education (%age of GDP)	Adult Literacy Rate	Gross enrolment ratio for primary, secondary and tertiary schools	Tertiary students in science and engineering etc. (% of tertiary students)
Bangladesh	2.2	39.2	57	13
Bhutan	–	–	–	–
India	3.3	61.0	62	22
Maldives	8.1	96.3	69	–
Nepal	3.4	48.6	57	–
Pakistan	2.0	49.9	38	–
Sri Lanka	6.2	90.7	64	–

Source: UNDP, *Human Development Report* 2006

SKILLED AND KNOWLEDGE-BASED PROFESSIONALS

The segregation of skilled and knowledge-based professionals in Pakistan and other countries of South Asian region are reported in Table 7. It is evident from the data that Pakistan is utilizing a very low percentage of its workforce on the professional, technical and managerial position, *i.e.* less than 20% of the total employed workforce. Majority of the people are working in agriculture and industrial labour force at front line. The ratio of labour force to total employed personals is quite higher in the South Asian countries, *i.e.* more than half or even two-third of the total employment which seems to reflect a characteristics of relatively labour-intensive economy. However, Pakistan is in a better position as compared to the rest of the region in terms of utilizing its workforce at administrative and professional levels. However, there is still a need to increase the proportion of professional, technical and managerial sections of workforce in Pakistan as well as in South Asian countries. To gain economic competitiveness, the existing education and technical training institutions need to be geared towards producing the required mix of skills in the workforce with different education and training levels.

TABLE 7

Employment by Major Occupational Groups (Percentage of Total Employment)

Countries	Bang-ladesh	Bhutan	India	Mal-dives	Nepal	Pakis-tan	Sri Lanka
Professional, Technical and Related Workers	3.89	–	–	16.19	2.57	6.86	9.93
Managerial workers	0.22	–	–	4.41	0.17	11.48	8.27
Clerical and related workers	3.43	–	–	5.33	1.13	1.64	4.48
Sales workers	14.77	–	–	12.87	2.11	2.34	3.89
Service workers	4.47	–	–	17.93	3.09	2.82	4.57
Agriculture, forestry, fishermen and hunters	51.36	–	–	13.41	70.26	34.92	24.05
Production and related workers, transport and labourers	21.87	–	–	29.86	20.67	40.18	44.82

Source: ILO, *Year Book of Labour Statistics* 2006

V. CONCLUSION AND POLICY IMPLICATIONS

The 21st century has witnessed fast changing global technological conditions and huge capital mobility in countries with developed infrastructure, skilled manpower, security and political stability. These factors pose a greater challenge for the developing countries in the wake of globalization process. These rapidly changing factors urge developing regions in general and developing countries in particular to respond to these global challenges with integrated and concerted efforts. The strategies like integration of available capital to the regional countries, indigenous capabilities and technologies through joint ventures and technology transfer are vital for the sustainability of developing regions.

Pakistan has not positioned itself to benefit substantially from the opportunities created by the globalization. The weak skill base is one of the major factors effecting the competitiveness and integration with the world markets. Development of human resource would help Pakistan to deal with the phenomenon of globalization effectively. The process of integration would be strengthened by the interaction of professionals, intellectuals, political scientists, technological experts, trade and industry circles, writers and policy makers of the country with the rest of the world. The problem of poverty, weak social and economic indicators and barriers of global trade policies can be overcome by the acceleration of regional economic activities and macroeconomic stability. Moreover, the manpower export should be an aggressive marketing agenda for Pakistani officials, which will help in decreasing poverty, and positive impact on the macroeconomic indicators through increased remittances and employment opportunities.

Positioning through education and training to face the challenges of globalization and competitiveness in the wake of skilled-based society is the major problem of Pakistan. Moreover, to promote the economic growth, employment creation and development of social sector and integrated set of labour market policies is needed. Acquisition of relevant knowledge and demand-based skills to be competitive and for sustainable growth is the main requirement of globalization. Although the promotion of education and training has been a part of ongoing efforts of Pakistan, however, this slow progress needs a focused and object-oriented approach to achieve desired results to become a skilled-based society. It is imperative to create favorable conditions for a knowledge-based economy in Pakistan in order to generate long-term competitiveness. The focus should be on the areas that will support the growth of the creative potential and economic competitiveness of the country. For this purpose, while making the strategy, Pakistan should focus on essential structural reforms and creating conditions for the development of a knowledge-based economy.

Basic education for all is the key to securing long-term competitiveness of human resources in Pakistan. The level and type of education must be relevant, provide general skills to the people and must be demand-driven with respect to the market needs and requirements. Moreover, familiarity with the use of information

technologies is one of the best means of transforming the nation into a dynamic, knowledge-based economy. High IT literacy must be insured in all the age and social groups and internet access must be expanded to grab the benefits of global libraries. Introduction of information technology should be in the syllabus of both traditional and modern professional education for all the students and teachers and private companies should be encouraged to develop the information technology services to general public.

Research and development is another essential aspect of the knowledge-based economy and therefore, Pakistan needs a wide variety of researchers who could be able to carry out high quality applied scientific research. The gap between the industry and university should be bridged up properly so that scientific knowledge and research could be materialized into industrial output, which would further contribute to the economic growth. Unfortunately in Pakistan, the total investment in research and development in negligibly low as compared to the other developing and developed countries like Korea, Malaysia, Singapore, Thailand, India, China, and Japan (Khan, 2005). The national research and development bodies should take into considerations the importance of R&D in the perspective of globalization and increasing competition and take suitable actions to improve the R&D activities.

Combining the human development policies with other economic and social policies would lead towards development of competencies that Pakistan could have in its skilled and educated labour force. However, some sectors like health, population control and welfare, availability of clean water and sanitation to the general public, working conditions for labourers, and pollution control are the issues that cannot be deferred until Pakistan eventually meets macroeconomics successes in trade and FDI. These sectors do need parallel attention and the government should simultaneously push these factors for sustainable economic and social development of the country.

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EXCHANGE RATE DETERMINATION IN PAKISTAN: EVIDENCE BASED ON PURCHASING POWER PARITY THEORY

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Abstract. This paper presents the empirical evidence on purchasing power parity (PPP) for Pak-rupee vis-à-vis US-dollar exchange rate using Johansen (1988) and Johansen and Juselius (1990) multivariate cointegration and bound testing approach to cointegration (Pesaran *et al.*, 2001) over the period 1982Q2-2005Q4. We find a considerable support for the existence of long-run PPP. Furthermore, the results of error-correction suggest that nominal exchange rate plays an important role in eliminating deviations from long-run PPP. The results further suggest that there is high degree of foreign exchange and goods markets integration. One major policy implication derived from the findings of this study is that the monetary authorities should contain money supply growth in order to stabilize prices and reduce balance of payments deficits.

I. INTRODUCTION

In the era of globalization and financial liberalization, exchange rate plays an important role in international trade and finance for a small open economy like Pakistan. This is because movements in exchange rates affect the profitability of multinationals and increase exchange exposure to enterprises and financial institutions. A stable exchange rate may help enterprise and financial institutions in evaluating the performance of investments, financing and hedging and thus reducing their operational risks (Nieh and Wang, 2005; Rahman and Hossain,

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2003). Fluctuations in the exchange rate may have a significant impact on the macroeconomic fundamentals such as interest rates, prices, wages, unemployment, and the level of output. This may ultimately results in a macroeconomic disequilibrium that would lead to real exchange rate devaluation to correct for external imbalances (Parikh and Williams, 1998). Purchasing power parity (PPP) is the most fundamental and controversial hypotheses in international finance through which the long-run equilibrium exchange rate can be explained. It serves as a benchmark for computing equilibrium exchange rate and assessing whether shocks to the real exchange rate dampen over time. This makes the PPP theory as an attractive theoretical and empirical tool for understanding the fluctuations in exchange rate over time.

PPP theory enjoys significance in the literature and has far-reaching implications at the theoretical, empirical and policy levels. For example, PPP theory constitutes one of the fundamental building blocks in modeling the theories of exchange rate determination.[1] At policy level, it provides an important theoretical basis for the financial stabilization and structural adjustment policies sponsored by the International Monetary Fund and World Bank. It also plays an important role in the choice between money and inflation targeting in the design of monetary policy (Boyd and Smith, 1999). PPP is also sets the criterion for judging whether the exchange rate is overvalued or undervalued in relation to its long-run equilibrium path. Omerbegivic (2005) has noted that:

> the appropriateness of the exchange rate is determined by the criteria whether the current level of the exchange rate that is associated with the equilibrium situation, which is defined in terms of goods and labour market equilibrium and the external balance being sustainable, which on the other hand is determined by the condition of the real economic variables found in equilibrium.

Hence, a proper understanding the determinants of exchange rate helps the policy-makers to design appropriate exchange rate policy in achieving the long-run sustainability of the balance of payments.

PPP theory was originally advanced by Cassel (1916, 1918), asserts that under the conditions of free trade[2] the nominal exchange rate between two countries is equal to the ratio of the two countries price level. PPP theory assumes that equilibrium real exchange rates remain constant over time and therefore, movement

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[1]The flexible-price monetary exchange rate model developed by Frenkel (1976) and Bilson (1978) presumes that PPP hold continuously, the Dornbusch's (1976) Sticky-price and the Frankel (1979) real interest rate differential models assumes that PPP hold in the long-run only. However, the poor performance of these models required the analysis of their underlying components, including PPP, to be tested for validity (Bhatti, 1996).

[2]Transaction costs, capital flows and speculative expectations are absent.

in nominal exchange rates tends to offset relative price movements.[3] It also postulates that adjustments to parity are made via nominal exchange rate movements.[4] This theory basically relies on the law of one price (LOP)[5] in an integrated and competitive product market with an implicit assumption of a risk-neutral world. The concept is based on a flow theory of exchange rates[6] where the demand for currency is to pay for exports and the supply is to pay for imports. Despite the fact that the theory has been known for centuries, PPP remains controversial as ever.[7]

The behaviour of exchange rate in the adjustment process assumes significance for Pakistan, which recently shifted from managed float exchange rate regime to a market-based exchange rate regime.[8] Besides changes in exchange rate regime, trade and financial liberalization and loosening of restrictions on capital flows in Pakistan during the past one and half decade has reduced many distortions. These structural changes may forces the parity condition to converge towards the long-run equilibrium path.

An extensive research has been carried out, *inter alia*, by Taylor (1988), Giovannetti (1989), Patel (1990), Nachane and Chrissanthaki (1991), Crowder (1992), Sarantis and Stewart (1993), Cooper (1994), Corbae and Ovliaris (1988), Arderi and Lubin (1991), Dornbusch (1988) and Moosa and Bhatti (1996). These studies investigated the validity of PPP theory for the Post-Bretton Woods floating

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[3]Although the assumption of free trade, absence of transport costs and speculative flows are unrealistic in the real world and the exchange rate may deviate from its PPP level and real exchange from its mean values.

[4]Under the fixed exchange rate adjustments to parity are made through the movements in domestic price level, while in floating exchange rate regime PPP reversion takes place via nominal exchange rate movements (Kohli, 2002).

[5]Law of one price states that when measured in a common currency, free traded commodities should cost the same everywhere under perfect market setting assumption (i.e. no transaction costs, no tax, homogeneous goods and complete certainty). If the prices deviate from each other, then the commodity arbitragers would capitalized by buying in one market and selling in another until the profitable opportunities cease to exist.

[6]PPP is called the flow model since it trace the flow of goods and services through the current account to determine the exchange rate.

[7]Much of the theory is reviewed and discussed by Officer (1984), Dornbusch (1988) and Levich (1998).

[8]Pakistan has opted managed floating exchange rate system in January 1982. In July 2000, the exchange rate policy shifted from managed float to free flexible exchange rate policy. These changes in exchange rate regime imply that deviations from parity might be eliminated through different processes. Adjustment to parity are made through the movements in domestic price level in fixed exchange rate, while in case of managed floating exchange rate regime parity reversion take place through the movements in exchange rates (Froot and Rogoff, 1995).

exchange rates system and failed to produce supportive evidence for long-run PPP.[9] The empirical evidence associated to Pakistan on this issue is still sparse (Chishti and Hasan, 1993; Bhatti, 1996, 2000; Liew *et al.*, 2004; Tang and Butiong, 1994; Ahmed and Khan, 2002; Qayyum *et al.*, 2004 and Junjua and Ahmed, 2006). All these studies found supportive evidence, while Chishti and Hasan (1993) found evidence which does not support the PPP hypothesis. This study attempts to extend the body of empirical literature by re-examining the validity of PPP using quarterly data over the period 1982Q2-2005Q4. The present study significantly differs from earlier studies conducted on this issue in Pakistan. *First,* unlike previous studies we have estimated PPP as a cointegration-based error-correction model that encapsulate short-run dynamics and the long-run response of the exchange rate to changes in relative prices. *Second,* we check the robustness of the results by using autoregressive distributed lag (ARDL) approach to cointegration. *Third*, the data used in this study is more recent and cover a wide span of time from 1982Q2-2005Q4.

The rest of the paper is organized as follows: section II deals with the theoretical model of purchasing power parity. The possible sources of deviations from the PPP are also discussed in section III. Section IV discusses data, methodology and empirical results, while concluding remarks along with policy implications are given in the final section.

II. PURCHASING POWER PARITY: A THEORETICAL MODEL

PPP is generally attributed to Cassell's writings in the 1920s, although its intellectual origins date back to the early writings of the 19th century British economist David Ricardo (1821). The basic concept underlying the PPP theory is that goods market arbitrage equalizes prices internationally once the prices of goods are measured in the same currency (Pilbeam, 1998). PPP continuously serves as an equilibrium condition in the theory of exchange rate determination and in exchange rate policy and frequently used to determine the link between exchange rate and relative prices.[10] The building block of PPP is the law of one price (LOP) which simply states that in the absence of a competitive market structure and the absence of transport costs, quotas, tariffs and other trade impediments, trade and effective arbitrage in goods markets should ensure identical price across countries. The LOP

[9]It must be noted that the majority of the studies conducted to data have been on developed countries and a limited number on high inflation developing countries.

[10]Many countries undertake corrective measures of their exchange rates based on inflation differentials with partner countries. While fundamental equilibrium exchange rates (FEERs), derived from medium term internal/external macroeconomic balance conditions, are becoming more and more attractive for detecting misalignment in a country's real exchange rate (Clark *et al.*, 1994), PPP remain much easier to compute. Moreover, deviations between FEERs and PPP have not yet been analyzed in empirical studies.

is based on the idea of perfect goods arbitrage. Arbitrage occurs where economic agents exploit price differences to provide a riskless profit. The proponents of PPP argue that the exchange rate must adjust to ensure that the LOP holds internationally for identical bundle of goods (Pilbeam, 1998). The testable version of absolute PPP is given by:

$$s_t = \beta_0 + \beta_1 (p - p^*)_t + u_t \tag{1}$$

Where s, p and p^* are the natural log of nominal exchange rate, domestic and foreign price indices respectively while u_t is the error term. This version of PPP states that the price of a common basket of goods in the two countries will be the same at all time because of costless spatial arbitrage. In equation (1), β_0 is the logarithm of the exchange rate observed in the base period. The presence of constant term β_0 is justified by Krichene (1998) on two grounds. *First*, the transportation costs, tariff and non-tariff barriers lead to market segmentations and create a wedge among prices across countries. *Second,* the use of constant is also necessary when prices are in terms of indices.

The absolute PPP theory states that an increase in the domestic price level due to monetary expansion or unrestrained credit expansion should result in equi-proportionate depreciation of the nominal exchange rate. This proposition holds true only when $\beta_0 = 0$ and $\beta_1 = 1$. Furthermore, real factor also affect the common basket of goods measured in a common currency. However, $\beta_0 = 0$ is often relaxed due to the presence of transportation costs, official intervention in the foreign exchange markets and other possible impediments to trade. The restriction $\beta_1 = 1$ can also be relaxed due to the measurement errors.[11] In addition, national price levels and the nominal exchange rates are generally found to be non-stationary so that the estimated coefficients in equation (1) are biased and do not have a usual t-distribution. For these reasons, cointegration tests of PPP do not usually impose restrictions on the values of the coefficients appearing in equation (1).

However, in the real world the equilibrium price of a good may not be the same when converted into a common currency. The reason for this includes the wedge between price levels across countries is created because of transport costs, asymmetric information and the distorting effects of tariffs and other forms of protectionism, which reduce the effectiveness of arbitrators.[12] In addition, the presence of non-traded goods can prevent arbitrators from responding to profitable investment opportunities. The non-traded neutrality of money in the short-run can

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[11] Although, one-to-one proportionality restrictions seem to be implausible and unrealistic in practice when transport costs, other trade impediments and measurement errors are allowed. Taylor (1988) and Sercu *et al* (1995) demonstrates that in the presence of transport costs and measurement errors in the price variables, the proportionality may still hold, but it will not necessarily equal to unity (*i.e.* $\beta_1 \neq 1$).

[12] Furthermore, in real world, different baskets are used for constructing price indexes in different currencies because their tastes and needs are different.

generate price differences in similar goods across countries. This price heterogeneity does not imply the market failure, but it may simply reflect the inability to shift the commodities costlessly and instantaneously from one location to the other. It is argued that a weaker form of PPP ─ known as relative PPP ─ can be expected to hold even in the presence of such distortions. The testable version of relative PPP is given by:[13]

$$\Delta s_t = \alpha_0 + \alpha_1(\Delta p - \Delta p^*)_t + \varepsilon \tag{2}$$

Where Δ is the first difference operator. For the relative PPP to hold the coefficient restrictions $\alpha_0 = 0$ and $\alpha_1 = 1$ must not be rejected. If these restrictions hold then relative PPP argues that the rate of change in exchange rate is equal to the inflation differential among two countries (Cassel, 1918).

The absolute PPP in equation (1) shows comparative prices in different currencies in a given location and common basket of identical goods. Due to the fact that the PPP hypothesis is regarded as a theory of exchange rate determination, hence, its validity may be depends on the degree of the exchange rate flexibility. The absolute PPP cannot be tested empirically due to the non-availability of comparable data, particularly, on the price levels across countries.[14] However, Bhatti (1996) has pointed out that the distinction between absolute and relative PPP becomes practically impossible because the domestic and foreign price levels are inevitably measured in relative terms by assuming unit price in some base year.

Cointegration analysis is useful for testing the PPP hypothesis as a long-run relationship. Many economists still hold the view that over the long-run, relative prices may move in proportion to the changes in the nominal exchange rate, so that the real exchange rate will revert to parity. If the variables entering in equation (1) are non-stationary, then PPP is tested first by testing the cointegration between *s* and $p - p^*$ and then testing the coefficient restrictions. If $s \sim I(1)$ and $(p - p^*) \sim I(1)$ then the necessary condition for absolute PPP to hold is that $u_t \sim I(0)$, while the sufficient condition is that $(\beta_0, \beta_1) = (0, 1)$.

The next step is to estimate error-correction model based on long-run relationship between nominal exchange rate and relative prices to examine the short-run dynamics. The theory underlying the error-correction model is that a proportion of the deviations from PPP in the initial period are corrected in the subsequent periods. The error-correction model takes the following form:

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[13]The lack of absolute price data constructed for an internationally standardized basket of goods to test the absolute PPP is often enforces researchers to retreat to the testing of relative PPP (Rogoff, 1996). Further, the relative or weak form of PPP relaxes the restriction that $\beta_0 = 0$, and often defines the evolution of exchange rates in growth rate form.

[14]See, for example, Junge (1984), Pippenger (1993) and Bhatti (1996).

$$\Delta s_t = \gamma + \sum_{i=0}^{k} \psi_i \Delta s_{t-i} + \sum_{i=0}^{k} \delta_i \Delta (p - p^*)_{t-i} + \rho EC_{t-1} + v_t \quad (3)$$

Where ρ is the speed at which the deviations from the PPP are corrected. $\rho < 0$ would indicate a reduction in the exchange rate in the current period. A negative and significant error-correction coefficient indicates the tendency for the exchange rate to revert to its long-run equilibrium path. $\rho = 0$ shows no statistical relationship between the exchange rate and the deviation from PPP. In this case there is no tendency for the exchange rate to revert back to its long-run equilibrium. While $\rho > 0$ would mean that the exchange rate is greater than its long-run equilibrium path. Under such situation one would expect that adjustments in exchange rate will take place in the next period and the movements in the price level will produce tendency in restoring long-run equilibrium.

III. SOURCE OF DEVIATIONS FROM PPP

The possible sources of deviations of PPP from the long-run equilibrium can be explained at theoretical and empirical levels. At theoretical level, PPP may have deviations from its long-run equilibrium in either 'structural' or 'transitory'. *First*, the structural changes may have been a trend deviation from PPP. For instance, a productivity growth differential between countries leads to trend changes in the real exchange rate. A rise in the domestic productivity would give real appreciation of domestic currency against foreign currency. Shifts in technology, tastes, commercial policies and labour force growth will bring changes in the national productivity and hence real exchange rate. Real factors such as, real income, factor endowments, productivity level, etc. will introduce systemic departure from PPP (Hoontrakul, 1999). *Second*, the transitory deviations from PPP occur as a result of disturbance through which the economy adjusts with differential speeds in goods and asset markets. This may be due to the price stickiness and imperfect competition in the product market. In addition, capital flows and divergent fiscal-monetary policies also generate significant deviations from the PPP. Dornbusch (1976) argued that if capital markets are highly integrated and goods markets exhibit slow price adjustment, then there can be substantial prolonged deviations of the exchange rate from PPP.

At empirical level, the conflicting evidence supporting absolute and relative PPP caused by the statistical difficulties (Plibeam, 1998).[15] Most evidence shows the sign of large persistent deviations from PPP for several reasons.[16] *First*, it is difficult to find accurate price index to measure the inflation rate for the countries being studied. Different commodity baskets in different countries cause PPP not to

[15]To test absolute or relative PPP, the data requirement usually is one time series of exchange rate and two time series of price indexes from the corresponding countries.

[16]See discussions on long swings in foreign exchange rate fluctuations by Engle and Hamilton (1990).

hold (Frenkel, 1978), a bias in PPP calculation using the consumer price index (Genberg, 1978). Perhaps non-tradable items such as (*i*) immovable property, (*ii*) perishable goods, and (*iii*) services can allow departure from PPP to persist when one measure inflation only from conventional market-bundle price indexes. Hence, given the different economic structures, the essence of PPP could be vastly different. The economies of the developing countries including Pakistan are heavily dependent on the international trade;[17] inflation and PPP are relevant to exchange rate especially in the medium to long-run for these economies. *Secondly*, obstacles to find support for PPP may be due to the statistical procedure (Pippenger, 1986). The problem of simultaneous determination of prices and foreign exchange rate is noted by Levi (1976) and Hakkio (1984), while the errors in measuring inflation differential were found by Levi (1977). The main results of these studies indicate that PPP does not hold in each and every period, since adjustment time must be allowed. *Third*, after using a cointegration test, Pippenger (1993) concludes that relative PPP holds in the long-run and that nominal exchange rate follows a random walk. Becketti *et al.* (1995) conclude that PPP holds in the long-run. Micheal *et al.* (1997) has pointed out that transaction costs such as, purchase of foreign exchange, forward cover, payments of tariffs and import licensing fees, and transportation costs may generate small deviations from PPP and will not be corrected through the process of commodity arbitrage. Frenkel (1981) argued that PPP holds better when the countries concerned are geographically close and trade linkages are high. Larger discrepancies are expected to be mean-reverting such that speed of adjustment is increasing function of the discrepancy. Furthermore, official interventions in the foreign exchange market when the nominal exchange rate movements are asymmetric and price stickiness are also responsible for nonlinear adjustment of real exchange rates.

Thus, the importance of PPP as a guide for policymakers remains meaningful element of macroeconomics for open economy as a benchmark for overvaluation or undervaluation of the domestic currency. In short, neither forms of PPP holds in the short-run, while there is some evidence favouring the validity of relative PPP in the long-run.

IV. DATA, METHODOLOGY AND EMPIRICAL RESULTS

The data set used in this study consists of quarterly observations covering the period from 1982Q2 to 2005Q4. The exchange rate (s_t) is the average market rate measured in terms of unit of Pak-rupee per US-dollar. Relative prices $(p - p^*)_t$ were

[17]Pakistan is small open economies, which rely heavily on imports because the exports of Pakistan are import oriented.

calculated on the basis of wholesale price index.[18] All the data were obtained from the International Financial Statistics (IFS) CD-ROM (2006).

Before the implementation of the cointegration test, we first examine the order of integration of the individual variable by means of ADF unit root test. The results are reported in table 1. The ADF test suggest that real exchange rate (q_t) is non-stationary in terms of log-level and stationary at log-first difference implying no mean reversion of real exchange rate. Parikh and Williams (1998) and Wu (1996) argued that the studies based on short spans of data find it difficult to prove that there is any mean reversion in real exchange rate. Hence, we concluded that based on the *a priori* coefficient restrictions PPP does not hold in the short-run.

TABLE 1

Unit Root Test

Series	Log-Level	Log-First Difference	Log-Level (with Dummies	Log-First Difference (with Dummies)	Decision
s_t	–1.288 (1)	–6.618 (0)*	–1.264 (1)	–6.461 (0)*	I (1)
$(p-p^*)_t^{cpi}$	–0.357 (4)	–1.711 (6)	–0.377 (3)	–1.602 (6)	I (2)
$(p-p^*)_t^{wpi}$	–1.384 (3)	–3.940 (2)*	–1.381 (3)	–3.596 (2)*	I (1)
q_t	–1.612 (2)	–6.769 (1)*	–1.547 (2)	–6.828 (0)*	I (1)

**indicate significant at the 1 percent level of significance. Numbers in brackets indicate the lags used in ADF test.

The ADF test associated to s_t and $(p-p^*)_t^{wpi}$ indicates that both series are I (1)[19] at their log-level and I (0) at their log-first difference. To capture the effects of seasonality we also used seasonal dummies in the ADF test, but this makes no difference in the results. Since both variables entered in the PPP formulation are integrated of order I (1), hence it is possible to test for the existence of cointegration.

For the presence of cointegration between exchange rate and the relative prices, Johansen (1988) and Johansen and Juselius (1990) multivariate cointegration tests were performed. Two lags were selected for VAR following the Likelihood ratio statistic adjusted for degrees of freedom and Akaike Information Criterion (AIC).

[18]We used (WPI) whole sale price indices (2000=100) for both Pakistan and U.S. because the relative prices based on the consumer price indices (CPI) seems to be $I(2)$ *i.e.* $(p-p^*)^{cpi} \sim I(2)$ while the exchange rate $s \sim I(1)$.

[19]The relative prices based on CPI are I (2).

The VAR model includes restricted intercept with no trend, three unrestricted seasonal dummies and one intervention dummy D_{00} representing shifts in exchange rate regime from managed float to free flexible in July 2000. Table 2 reports the maximal eigenvalue ($\lambda - \max$) and trace ($\lambda - trace$) statistics of the underlying VAR model.

TABLE 2

Cointegration Analysis of the PPP Hypothesis
Series [s_t, $(p - p^*)_t$] and lag = 2

Eigenvalues	0.1869	0.0430
Hypothesis	$r = 0$	$r <= 1$
$\lambda - \max$	19.45 [0.011]*	4.13 [0.405]
$\lambda - trace$	23.58 [0.015]*	4.13 [0.405]
$\lambda - \max$ #	18.62 [0.016]*	3.95 [0.430]
$\lambda - trace$ #	22.57 [0.022]*	3.95 [0.430]
Panel B: Standardized Eigenvector (β matrix)		
s_t	1.0000	–0.9453
$p_t - p^*_t$	–1.0775	1.0000
Constant	–4.0073	3.4880
Panel C: Standardized Adjustment Coefficient (α matrix)		
s_t	–0.1206	–0.0162
$p_t - p^*_t$	0.0153	–0.0459
Panel D: Vector Statistics	Test Statistics	p-value
Vector Portmanteau 10 lags	42.83	–
Vector AR 1-5 Test: F (20, 148)	1.39	0.13
Vector Normality test: Chi^2(4)	39.07*	0.00
Vector Hetero test: F (24, 215)	1.09	0.36
Vector Hetero-X test: F (42, 202)	1.10	0.32

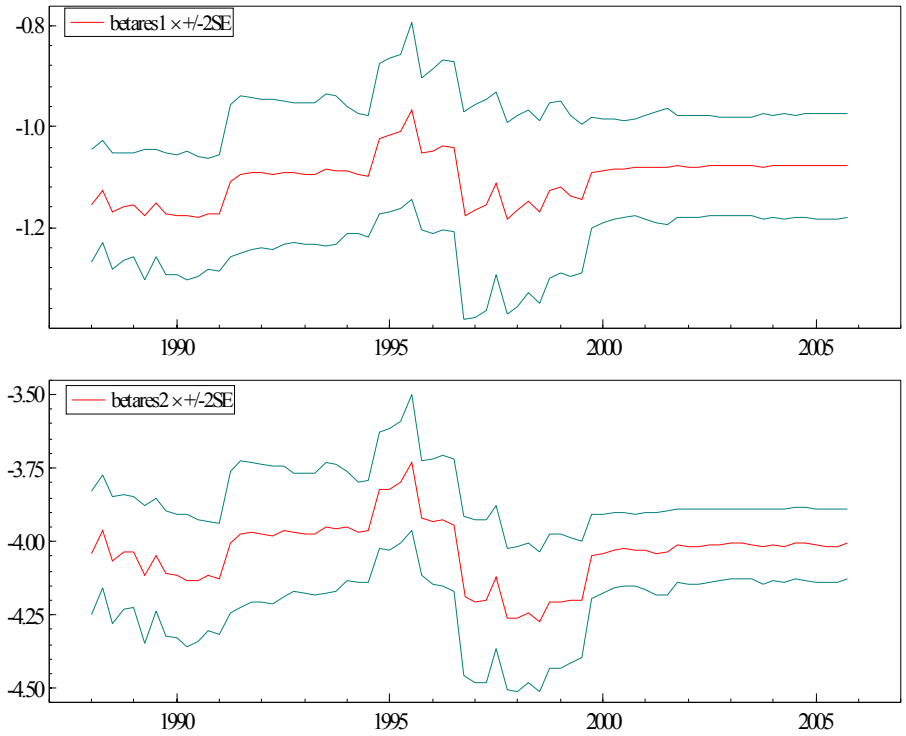
*indicate 95% level of significance. Figures in parenthesis represent p-values. The critical values are taken from Pesaran *et al.* (2000). # represents max and trace statistics adjusted for degrees of freedom.

It may be noted that the exchange rate and price series reveals strong evidence of cointegration using either of the two statistics with the existence of one significant cointegrating vector. The presence of one cointegrating vector confirms the long-run relationship between the nominal exchange rate and relative prices over the sample period 1982Q2-2005Q4. Thus, we get a considerable support for

the weak-form of PPP, which purport that exchange rate and relative prices are cointegrated to produce stationary residual. Interesting findings are the adjustment coefficients (panel C, Table 2) indicating the speed with which the deviations from PPP are corrected in each period to bring back the nominal exchange rate on the path dictated by the long-run equilibrium. The results suggest that around 12% of the deviations from PPP are corrected within a quarter.[20] Recursive estimation of the parameters associated to first cointegrating vector is depicted in Figure 1.

FIGURE 1

Recursive Estimation of Parameters



The recursive estimates of the coefficients show that the slope and intercept coefficients exhibits large movements in the parameters between 1995 and 2000 but remained within the band. However, these parameters remain stable since 2000 and onward. This implies that the free floating exchange rate enhance the exchange rate stability since 2000.

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[20]First element of the first column of the adjustment matrix is the error-correction term for PPP.

To examine the evidence of strong-form PPP, we normalized the first cointegrating vector on nominal exchange rate by imposing exactly-identifying restrictions and tested for the proportionality restriction.[21] The results are reported in Table 3.

TABLE 3

Testing for coefficient Restrictions

$(s_t = \beta_0 + \beta_1 (p - p^*)_t + u_t)$

Panel A: Coefficients and Coefficient Restrictions			
β_0			4.0073 (0.0603)**
β_1			1.0775 (0.0511)**
χ^2 ($\beta_0 = 0$)			8.2172 [0.0041]*
χ^2 ($\beta_1 = 1$)			2.1919 [0.1387]
Panel B: Adjustment Coefficient (α)			
Δs_t			–0.121 (0.028)**
$\Delta (p_t - p^*)_t$			0.015 (0.022)
Panel C: Exclusion Restrictions			
s_t			χ^2 (1) = 7.5672 [0.0059]*
$(p_t - p^*)_t$			χ^2 (1) = 7.7429 [0.0054]*
Panel D: Coefficient Restrictions and Weak Exogeneity (Standardized eigenvector (β) and Adjustment Coefficient ($\alpha = A\theta$)			
β' (normalized on s_t)	s_t 1.0000	$(p_t - p^*)_t$ 1.0791 (0.0556)*	Constant 4.0333 (0.0658)*
α	s_t –0.1134 (0.0256)**	$(p_t - p^*)_t$ 0.000	
LR test of restrictions: χ^2 (1) = 0.4309 [0.5116]			

* and ** indicate significant at the 99% and 95% level. Figures in ( ) indicate standard errors while figures in [ ] indicate p-values.

[21]These restrictions have been tested by employing Johansen (1988, 1991) maximum likelihood ratio test.

The results indicate that all the coefficients are correctly signed and statistically significant. The coefficient restrictions test reveals that the hypothesis of $\beta_0 = 0$ is rejected. This result could be due to: (*i*) barrier to free trade such as tariffs and transport costs, (*ii*) different consumption patterns across partner countries, (*iii*) preference of non-traded goods in consumer bundles, (*iv*) under developed and segmented domestic markets, and (*v*) price stickiness. The proportionality hypothesis (*i.e.* $\beta_1 = 1$) cannot be rejected. This result confirms the proportionality proposition which means that exchange rate move one-by-one with the relative price levels of both countries. Therefore, PPP holds true in Pakistan in the long run. These results are consistent with the previous results obtained by Tang and Butiong (1994), Bhatti (1996, 2000), Qayyum *et al.* (2004) and Junjua and Ahmed (2006) for Pakistan.

Given the number of cointegrating vectors, the statistical property of the data was also verified by imposing long-run exclusion test. This test provides useful information about which variables can or cannot be omitted from cointegration analysis. The test rejects the exclusion of exchange rate and relative prices from the analysis (Table 3 panel C).

Now the question is whether nominal exchange rate or relative prices adjust to clear the deviations from long-run PPP. For this purpose weak exogeneity test is implemented. Panel D of table 3 presents the result of long-run weak exogeneity of s_t and $(p_t - p^*)_t$. Along with the normalized first cointegrating vector, we impose zero restriction on the adjustment coefficient associated to relative price variable. The restriction does not rejected at the 5% level of significant. This suggests that exchange rate alone clear the short-run deviations by about 11% per quarter and the relative price variable is weakly exogenous. This finding is consistent with the fact that in Pakistan inflation is associated to the budget deficit and determine outside the system.

To check the robustness of the empirical results obtained from the Johansen cointegration method and to ensure that the conclusions are fully coherent with the data, bound testing approach to cointegration advanced by Pesaran *et al.* (2001) is used. To implement the bound testing approach, 2 lags were selected on the basis of Akaike Information Criterion (AIC). We estimated unrestricted error-correction model (UECM) and tested for the presence of cointegration among exchange rate and relative prices by setting the coefficients of lag-level variables equal to zero by means of F-statistic. The calculated F-statistic is 4.73 which are higher than the upper bound of the F-statistic (*i.e.* 3.87) at the 5% level,[22] rejects the hypothesis of no cointegration. Thus we get considerable support for the existence of cointegration among nominal exchange rate and relative prices. In the next step, we have estimated the long-run relationship between s_t and $(p_t - p^*)_t$ and tested for coefficient restrictions. The results are reported in Table 4.

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[22]See Pesaran *et al.* (2001), p. T.1 Table C1 case II.

TABLE 4

Long-run Coefficients and Coefficient Restrictions ((ARDL) Approach)

$s_t = \beta_0 + \beta_1 (p - p^*)_t + u_t$	
β_0	4.0270 (82.0414)*
β_1	1.00939 (21.3522)*
χ^2 ($\beta_0 = 0$)	6730.8 [0.000]*
χ^2 ($\beta_1 = 1$)	3.3580 [0.067]

* and ** indicate significant at the 99% and 95% level. Figures in ( ) indicate t-values, while figures in [ ] indicate p-values. ARDL (2, 2) selected based on AIC

TABLE 5

Results of Specific Error Correction Model for Δs_t
(1982Q4-2005Q4)

Variables	Coefficient	t-value	p-value	Split1	Split2	Reliable
Δs_{t-1}	0.327	4.516	0.000	0.0116	0.0000	1.0000
$\Delta (p - p^*)_{t-1}$	–0.251	–2.370	0.020	0.0316	0.0170	1.0000
EC_{t-1}	–0.117	–6.650	0.000	0.0033	0.0000	1.0000
I1993:3	0.073	4.096	0.000	0.0000	0.0000	1.0000
I1996:4	0.071	3.990	0.000	0.0000	0.0001	1.0000
I2000:4	0.071	3.967	0.000	0.6914	0.0000	0.4926
RSS = 0.03	$\sigma = 0.02$		$R^2 = 0.49$		$\overline{R}^2 = 0.46$	
Diagnostic Tests			Value		Prob	
Chow (1994:2)			1.4555		0.1122	
Chow (2003:3)			0.1037		0.9995	
AR 1-4 test			0.8884		0.4747	
ARCH 1-4 test			0.4499		0.7722	
Hetero test			2.3397		0.0217	

NOTE: Figure in brackets is the p-values. F (20,152) means that the test has an F-distribution with 20 degrees of freedom in the numerator and 152 degrees of freedom in the denominator. Chi^2(4) refers to the χ^2 test with 4 degrees of freedom. I1993:3, I1996:4 and I2000:4 are the dummy variables created to correct the outliers.

The results based on autoregressive distributed lag (ARDL), reported in Table 4 confirm the Johansen-Juselius cointegration results reported in Tables 2 and 3 in terms of signs and significance. Results based on ARDL are very much similar to those from the Johansen procedure and conclusions are not affected by the used of ARDL method of estimation.

Since relative prices are weakly exogenous, hence we estimate the short-run dynamics only for the nominal exchange rate using general-to-specific methodology. The results of specific model subject to a battery of multivariate diagnostics are presented in Table 5. While the results of error-correction model based on ARDL are reported in Table 6.

TABLE 6

Error-Correction Representation for the Selected ARDL Model
ARDL (2, 2) selected Based on AIC

Dependent Variable: Δs_t (1983Q1- 2005Q4)			
Regressor	Coefficient	t-ratio	Prob
Δs_{t-1}	0.326	3.362	0.001
$\Delta (p - p^*)$	0.133	1.009	0.316
$\Delta (p - p^*)_{t-1}$	–0.294	–2.143	0.035
Δ Constant	0.417	3.340	0.001
$EC(-1)$	–0.103	–3.257	0.002
R^2	0.22	$\overline{R}^2$	0.18
S.E. Regression	0.02	F-statistic	6.17
R.S.S	0.04	Equation-LL	224.58
AIC	218.58	SBC	211.02
D.W-statistic	1.93		

Error-Correction (EC) = s_t – 1.0939 * $(p - p^*)_t$ – 4.0270 * constant

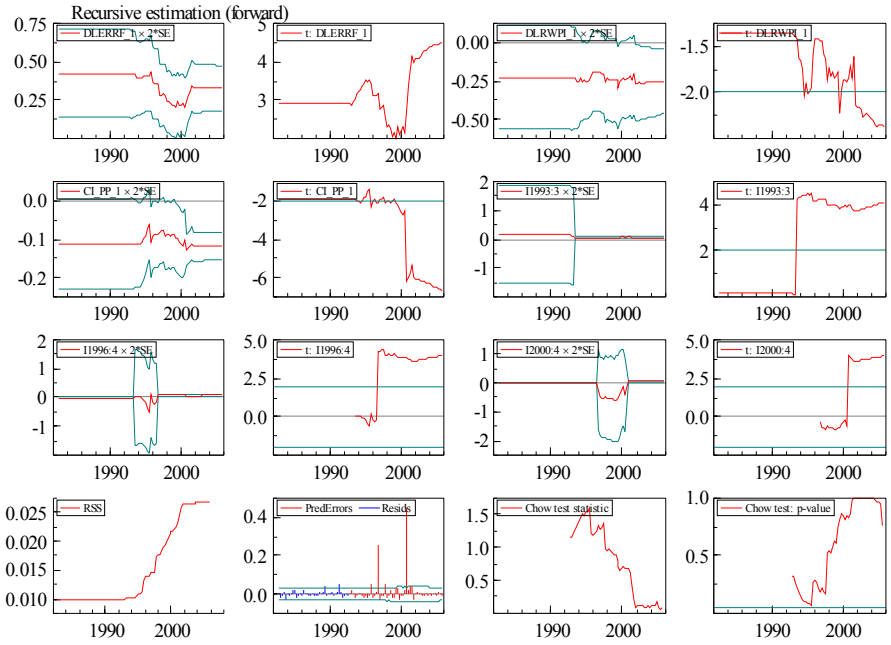
The results of the error-correction model suggest that changes in exchange rate (Δs_t) lagged by one period is positively correlated to current changes in exchange rate. This result implies that the exchange rate depreciation further weakening the strength of Pak-rupee. The coefficient of inflation differential lagged by one period exerted negative impact on exchange rate in the short-run. This could be due to the fact that during the late 1990s the inflation in Pakistan remained low as compared to partner countries. The error-correction coefficient remains significant and possesses expected negative sign. The magnitude of the error-correction term is –0.12 indicates that the exchange rate would adjust about 12% of the inflation difference between Pakistan and United States per quarter. The ARDL-based error-correction

model also provides similar results to those obtained by using general-to-specific methodology.

Various specification tests suggest that the estimated model is quite reasonable given its parsimony. Particularly, Chow tests indicate that the model is stable over time. The model evaluation statistics show that at the system level, vector autocorrelation, vector heteroscedasticity and vector ARCH have been kept under control. We judge the parameter constancy through forward recursive estimation. The summary of recursive estimates given in Figure 2 indicates that despite the various structural shifts during the sample period, parameter constancy cannot be violated.

FIGURE 2

Diagnostic Graphs for Parameters Constancy
(Based on the Results Reported in table 5)



V. CONCLUSIONS

The main purpose of this paper is to examine the validity of PPP for Pakistan using quarterly data over the period 1982Q2 to 2005Q4. The mean reversion hypothesis is examined by testing the stationarity of the real exchange rate. Stationarity test of real exchange rate show that PPP does not holds. However, using Johansen-Juselius multivariate cointegration test we find one significant cointegrating vector, which indicates the presence of PPP in Pakistan. The robustness of the Johansen results is

confirmed by implementing ARDL cointegration technique. ARDL verified the Johansen-Juselius results. An important finding of the study includes: *first*, the nominal exchange rate is cointegrated with WPI-based relative price level. The cointegration coefficient between nominal exchange rate and the WPI-based price ratio is close to unity, confirming the proportionality proposition. These results lend strong support for the validity of WPI-based PPP. The reason for the presence of PPP in the traded sector could be: (*i*) the economic development of Pakistan is heavy dependent on the developed countries, and (*ii*) the government is pursuing trade, finance and exchange rate liberalization policies since 1990. To this end, various price controls were lifted and significant efforts were made in liberalizing the trade and payment systems. These liberalization policies allowed the LOP to work more efficiently as shown by the supportive evidence of PPP. The results further implies that high inflation rate due to monetary shocks have been neutralized over the long-run. *Second*, the validity of PPP indicates a higher degree of goods and foreign exchange markets integration. The short-run deviation from PPP has frequently occurred, but the long-run validity of PPP could not be rejected. An error-correction term is negative and significant. The size of the error-correction term is small indicating that the speed of adjustment towards long-run equilibrium is rather slow. *Third*, economic reforms helped to increase the flexibility of prices and nominal exchange rates in adjusting the short-term deviations and shortened the time span required for dampening these deviations.[23]

The major policy implications drawn from this study includes:

- The findings confirm WPI-based PPP as a long-term anchor; namely, nominal exchange rate will tend to adjust to inflation differentials.
- If the monetary authorities wish to stabilize domestic prices and reduce balance of payments deficits, then monetary growth should be contained.
- High degree of integration between foreign exchange and goods markets unable the monetary authority to run monetary policy independently.
- Depreciation of exchange rate further weakening the strength of Pak-rupee.

[23]Empirical findings for developed countries suggest that the time period required for re-establishing PPP is shorter under floating exchange rate regimes; in this case, deviations from PPP could have a half-life as short as three to four years.

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ISSUES, GROWTH AND INSTABILITY OF INLAND FISH PRODUCTION IN SINDH (PAKISTAN) Spatial – Temporal Analysis

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Abstract. Apart from marine fisheries, inland fisheries (comprising of rivers, lakes, ponds, dams, etc.) are also very important source of animal protein. The consumption of fish is very low in Pakistan. The fisheries sector in Pakistan has not received due attention and as a consequence its contribution in Pakistan's economy has been relatively meager. There are substantial waterlogged and saline areas in Sindh, which are no longer suited for crop producing, they can be developed for fish culture. There is a need to examine the growth and instability of inland fish farming in Sindh before an intensive campaign can be launched to convince farmers to engage in fish farming. The study analyzed the growth and instability in inland fish production for two different periods of Sindh province: Period I (1975-1988) and period II (1989-2002). The study reveals that in period II, the inland fish production growth rate of Khairpur, Larkana, Hyderabad, Badin, Thatta and of Sindh province positively and significantly increased, while that of Sanghar and Tharparkar districts, significantly decreased. The study also confirms that in period I, a majority of districts have moderate growth with less instability in inland fish production as compared to period II. The study also reveals that none of the districts showed continuous increase in the relative share in any period.

I. INTRODUCTION

Faced with a growing population (2.2 percent growth rate per annum, 2002-03) and limited sources of protein, it is essential that Pakistan is able to utilize all available

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sources. The present per capita availability of protein is much below the minimum daily requirement and the livestock and dairy farming sector alone will not be able to meet the increasing requirement of protein. Fish is an excellent source of animal protein. The importance of animal protein in human diet as described in a report of a joint FAO/WHO expert group on "Protein Requirement" states that in practice the protein intake for all adults should not fall below one gram of protein per kilogram of body weight. The protein should be derived from a variety of sources and it is desirable that a part of the protein should be of animal origin. As fish protein has a high biological value similar to that of land animals, and is relatively cheaper source of protein, its use may result in bridging the protein gap because of its multifarious economic advantages and nutritional significance. The data presented in Table 1 shows the comparison of the efficiency of utilization of fish protein with other animal proteins. Apart from marine fisheries, inland fisheries (comprising of rivers, lakes, ponds, dams etc.) are also very important source of animal protein. Fish contributes more than 10 percent of the total animal protein intake of the world. The consumption of fish is very low in Pakistan. In 2002-03, it was 1.77 kgs per capita annually (Table 2). Whereas in the rest of South and East Asia the domestic consumption accounts for at least half of the total production. Pakistan consumes domestically only 26 percent with 19 percent being exported and giant 55 percent going for fishmeal. This pattern reflects the low quality of fish brought in by the fisherman.

TABLE 1

Efficiency of Utilization of Various Animal Proteins

Source	Biological Value (%)	Net Protein Utilization (%)	Diges-tibility (%)	Refuse (%)	Protein Efficiency Ratio	Protein Gain Per 100 Grams Protein Consumed
Fish	96.0	80.0	85.0	13.7 (Cattle)	3.55	77.0
Beef	74.0	68.0	99.0	15.0 (Cattle)	2.30	13.0 (Cattle)
Chicken	74.0	71.0	85.0	32.0	–	18.0

Source: Khan (1986), *Progressive Farming*, Volume 6, No. 5 (Sep/Oct) 1986. Pakistan Agricultural Research Council, Islamabad.

This low average in Pakistan becomes more crucial when other resources of protein are also below the required level. However, there is tremendous variation in per capita consumption of fish within the country. In this respect Balochistan is at the top, *i.e.* 6.80 kgs per capita per annum in 1975-76 which declined to 5.28 kgs per annum in 2002-03. Per capita per annum consumption of fish in Sindh though

declined from 4.25 kgs per capita per annum in 1975-76 to 2.98 kgs per capita per annum in 2002-03, is second. Per capita annually fish consumption of Punjab and NWFP though increased from 0.12 and 0.04 kgs in 1975-76 respectively to 1.00 and 0.71 kgs in 2002-03, is till very low. This indicates that fish in Sindh occupy a prominent place in consumer's diet (though its consumption has decreased). The consumption of fish in Sindh can increase if the price of fish is brought down to a reasonable level. To do that it is essential that production of fish is increased. The government can increase fish production; by giving more incentives and subsidies to fishermen, by improving socio-economic conditions of fishermen and through an efficient fish marketing system.

TABLE 2

Consumption of Fish in Various Provinces of Pakistan

(Kgs per capita per annum)

Year	Pakistan	Punjab	Sindh	NWFP	Balochistan
1975-76	1.28	0.12	4.25	0.04	6.80
1980-81	1.99	0.36	4.30	0.17	15.0
1985-86	1.80	0.57	4.10	0.04	7.60
1990-91	1.70	0.74	3.71	0.74	4.62
1995-96	1.81	0.98	2.58	0.41	4.61
2000-01	1.76	1.00	2.90	0.65	5.15
2002-03	1.77	1.00	2.98	0.71	5.28

Source: Government of Pakistan (1980, 1991-92, 2002-03), *Agricultural Statistics of Pakistan*. Ministry of Food, Agriculture and Livestock, Islamabad.

Recognizing the importance of fish in reducing the existing protein deficiency in the diet of the people, a source of foreign exchange earnings and being valuable raw material for various industrial produce, the Government has adopted measures to explore the potential for increasing fish production. Though fisheries resources have so far been partially exploited, an upward trend has been observed in fish production, *i.e.* marine as well as inland and total production. Total production which was 174 thousand tones in 1975-76, increased to 638 thousand tones in 2002-03 (Table 3). In case of inland fish, increase in fish production was more than nine times during the same period.

The share of Sindh in total, and marine fish production is though more than 66 and 50 percent respectively has exhibited a fluctuating trend. It became 68.2 percent of the total in 2002-03 compared with 72.9 percent in 1975-76. The share of inland fish production in total production increased from 8.0 percent in 1975-78 to 18.3 percent in 2002-03. Its share though somewhat decreased in 2002-03, is showing an

increasing trend. As far as the share of inland fish production in total inland production of Pakistan is concerned, it is showing decreasing trend. It was 70.0 percent in 1975-76 and in 2002-03 decreased to 63.8 percent. The share of Sindh's marine production decreased while that of inland production, it increased.

TABLE 3

Inland and Marine Fish Production in Sindh and Its Share in Pakistan's Total Fish Production

Years	Pakistan (000 Tonnes)			Sindh (000 Tonnes)			Share of Sindh (Percent)			Share of Sindh Inland Fish Production in Pakistan's Total Inland Production
	Total Production	Inland Production	Marine Production	Total Production	Inland Production	Marine Production	Total Production	Inland Production	Marine Production	
1975-76	174.1	20.0	154.1	127.0	14.0	113.0	72.9	8.0	64.9	70.0
1980-81	279.3	46.3	233.0	204.2	28.9	175.3	73.1	10.3	62.8	62.4
1985-86	408.4	75.1	333.3	275.8	46.6	229.2	67.5	11.4	56.1	62.0
1990-91	481.0	113.2	367.8	320.9	60.3	260.6	66.7	12.5	54.2	53.3
1995-96	541.9	136.4	405.5	358.4	75.4	283.0	66.1	13.9	52.2	55.3
2000-01	614.8	176.4	438.4	422.3	113.6	308.7	68.7	18.5	50.2	64.4
2002-03	637.8	183.3	454.5	435.0	117.0	318.0	68.2	18.3	49.8	63.8

Source: Government of Pakistan (1978, 1982-83, 1991-92, 2000-01, 2002-03), *Economic Survey*. Economic Advisor's Wing, Ministry of Finance, Islamabad.

The value of total fish and fish products in Pakistan in 2002-03 was about 0.80 percent of the country's total GDP. Export earning for fish and fish products which was 3.37 percent in 1976-77, decreased to 1.23 percent in 2002-03. The details regarding fisheries share, in total Gross Domestic Product (GDP), agricultural sector and total export earnings during 1976-77 to 2002-03, are given in Table 4.

TABLE 4

Fisheries Significance in Pakistan Economy

(Percent)

Year	Fisheries Share in GDP	Fisheries Share in Agriculture Sector	Fisheries Share in Total Export Economy
1975-76	0.50	1.54	3.37
1980-81	0.62.	2.12	1.91
1985-86	0.78	3.18	2.69
1990-91	0.50	1.28	1.86
1995-96	0.81	3.27	1.59
2000-01	0.90	3.64	1.48
2002-03	0.80	4.24	1.23

Source: Government of Pakistan (1978, 1982-83, 1991-92, 2000-01, 2002-03), *Economic Survey*, Economic Advisor's Wing, Ministry of Finance, Islamabad.

As described earlier, about 64 percent of the country's inland fish production share was contributed by Sindh province. In view of the resources endowed to the province (*i.e.* Indus River, canal networks, reservoirs, lakes, stream, water logged area and village ponds) fish production share can be increased up to 90 percent with proper use of these resources.

However, with the diversion and control of the river and canals under the Indus basin treaty works, water regime has been distributed and the natural breeding grounds of fish have been ruined. Consequently the potential for increased fish production from the riverine and flood plain fishery has been restricted. Hence, the major potential for increase in fish production lies in fish farming on commercial scale especially on water logged areas. Sindh has more than 1050 thousand hectares of area water logged (2002-03).

The total number of persons engaged in fisheries sector during 2002-03 is estimated at 365,000. Out of which 138,000 persons (37.8 percent) were engaged in marine sector and 227,000 persons (62.2 percent) in inland fisheries.

ISSUES OF INLAND FISHING IN SINDH

The following are the issues of inland fishing in Sindh.

1. Till June 2005 the contract/Auction system has played havoc with the fish resources and has resulted in exploitation and worst ever poverty among the fisherfolk communities.

2. The fishermen are living the life of bondage as due to non-availability of formal credit system, the fishermen are compelled to take loans from the middlemen and contractors.
3. Major fishing grounds/lakes in different districts of Sindh have been practically occupied by the influential landlords of those areas.
4. The fisherfolk settlements completely lack educational and health facilities.
5. The fisherfolk villages/populations also lack fresh drinking water as due to lack of fresh water flows from Indus the fishing ground water has become polluted.
6. Due to overall livelihood resource degradation as well as with the encouragement by contractors, non-fishing community populations are being engaged in fishing activities at many fishing grounds, while ignoring the indigenous fishermen.

NEED FOR THE STUDY

Keeping in view the emerging situation, the Sindh government has developed hatcheries and nurseries, to produce fingerlings locally for stocking in rivers, reservoirs and fish farms etc. This represents a minor progress in the establishment of fish farming business in the province. As there are substantial waterlogged and saline areas which are no longer suited for crop producing, they can be developed for fish culture. There is a need to examine the growth and instability of inland fish farming in Sindh before an intensive campaign can be launched to convince farmers to engage in fish farming. No in-depth study of inland fish production in Sindh is available, this study is a maiden attempt in this direction. Results of such a study would also be helpful for the policy makers and extension staff.

Against this background this study was undertaken, with the following specific objectives:

1. To present some brief history about Fish.
2. To estimate growth performance of Fish in terms of inland production for two different periods of Sindh.
3. To estimate the level of instability in inland fish production for two different periods of Sindh.
4. To estimate temporal change in districts and relative share of different districts in inland fish production of Sindh.
5. To make a period-wise comparison of growth rates with their instability indices.
6. To look into the problems faced by fish farmer.
7. To suggest measures to promote fisheries development.

II. DATA AND METHODOLOGY

The study is based on secondary data for the last 28 years, *i.e.* from 1975-76 to 2002-03. The data relating to inland fish production of the districts of Sindh were collected from various issues of *Development Statistics of Sindh*, Government of Sindh, *Agricultural Statistics of Pakistan* and *Economic Survey*, Government of Pakistan. The period 1975-76 to 2002-03 has been divided into three sub-periods, *viz.* period I (1975-76 to 1988-89); period II (1989-90 to 2002-03); and period III (1975-76 to 2002-03).

GROWTH RATES

In order to examine the period-wise and whole period trend of inland fish production, linear, exponential, and semi exponential functions were fitted. But exponential function was finally selected considering the highest value of coefficient of determination (R^2). The form of exponential function is as under:

$$Y = ab^t \text{ or } \ln Y_t = \ln a + t \ln b + \mu_t \quad (1)$$

where,

- Y = fish production (inland)
- a = intercept
- b = expresses the rate of change and when multiplied by 100 gives the percentage growth rate
- t = time period in years (1, 2, …, n)

INSTABILITY INDICES

Production of fish is known to fluctuate widely over time and regions. It may also indicate the pitfalls in arriving at any general conclusion on the basis of averages only. In reality, wide variations in these data over time, as well as, over space may lead to many of the stresses and strains in the economy. Hence, it might be useful for the purpose of policy making to study in which of the districts/time periods, the production of fish are more stable/unstable than in the others. Coefficient of variation (*CV*) is used as the usual measure of instability. Hence the period-wise coefficients of variation were computed separately for different districts of Sindh. The usual measure of *CV* is given by:

$$CV = \frac{\text{Standard Deviation}}{\text{Mean}} \times 100 \quad (2)$$

The *CV* has an easy interpretation in the context of measuring an overall variation in the data not showing any trend. But usually when we have a time-series for a variable showing some kind of trend which may be linear or non-linear, *CV* does not take into account any such time trends of the data while measuring instability in the variable values (Mitra, 1980). The instability Index (II) was,

therefore measured by fitting an exponential time trend. There are a number of techniques available to measure the index of instability. Such techniques are found in Coppock (1962), Mac-Bean (1966), Massel (1970), Weber and Sievers (1983), Cuddy-Della Valle (1978), Sing and Byerlee (1990), Parthasarathy (1984) and Wasim (1999). In this study the variability in fish production is measured by a method suggested by Parthasarathy, which was based on residuals,

$$II = \sqrt{\frac{\sum_{i=1}^{n} ei^2}{(n-k)}} \tag{3}$$

where,

ei = value of residual of i^{th} observation

n = number of observation

k = number of variables

Sen (1989) pointed out that the measure of instability based on exponential time trend is scale free and can be readily used for cross comparisons. Chand and Tewari (1991) also used this method for measuring instability of Indian exports and imports of agricultural commodities.

III. DETERMINANTS OF INLAND FISH PRODUCTION

To determine the factors affecting inland fish production, the following log-linear function was hypothesized.

$$\log IFP_t = \alpha + \beta_1 \log NOF_t + \beta_2 \log NOB_t + U_t \tag{4}$$

where,

IFP_t = Inland fish production in year t.

NOF_t = Number of fisherman in year t.

NOB_t = Number of boats in year t.

U_t = random disturbance term

Other most important independent variable, *i.e.* inland fish production price was also considered, but the data on price was not available. Only marine fish production price is available. Therefore it was not possible to determine its effect.

JUSTIFICATION OF THE VARIABLES

The estimating equation indicates that inland fish production in a given period is a log-linear function of a constant term, two variables and an error term. The theoretical justification for different variables being included as arguments in equation is as follows. The second term in the right hand side of the equation refers

to number of fisherman. Since increase in number of fisherman, other things remaining the same, would provide an incentive to fishermen to catch more fish, we would expect, and the model yields, the coefficient β_1 to be positive. In reverse case the coefficient β_1 will be negative. In other words, it means that due to poverty the fishermen are decreasing and they prefer to do other profitable work like crop farming or livestock farming. In Pakistan and Sindh a majority of the fishermen are poor. The third term on the right hand side is number of boats for fish catching. It is understood that if the number of boats for fish catching will increase, more fisherman will go on boat for fish catching and the fish production will increase, we would expect, and the model yields, the coefficient β_2 to be positive. If the case is reverse the coefficient β_2 will be negative.

Whether this model suffers from auto-correlation problem or not, it will be tested by using the DW d-statistic. "Inter-correlation of variables is not necessarily a problem unless it is highly relative to the overall degree of multiple correlations" (Klein 1962). If there is a strong interrelationship among the independent variables, it becomes difficult to disentangle their separate effects on the dependent variable. If there are more than two explanatory variables, it is not sufficient to look at simple correlations. Thus the term "Intercorrelations" should be interpreted as multiple correlation of each explanatory variable with the other explanatory variable. Thus, by Klein's rule multicollinearity would be regarded as problem only if $R_{\gamma}^2 < R_i^2$, where $R_y^2 = R_{y \cdot x_1 \cdot x_2 \cdots x_k}^2$ and $R_i^2 = R_{xi}^2$ other *x*'s. With the non-experimental data, it would be impractical to ascertain a priori that the multicollinearity problem among the explanatory variables is not severe. Therefore, a categorical test of intercorrelations among the explanatory variables is conducted and results are presented in Appendix 1. All these ensure the best linear unbiased estimates.

IV. RESULTS AND DISCUSSION

The results of the study are discussed as below:

GROWTH PERFORMANCE OF DISTRICT-WISE INLAND FISH PRODUCTION IN SINDH

The results of district-wise compound growth rates of inland fish production of the districts of Sindh are presented in Table 5. During period I, the inland fish production growth in all the districts (except Badin and Thatta) are positive and significant. In Khairpur, Jacobabad, Sukkur, Nawabshah, Sanghar, Tharparkar, Dadu and Sindh, it is significant at 1 percent level while in Hyderabad it is significant at 10 percent level. In Badin and Thatta, though the growth rate is positive but statistically insignificant. The possible reason may be that the fishermen of these districts are taking the advantage of marine fishing because Thatta and Badin districts are also coastal districts. It is interesting to note that though the growth rate of Thatta is positive and statistically insignificant, its relative share in

TABLE 5

Compound Growth Rates of District-Wise Inland Fish Production in Sindh

(Percentage)

Districts	Period I (1975-1988)	Period II (1989-2002)	All Period (1975-2002)
Khairpur	56.62 (13.00)*	66.89 (3.16)*	65.34 (19.59)*
Jacobabad	52.65 (3.67)*	–59.17 (0.57)	60.11 (4.36)*
Sukkur	80.60 (3.95)*	21.87 (0.34)	59.49 (4.48)*
Nawabshah	62.57 (7.85)*	112.33 (1.37)	33.61 (2.98)*
Larkana	39.63 (2.64)**	111.46 (6.87)*	67.85 (8.29)*
Sanghar	119.29 (3.96)*	–382.87 (2.86)**	38.41 (1.44)
Tharparkar	129.21 (3.65)*	–562.61 (6.52)*	1.78 (0.06)
Dadu	19.94 (4.28)*	94.30 (1.29)	22.66 (2.60)**
Hyderabad	20.15 (1.89)***	256.17 (2.10)***	40.15 (2.48)**
Badin	12.73 (0.60)	549.36 (5.37)*	107.70 (4.39)*
Thatta	40.72 (1.22)	526.69 (3.11)*	62.00 (2.20)**
Sindh	47.17 (3.86)*	121.78 (5.59)*	64.62 (9.75)*

NOTE: *, **, *** Significant at 1, 5 and 10 percent level of significance respective.

Figures in parenthesis are ‘t’ values.

the total inland fish production of Sindh province in that period is 23 percent (more than from each district) Table 10. Tharparkar has the highest growth rate of 129.21 percent per annum, while its share in total inland fish production of Sindh is less than one percent. The lowest growth rate of 12.73 percent per annum is observed by

Badin district while its share is 4 percent. The positive growth rates in nine districts out of eleven districts and in Sindh province clearly indicates that this profession in the above districts and in Sindh province is profitable mainly due to; different sources of fish catching, low prices of inputs used, easy availability of formal credit system, better process of issuing license system and better livelihood resource gradation.

In period II out of 11 districts five districts are positively significant and two districts are negatively significant. The growth rate of Khairpur which was 56.62 percent per annum in period I, increased to 66.89 percent in period II. Similarly of; Larkana from 39.63 percent to 111.46 percent, Hyderabad from 20.15 percent to 256.17 percent, Badin from 12.73 percent to 549.36 percent, Thatta from 40.72 percent to 526.69 percent and of Sindh province from 47.17 percent per annum in period I to 121.78 percent in period II. The growth rate of Sanghar and Tharparkar significantly decreased. Sukkur, Nawabshah and Dadu districts were previously (period I) positively significant but in period II they become insignificant. It means that the inland fisheries profession in the districts of Khairpur, Larkana, Hyderabad, Badin, Thatta and in Sindh province are profitable. The fishermen of Sanghar, Tharparkar, Sukkur, Nawabshah and Dadu districts were not finding this job profitable mainly due to; contract system, non-availability of formal credit system, overall livelihood resource degradation, insufficient sources of catching fish and shifting of fishermen to other profitable work, (for example agriculture). The increase in the growth rate of 5 districts in period II (specially Badin and Thatta) may be due to; fighting of fishermen against contract system, better availability of formal credit system and better fishing grounds. They must have to purchase fishing nets and fishing boats, which requires money.

Except Sanghar and Tharparkar, the growth rate of other districts and Sindh province are positive and significant in all period. In all period though the growth rate of Sanghar and Tharparkar become positive but statistically insignificant. Positive and significant growth rates of inland fish production in almost all the districts and province during all period show the active involvement of Sindh Fisheries Department. A number of initiative are being taken by the Sindh Fisheries Department which, inter-alia, include strengthening of extension services, diversification of fishing efforts, development of value added products, enhancement of per capita consumption and upgradation of socio-economic condition of fishermen's community.

If a differentiation is made between two periods, then it can be said that more districts have positive and significant growth rates in period I, as compared to period II.

INSTABILITY IN INLAND FISH PRODUCTION

The level of instability in inland fish production is very important for sustainable production. We have estimated district-wise instability in inland fish production for period I, period II and all periods in Table 6 using equation (3). Instability

percentage change in inland fish production are also calculated for period II over period I (Table 7).

TABLE 6

Instability Indices of District-Wise Inland Fish Production in Sindh

Districts	Period I (1975-1988)		Period II (1989-2002)		Period III (1975-2002)	
	Instability Index	CV	Instability Index	CV	Instability Index	CV
Khairpur	0.08	6.88	0.19	2.65	0.05	8.11
Jacobabad	0.15	7.30	0.41	6.05	0.10	9.63
Sukkur	0.18	9.86	0.33	5.08	0.10	8.06
Nawabshah	0.11	7.13	0.37	8.07	0.09	7.52
Larkana	0.16	6.52	0.16	2.82	0.08	8.10
Sanghar	0.22	15.95	0.47	15.57	0.14	15.47
Tharparkar	0.24	31.19	0.38	34.88	0.15	33.74
Dadu	0.09	2.55	0.35	6.71	0.08	5.32
Hyderabad	0.13	4.07	0.45	11.17	0.11	9.35
Badin	0.19	8.33	0.41	14.76	0.14	17.72
Thatta	0.23	10.95	0.53	16.79	0.15	14.66
Sindh	0.14	4.78	0.19	2.55	0.07	5.74

Instability in inland fish production in all the districts and province (except Sanghar, Tharparkar and Thatta) of period I are low. The higher instability of inland fish production in the districts of Sanghar (0.22), Tharparkar (0.24) and Thatta (0.23) did not deter the concerned districts from attaining high growth rates. Nadkarni and Deshpande (1983) also found the positive association between growth and instability in crop yields in Karnatka. Khairpur district (0.08) has the lowest degree of instability in inland fish production. In period II, the magnitude of instability in inland fish production of all the districts (except Larkana) and province increased as compared to period I. The production instability of Nawabshah (0.37), Dadu (0.35) and Hyderabad (0.45), increased by more percentage as compared to other districts and province (Table 7). It means, it may be concluded that the higher instability of inland fish production in the districts of Nawabshah, Dadu and Hyderabad did not deter from attaining high growth rates.

TABLE 7

Period-Wise Relative Instability Index and Their Percentage Change in Inland Fish Production in the Districts of Sindh

Districts	Production		Percentage Change II over I
	Period I	Period II	
Khairpur	0.08	0.19	137.50
Jacobabad	0.15	0.41	173.33
Sukkur	0.18	0.33	83.33
Nawabshah	0.11	0.37	236.36
Larkana	0.16	0.16	0.00
Sanghar	0.22	0.47	113.63
Tharparkar	0.24	0.38	58.33
Dadu	0.09	0.35	288.89
Hyderabad	0.13	0.45	246.15
Badin	0.19	0.41	115.78
Thatta	0.23	0.53	130.43
Sindh	0.14	0.19	35.71

For better understanding of growth and instability in inland fish production, we have presented Table 8. In period I, the districts of Khairpur, Jacobabad, Sukkur, Nawabshah, Larkana, Dadu, Hyderabad and Sindh province has moderate growth in inland fish production accompanied by low level of instability while Sanghar and Tharparkar districts has high growth and high instability in inland fish production. In period II, the growth rate of inland fish production of the districts of Khairpur, Hyderabad, Badin, Thatta and Sindh province significantly increased but at the same time their instability also increased. The growth rate of Sanghar and Tharparkar districts significantly declined but their instability increased. High instability for the districts of Sanghar and Tharparkar may be due to limited sources of catching fish, poverty of fishermen and non-profitable job for the fishermen.

Changes in inland fish production growth rate which cause instability can be due to a number of factors which include, non-strengthening of extension services, diversification of fishing efforts, behavior of prices and less per capita consumption.

A moderate and significant growth in inland fish production accompanied by a low level of instability is desired for sustainable development of agriculture as compared to high growth in production and high level of instability.

TABLE 8

Period-Wise Growth and Instability in Inland Fish Production in the Districts of Sindh

Districts	Period I		Period I	
	Growth (%)	Instability	Growth (%)	Instability
Khairpur	56.62*	0.08	66.89*	0.19
Jacobabad	52.65*	0.15	-59.17	0.41
Sukkur	80.60*	0.18	21.87	0.33
Nawabshah	62.57*	0.11	112.33	0.37
Larkana	39.63**	0.16	111.46*	0.16
Sanghar	116.29*	0.22	-382.87**	0.47
Tharparkar	129.21*	0.24	-562.61*	0.38
Dadu	19.94*	0.09	94.30	0.35
Hyderabad	20.15***	0.13	256.17***	0.45
Badin	12.73	0.19	549.36*	0.41
Thatta	40.72	0.23	526.69*	0.53
Sindh	47.17*	0.14	121.78*	0.19

NOTE: Taken from Tables 5 and 6.

*, **, ***, Significant at 1, 5 and 10 percent level of significance respectively.

DISTRICT-WISE TEMPORAL CHANGE AND RELATIVE SHARE OF INLAND FISH PRODUCTION

Temporal change in district-wise inland fish production in Sindh is presented in Table 9. It can be seen from the table that the production of inland fish declined in the district of Badin during the triennium ending 1980-85 as compared to previous period. The highest percentage increase was recorded in Sanghar district (656.23 percent), and lowest percentage increase was recorded by Dadu district (40.67 percent). A quantum decline in the inland fish production in the districts of Sukkur, Nawabshah, Sanghar, Tharparkar, Dadu and Hyderabad during 1990-95 as compared to 1985-90 was noticed, though their relative shares were 15.08, 2.28, 12.92, 0.19, 5.38 and 7.17 percent respectively (Table 10). The maximum percentage increase in inland fish production was in Jacobabad district (90.29 percent) during 1990-95 over 1985-90. Its relative share was also 17.18 percent.

Percent increase in inland fish production during 1999-03 over the period 1995-99 was maximum in Nawabshah district, (in 1990-95 over 1985-90 it was negative production) 253.38 percent, followed by Jacobabad (224.13 percent), Sanghar (93.32 percent), Sukkur (69.40 percent), Dadu (64.14 percent), Khairpur (41.75 percent) and Larkana (20.61 percent). But the relative share of all these districts in the total inland fish production of the province is low (Table 10). The inland fish production of Badin and Thatta districts though declined during 1999-03 as compared to 1995-99 but they have maximum relative share during the period. Tharparkar and Hyderabad also recorded negative increase in inland fish production. A perusal of Table 10 shows that the relative share of the districts of Khairpur, Jacobabad, Sukkur, Nawabshah, Sanghar, Dadu and Badin in the total inland fish production of Sindh declined during 1999-03 as compared to 1975-80, though their absolute production increased. This was due to increase in the relative share of other districts [Larkana, Badin and Thatta (Table 10)]. It is interesting to note that none of the districts showed continuous increase in the relative share in all the different periods. Thatta district ranked first in relative share of total inland fish production in the province (27.32 percent), followed by Badin (21.36 percent), Sukkur (10.60 percent), Larkana (9.72 percent), Hyderabad (8.46 percent) etc. A Bar-Diagram showing average relative share of different districts in inland fish production for different periods are presented in Appendix 2.

TABLE 9

Temporal Change in District-Wise Inland Fish Production

(Metric tones)

Districts	1975-1980	1980-1985	Percentage Change	1985-1990	1990-1995	Percentage Change	1995-1999	1999-2003	Percentage Change
Khairpur	2322	4140	78.29	6315	7690	21.77	6515	9235	41.75
Jacobabad	6568	11437	74.13	22419	42661	90.29	8927	28935	224.13
Sukkur	8800	37418	325.20	43249	37422	–13.47	22978	38925	69.40
Nawabshah	4900	10261	109.41	14345	5656	–60.57	4910	17351	253.38
Larkana	7911	13395	69.32	19054	30041	57.66	29598	35698	20.61
Sanghar	3032	22929	656.23	33140	32080	–3.20	3490	6747	93.32
Tharparkar	111	836	653.15	2028	470	–76.82	126	52	–58.73
Dadu	9507	13374	40.67	14564	13297	–8.70	12508	20531	64.14
Hyderabad	11636	16567	42.38	20594	17812	–13.51	50333	31085	–38.24
Badin	5413	5196	–4.01	7302	8363	14.53	86858	78437	–9.69
Thatta	22619	39058	72.68	49227	52703	7.06	128650	100255	–22.07
Total	82819	174611	110.83	232237	248195	6.87	354893	367251	3.48

TABLE 10

Relative Share of Different Districts in Inland Fish Production of Sindh

(Metric tones)

Districts	1975-1980	Percent Share	1980-1985	Percent Share	1985-1990	Percent Share	1990-1995	Percent Share	1995-1999	Percent Share	1999-2003	Percent Share
Khairpur	2322	2.80	4140	2.37	6315	2.71	7690	3.10	6515	1.83	9235	2.51
Jacobabad	6568	7.93	11437	6.55	22419	9.65	42661	17.18	8927	5.52	28935	7.87
Sukkur	8800	10.62	37418	21.43	43249	18.62	37422	15.08	22978	6.47	38925	10.60
Nawabshah	4900	5.92	10261	5.87	14345	6.17	5656	2.28	4910	1.38	17351	4.72
Larkana	7911	9.55	13395	7.67	19054	8.20	30041	12.10	29598	8.34	35698	9.72
Sanghar	3032	3.66	22929	13.13	33140	14.27	32080	12.92	3490	0.98	6747	1.84
Tharparkar	111	0.13	836	0.48	2028	0.87	470	0.19	126	0.03	52	0.01
Dadu	9507	11.48	13374	7.65	14564	6.27	13297	5.38	12508	3.52	20531	5.59
Hyderabad	11636	14.05	16567	9.48	20594	8.87	17812	7.17	50333	14.18	31085	8.46
Badin	5413	6.53	5196	2.97	7302	3.14	8363	3.37	86858	24.49	78437	21.36
Thatta	22619	27.31	39058	22.37	49227	21.20	52703	21.23	128650	36.25	100255	27.32
Total	82819	100.00	174611	100.00	232237	100.00	248195	100.00	354893	100.00	367251	100.00

DETERMINANTS OF INLAND FISH PRODUCTION

To determine the factors affecting inland fish production, equation (4) was applied. The results of the equation are given below:

$$LIFP_t = 31.33882 + 0.457786^{*} NOF_t + 0.185860\ NOB_t$$
$$\qquad\qquad\quad (3.729965) \qquad\quad (1.072453)$$

$R^2 = 0.657796$

DW 'd' (statistic) = 1.778998

NOTE: Figures in parentheses are 't' values.

*Significant at 1 percent level of significance.

The above equation not only gave a high value of the coefficient of multiple determination (R^2) but also indicated the absence of multicollinearity (Appendix 1) and autocorrelation (indicated by the calculated Durbin-Watson 'd' statistics). In the above equation only the number of fishermen in Sindh is positive and significant at 1 percent level of significance. It means that there is a direct relationship between number of fishermen and inland fish production in Sindh. As the number of fishermen is increasing, the inland fish production is also increasing. It indicates that in Sindh province the profession of fishermen is profitable. As far as the other

variable (number of boats) is concerned, though it is positive but statistically insignificant. This variable has no effect on inland fish production. It may be mainly due to bad socio-economic condition of the fishermen's community.

PROBLEMS AND CONSTRAINTS FACED BY INLAND FISH FARMERS IN SINDH

The following problems are faced by inland fish farmers:

1. Seed is a basic component in fish farming. Timely use, accurate quantity, proper length of fingerlings and suitable combination of species can have positive effect on fish production. But, fish farmers are facing the problems regarding the seed. Seed supplied by Fisheries Department are not in proper length. Also the problems faced by fish farmers are non-availability of the high valued and desired types of species. Undercounting and untimely supply of seed are also major problem.
2. Non-availability of preservation of fish facility at any stage of marketing system is also lacking.
3. Availability of credit at the right time and at reasonable interest rates may prove a key element that determines the intensification, expansion of production and technological improvements in fish farming business. Procedural complexities and inadequate grace period for repayment of loan are the main problem with respect to credit availability.
4. Lack of extension service and non-availability of training facilities in fish farming are also the main problems in increasing fish production.

V. CONCLUSIONS

The study analyzed the growth and instability in inland fish production for two different periods of Sindh province: Period I (1975-1988) and period II (1989-2002). The study reveals that in period I, nine districts (out of eleven districts) and in Sindh province the growth rate of inland fish production is positive and statistically significant. This means that in the above districts and in Sindh province the fishing profession is profitable mainly due to; different sources of fish catching, low prices of input, easy availability of formal credit system, better process of issuing license system and better livelihood resource gradation. The study also confirms that in period II, the growth rate of Khairpur, Larkana, Hyderabad, Badin, Thatta and Sindh province positively and significantly increased, while that of Sanghar and Tharparkar districts, significantly decreased. The negative growth may be due to; non-profitability of this job, poverty, shifting of inland fish farmers to other profitable job, contract system, non-availability of formal credit system, overall livelihood resource degradation and insufficient sources of catching fish. The increase in the growth rate of 5 districts in period II (specially Badin and Thatta) may be due to; fighting of fishermen against contract system, better availability of formal credit system and better fishing grounds. The results of the

study also indicate positive and significant growth rate in all the districts (except Sanghar and Tharparkar) and province in All period. This shows the active involvement of Sindh fisheries department. The study also indicates that in period I, a majority of districts have moderate growth rate with less instability in inland fish production as compared to period II. The study also reveals that in period II, the growth rates of the districts of Jacobabad, Sanghar and Tharparkar not only decreased but their instability also increased. Moderate growth and low instability in inland fish production is the best situation from the biodiversity point of view. However, high growth and high instability (most of the districts of period II) in inland fish production needs a special attention in the future research agenda. The results of the study also confirms that the relative share of the districts of Khairpur, Jacobabad, Sukkur, Nawabshah, Sanghar, Dadu and Badin in the total inland fish production of Sindh declined during 1999-03 as compared to 1975-80, though their absolute production increased. This was due to increase in the relative share of other districts. The study also reveals that none of the districts showed continuous increase in the relative share in any of the periods.

VI. POLICY IMPLICATIONS

The results obtained in this study lead to important implications that seem to be relevant from the point of view of policy formulation.

1. The study confirms that in period II, the growth rate of inland fish production in the districts of Sanghar and Tharparkar significantly declined. Therefore the production growth rate needs to be increased. This can be done through: improving their socio-economic conditions, decreasing the prices of inputs, increasing the sources of catching inland fish production, strengthening of extension services, diversification of fishing efforts, development of value added products, enhancement of per capita fish consumption, ending of contract system, better availability of formal credit system and better livelihood resource gradation.

2. The fisherfolk organizations including Pakistan Fisherfolk Form [PFF] should be made part of the process of issuing licenses under license system as in the past the Fisheries Department officials failed the system by issuing fake license fees receipts to the fishermen, pocketing the license fees, and reporting to the government that fisherfolk communities are not paying their license fees.

3. Fish Hatcheries should be established near major fishing waters to provide fish seed for those fishing grounds as no new fish seed is coming due to lack of flows from Indus. The performance of existing fish hatcheries should be improved forthwith.

4. The study also indicates high instability in all the districts (except Larkana and Sindh province) in period II, as compared to period I. The instability can be declined through controlling the price of inland fish production,

improving their socio-economic conditions, decreasing the prices of inputs, strengthening the extension services and enhancement of per capita fish consumption.

5. The study also reveals that none of the districts showed continuous increase in the relative share of inland fish production in all the different periods. The relative share of all the districts in inland fish production of Sindh needs to be increased. This can be done if the Sindh Fisheries Department takes the following steps:

   (*i*) Strengthening of extension services.

   (*ii*) Improved management of inland waters.

   (*iii*) Increased local consumption of fish by telling the peoples that its consumption will minimize the disease of Heart and Blood Pressure.

   (*iv*) Upgradation of socioeconomic condition of the fishermen's community.

   (*v*) Improvement in marketing arrangement.

Some of the other policy implications are being listed here, which do not directly depend upon the results of the study but indirectly they depend upon Sindh fishermen fishing.

1. The contract/Auction system has played havoc with the fish resources and has resulted in exploitation and worst ever poverty among the fisherfolk communities. The government needs to abolish contract system from all the fishing grounds. License system should be adopted on all the fresh water fishing grounds.

2. Even if license system is introduced in the fishing grounds there are fears that the influential people, who have been exploiting the fishing resources of the fishing grounds, would not allow the fishermen to fish independently and would threaten and even punish them. The government needs to make the fishermen fishing in the fishing grounds under license system.

3. Major fishing grounds/lakes in different districts of Sindh have been practically occupied by the influential landlords of those areas. Those landlords, with the help of Fisheries Department officially receive contracts of the fishing grounds and exploit the fishermen. In many cases the fishermen are killed and their fishing boats and nets are taken away by the influential landlords and their henchmen whenever the fishermen raise their voice against their injustice. The government needs to bring such illegal occupations of the fishing waters to an end and take severe action against the landlords occupying fishing grounds and exploiting fishermen.

4. Indus flow should be considered as important for the wetlands/fishing grounds as is being considered for agriculture. In the case of water availability wetlands and fishing grounds should also be provided their due water shares besides providing water share to agriculture, industries and urban consumers.

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APPENDIX 1

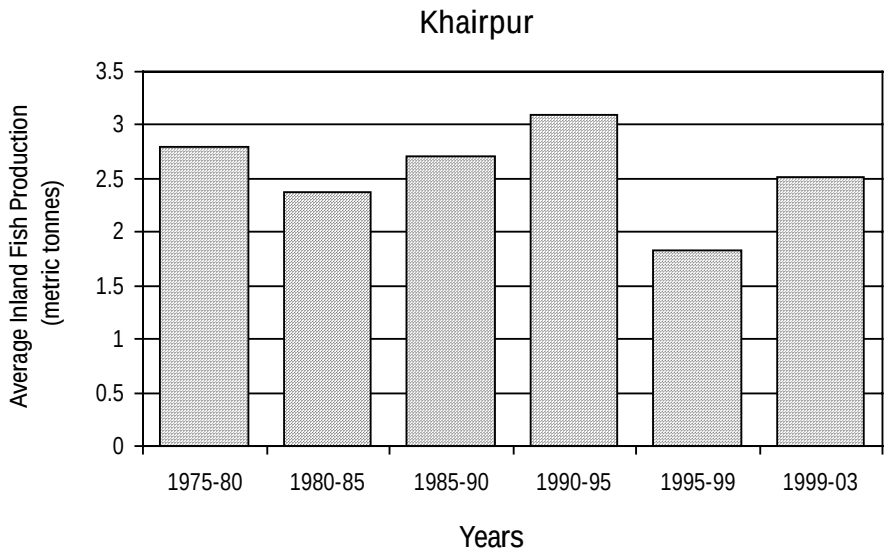
Test of Multicollinearity of the Explanatory Variables (By Klein's Rule)
Used in the Regression Analysis of Inland Fish Production

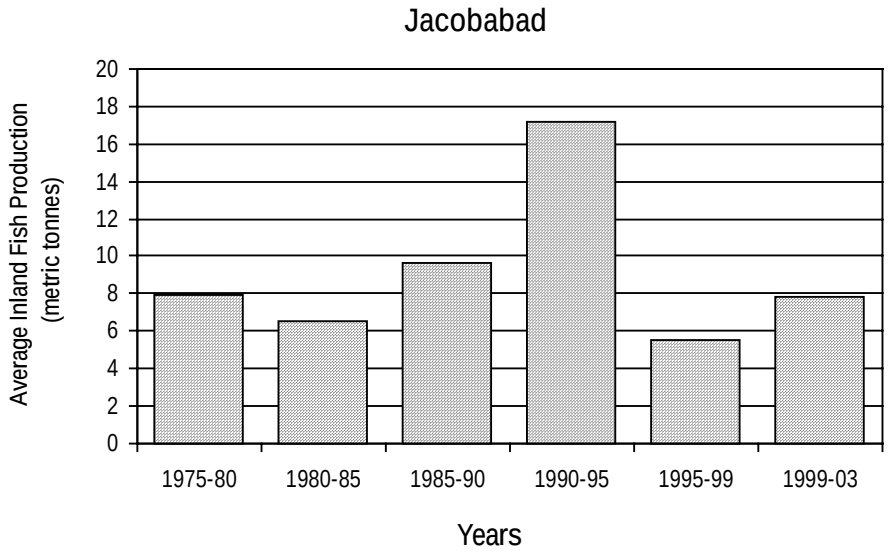
Province	Total R^2	Partial R^2 (Each Explanatory Variable as a Dependent Variable)	
		Number of Fishermen	Number of Boats
Sindh	0.66	> 0.36	> 0.28

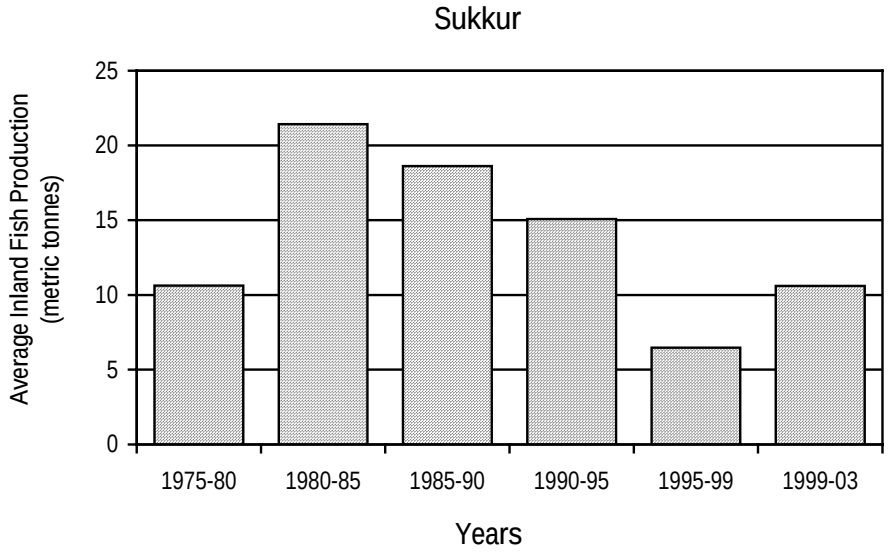
NOTE: Each explanatory variable used as dependent variable, in turn, on other explanatory variables (according to the model type of the Table Equation). If the partial R^2 is greater (>) then the total R^2, then there is harmful multicollinearity of the variable on the other variable conversely (*i.e.* R^2 total > R^2 partial). The collinearity problem is not serious (see Maddala, 1977). The associated symbol of the explanatory variables, *i.e.* > indicates that the total R^2 is greater than the partial R^2. All the variables are in natural logarithms.

APPENDIX 2

Bar-Diagram Showing Averages of Different Districts
in Inland Fish Production of Sindh, 1975-2003




Jacobabad
Average Inland Fish Production (metric tonnes)
20
18
16
14
12
10
8
6
4
2
0
1975-80
1980-85
1985-90
1990-95
1995-99
1999-03
Years


Sukkur
Average Inland Fish Production (metric tonnes)
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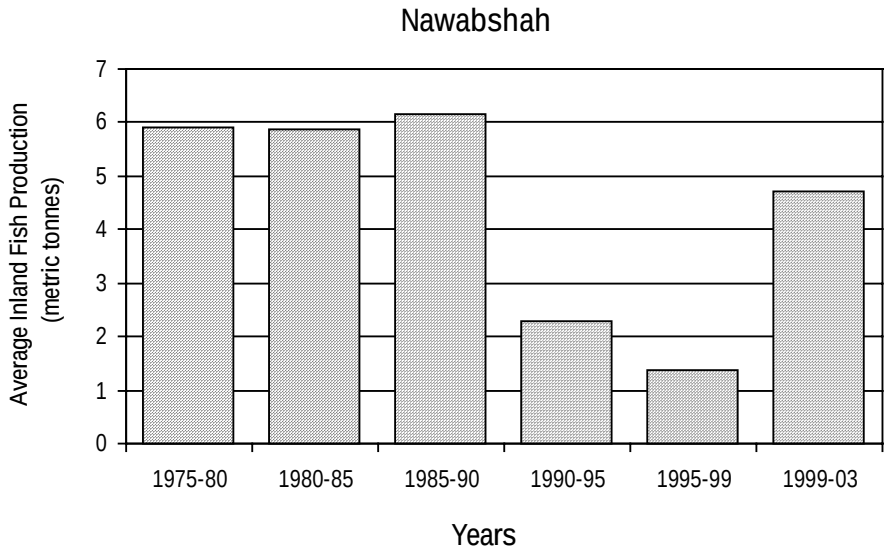
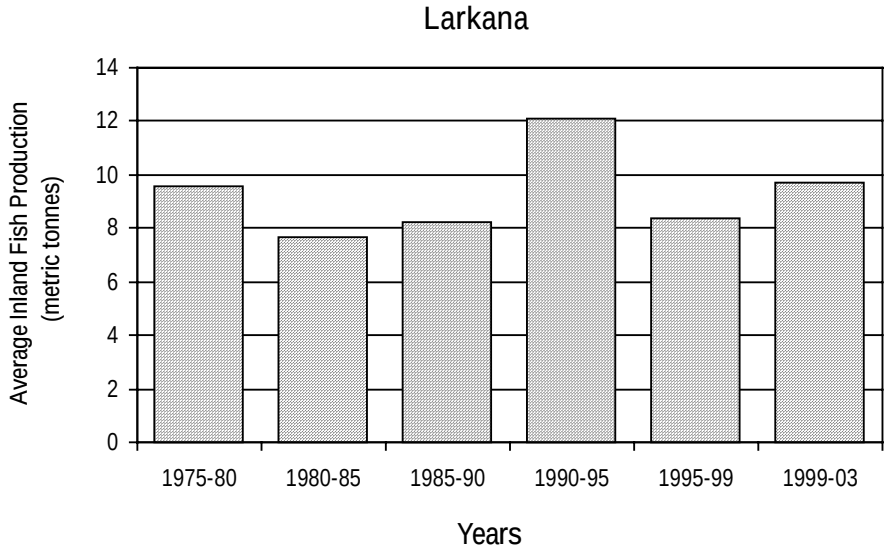
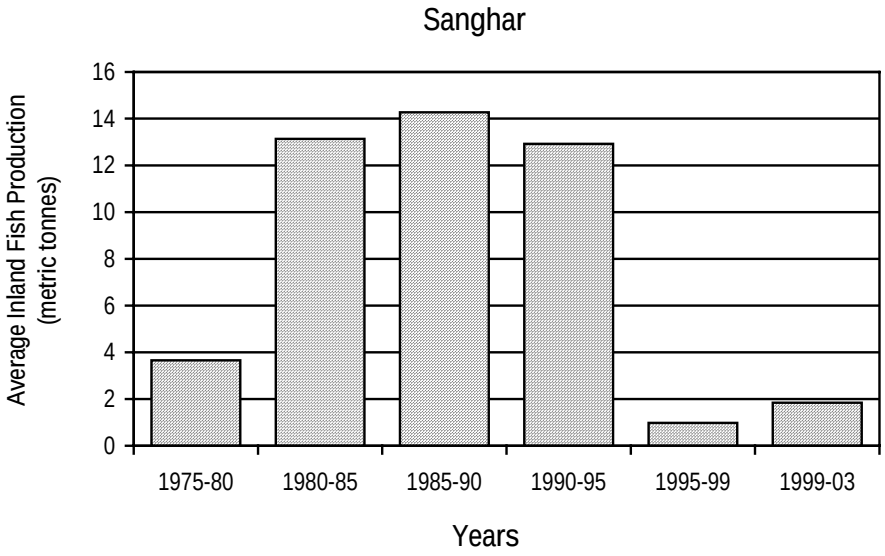
20
15
10
5
0
1975-80
1980-85
1985-90
1990-95
1995-99
1999-03
Years


Nawabshah
Average Inland Fish Production (metric tonnes)
0
1
2
3
4
5
6
7
1975-80
1980-85
1985-90
1990-95
1995-99
1999-03
Years


Larkana
Average Inland Fish Production (metric tonnes)
0
2
4
6
8
10
12
14
1975-80
1980-85
1985-90
1990-95
1995-99
1999-03
Years


Sanghar
Average Inland Fish Production (metric tonnes)
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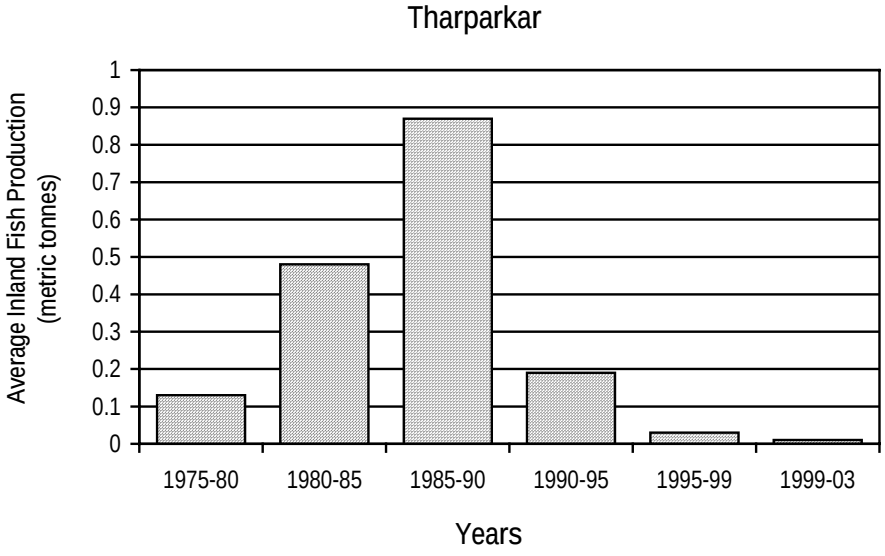
14
12
10
8
6
4
2
0
1975-80
1980-85
1985-90
1990-95
1995-99
1999-03
Years


Tharparkar
Average Inland Fish Production (metric tonnes)
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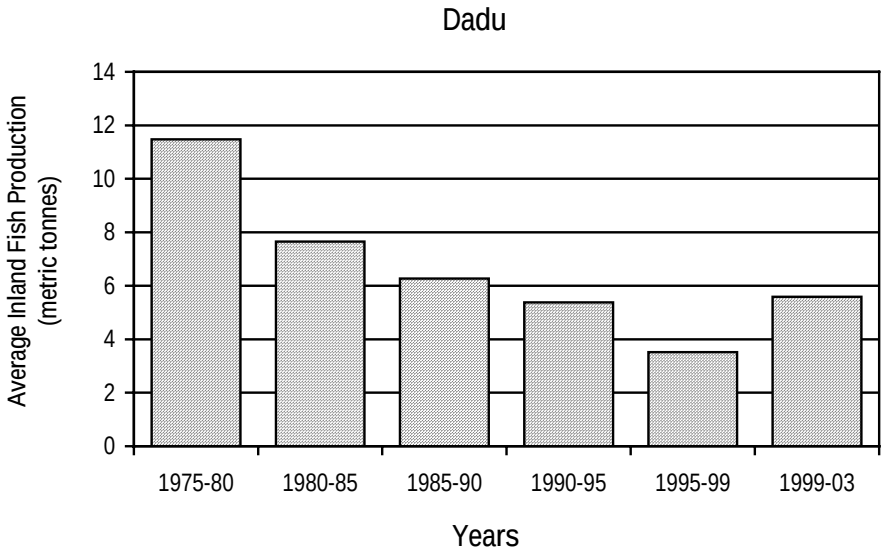
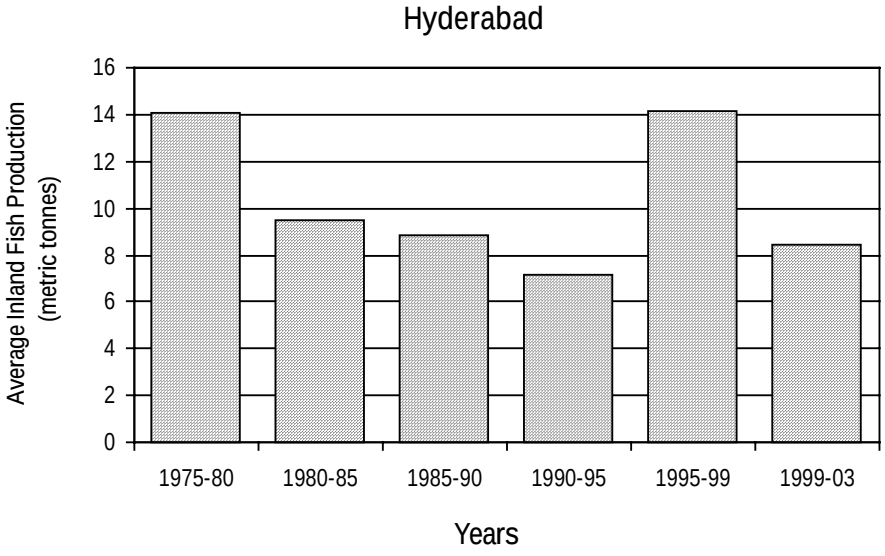
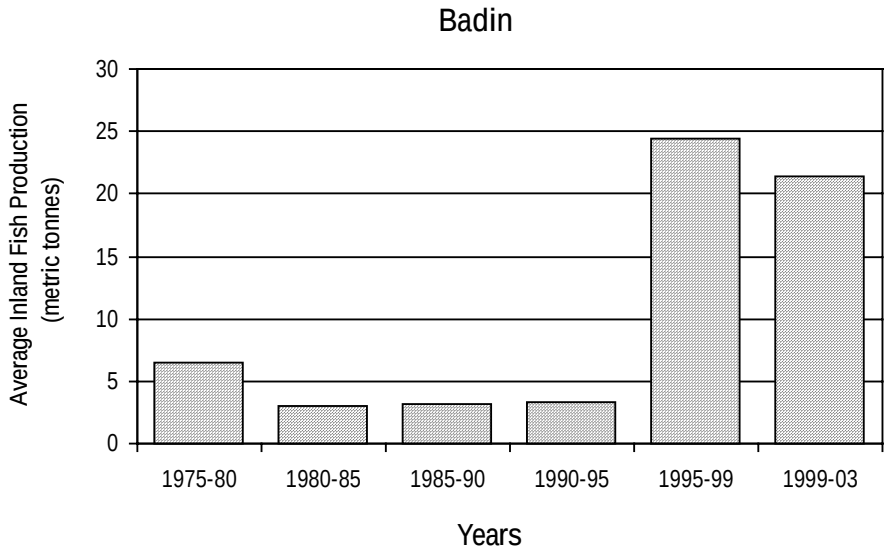
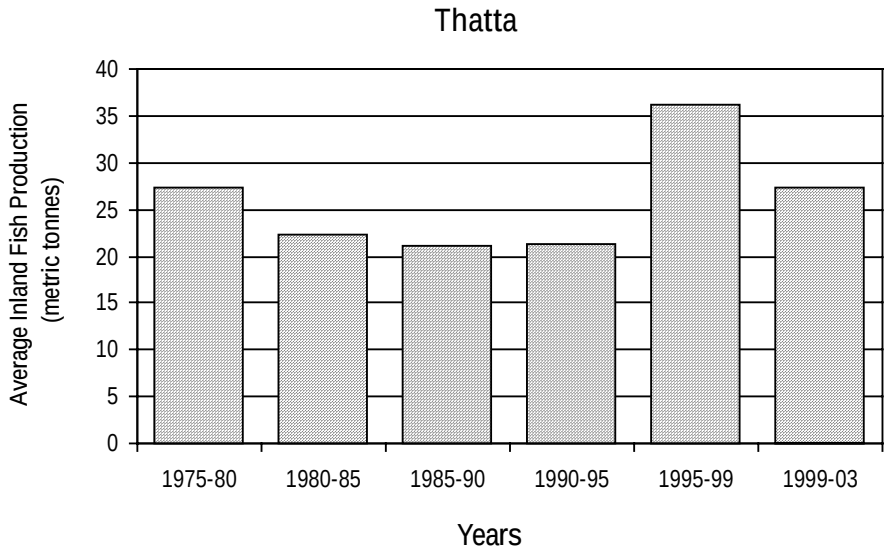
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
1975-80
1980-85
1985-90
1990-95
1995-99
1999-03
Years


Dadu
Average Inland Fish Production (metric tonnes)
14
12
10
8
6
4
2
0
1975-80
1980-85
1985-90
1990-95
1995-99
1999-03
Years


Hyderabad
Average Inland Fish Production (metric tonnes)
16
14
12
10
8
6
4
2
0
1975-80
1980-85
1985-90
1990-95
1995-99
1999-03
Years


Badin
Average Inland Fish Production (metric tonnes)
30
25
20
15
10
5
0
1975-80
1980-85
1985-90
1990-95
1995-99
1999-03
Years


Thatta
Average Inland Fish Production (metric tonnes)
40
35
30
25
20
15
10
5
0
1975-80
1980-85
1985-90
1990-95
1995-99
1999-03
Years

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ANALYSIS OF TECHNICAL EFFICIENCY OF RICE PRODUCTION IN PUNJAB (PAKISTAN) Implications for Future Investment Strategies

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Abstract. The study employed a Stochastic Frontier Production approach to determine the future investment strategies that can enhance the production of rice in Punjab, Pakistan. The data is collected from 200 farmers in the year of 2005 from two Tehsils of Sheikhupura district which is one of the major rice growing districts of Punjab province. The results of stochastic production function indicate that coefficient of pesticide is non significant probably due to heavy pest infestation while fertilizer is found to have negative impact on rice production mainly because of improper combination of N, P, and K nutrients. The improper combination of input use indicates poor dissemination of extension services. Therefore, the role of extension department should be strengthened to enhance the productivity of rice and to protect the major natural resource, ground water for future generations. The results of inefficiency model suggest that investment on tractor (mechanization) could significantly contribute to improve farmer's technical efficiency, implying that the role of agricultural credit supply institutes (such as banks) needs to be redefined. Rice farmers are 9 percent technically inefficient, implying that little potential exists that can be explored through improvement in resource use efficiency. As a long run strategy, the investment on research related activities should be increased to shift the production technology.

I. INTRODUCTION

Rice is one of the most important cash crops that play a vital role in uplifting the country's economy. It contributes more than two million tons to our food

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requirements and is an important source of employment and income generation for rural areas in the rice zone. It also contributes significantly in the foreign exchange earnings. Rice is the third largest crop in terms of area sown, after wheat and cotton, and is cultivated on over 2.5 million hectares in 2005. Its importance in the national economy needs no emphasis as it accounts for 6.1 percent of the total value added in agriculture and about 1.3 percent to GDP (Government of Pakistan, 2005-06).

Pakistan has two major rice-producing provinces, namely Punjab and Sindh. Both provinces account for more than 88 percent of total rice production. Punjab due to its agro-climatic and soil conditions is producing 100 percent of Basmati rice in the country. Important rice producing districts in Punjab are Gujranwala, Sheikhupura, Sialkot, Okara, Hafizabad, Mandi Bahaudin Din and Jhang accounting for more than 70 percent of Basmati rice production in the country.

Several recent studies on the technical and economic efficiencies of crop production, particularly for wheat and rice, have pointed out the existence of a 'yield gap'. This 'gap' refers to the difference in productivity on 'best practice' and on other farms operating with comparable resource endowments under similar circumstances (Kebede, 2001; Wadud, 1999; Villano, 2005). The difference between actual and technically feasible output for most crops implies great potential for increasing food and agriculture production through improvements in productivity, even without further advancement in technology and employment of additional resources (land, labour and water etc.). It is generally believed that resources in the agricultural sector, especially in under-developing countries, are being utilized inefficiently. Farmers are mainly concerned with profitability of farming business which directly or indirectly depends on resource use efficiency. However, little work has been done along these lines in the rice sector of Pakistan and present study is attempting to fill this gap.

Rice production can be increased either by increasing the area under rice production or by improving the efficiency of existing resources allocated to rice production. If rice farmers are already technically efficient, then increase in productivity requires new inputs and technology to shift the production frontier upward. However, if significant opportunities exist to increase productivity through more efficient use of existing resources and inputs with current technology, a stronger case can be made for institutional investment in input delivery, infrastructure, extension system, farm management services, and farmers' skills in order to promote technical efficiency of resource use at the farm level (Ali and Chaudhury, 1990). Hence, like in other crops it is important to investigate technical efficiency and its determinants in rice production.

The present study is attempting to establish a relationship between resource endowments and technical efficiency in rice production in Pakistani environment. It is expected to lead the policy manager to decide where future resources should be allocated to improve rice productivity. The key objective of present study is to estimate technical inefficiency of rice farmers that could contribute in explaining

the yield gap and to determine the role of institutes in improving technical efficiency and rice productivity.

The scheme of the paper is as follows. Section II delineates the analytical model, explains the data collection procedure and discusses the empirical model. Section III presents empirical results and discusses their implications. Last section derives conclusion based on empirical findings.

II. METHODOLOGY AND DATA COLLECTION PROCEDURE

ANALYTICAL FRAMEWORK

Mainly there are three sources of variation in output namely, fluctuations in inputs, technical inefficiency and random shocks. The contribution of inputs can be captured through a production function specification. The variation in output due to technical inefficiency and random shocks can be decomposed through stochastic production frontier approach (parametric approach). The existence of inefficiency in production leads to inefficient use of scarce resources. Technical efficiency (TE) can be estimated by employing different approaches and these includes stochastic production frontier and data envelopment analysis (DEA), also called the non-parametric approach. The advantages and disadvantages of each approach have been discussed by Coelli (1996) and Coelli and Perelman (1999). However, DEA approach works under the assumption of no random shocks in the data set. Farmers always operate under uncertainty and therefore, present study employs a stochastic production frontier approach introduced by Aigner *et al.* (1977); and Meeusen and Broeck (1977). Following their specification, the stochastic production frontier can be written as,

$$y_i = F\left(x_i, \beta\right)e^{\varepsilon} \quad i = 1, 2, \ldots, N \tag{1}$$

where, y_i is the output of rice for the i^{th} farm, x_i is a vector of k inputs (or cost of inputs), β is a vector of k unknown parameters, ε_i is an error term. The stochastic production frontier is also called 'composed error' model, because it postulates that the error term ε_i is decomposed into two components: a stochastic random error component (random shocks) and a technical inefficiency component as follows:

$$\varepsilon_i = \nu_i - u_i \tag{2}$$

where ν_i is a symmetrical two sided normally distributed random error that captures the stochastic effects outside the farmer's control (*e.g.* weather, natural disaster, and luck), measurement errors, and other statistical noise. It is assumed to be independently and identically distributed $N\left(0, \sigma_\nu^2\right)$. Thus, ν_i allows the production frontier to vary across farms, or over time for the same farm and therefore, the production frontier is stochastic. The term u_i, is a one sided ($u_i \geq 0$) efficiency component that captures the technical inefficiency of the i^{th} farmer. This

one sided error term can follow different distributions such as, truncated-normal, half-normal, exponential, and gamma (Stevenson, 1980; Aigner *et al.*, 1977; Green, 2000, 1990; Meeusen and Broeck, 1977). In this paper it is assumed u_i follows a half normal distribution $N\left(0,\sigma_\mu^2\right)$ as typically done in the applied stochastic frontier literature. The truncation-normal distribution is a generalization of the half-normal distribution. It is obtained by the truncation at zero of the normal distribution with mean μ, and variance, σ_μ^2. If μ is pre-assigned to be zero, then the distribution is half-normal. Only two types of distributions are considered in FRONTIER 4.1, *i.e.* half-normal and truncated-normal distributions.[1] The two error components (*v* and *u*) are also assumed to be independent of each other. The variance parameters of the model are parameterized as:

$$\sigma_S^2 = \sigma_v^2 + \sigma_u^2; \quad \gamma = \frac{\sigma_u^2}{\sigma_S^2} \text{ and } 0 \le \gamma \le 1 \tag{3}$$

The parameter γ must lie between 0 and 1. The maximum likelihood estimation of equation (1) provides consistent estimators for β, γ, and σ_s^2 parameters. Where, σ_s^2 explains the total variation in the dependent variable due to technical inefficiency (σ_u^2) and random shocks (σ_v^2) together. Hence, equations (1) and (2) provide estimates for v_i and u_i after replacing ε_i, σ_s^2 and γ by their estimates.

The function determining the technical inefficiency effect is defined in its general form as a linear function of socio economic and management factors:

$$U_i = F\left(Z_i\right) \tag{4}$$

The more detail about dependent and independent variables is given in empirical model.

DATA COLLECTION PROCEDURE

Analysis is carried out by using primary data on input-output quantities and prices from 200 farm households' belongings to two Tehsils, Sheikhupura and Ferozewala from Sheikhupura district of Punjab. The data is collected from 10 villages from these tehsils by the extension department of the Punjab Government. Twenty farmers from each village are randomly selected. A well structured and field pre-tested comprehensive interviewing schedule is used for the collection of detailed information on various aspects of rice for the year 2005.

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[1]On the basis of generalized likelihood ratio test, half-normal distribution is selected for the present study.

EMPIRICAL MODEL

Technical Efficiency can be defined as the ability of a decision-making unit (*e.g.* a farm) to produce maximum output given a set of inputs and technology. The empirical specification of stochastic frontier production function is given as below:

$$\ln y_i = \ln \beta_0 + \sum_{j=1}^{6} \beta_j \ln x_{ij} + \sum_{m=1}^{3} \beta_m D_{im} + \varepsilon_i, \quad i = 1, 2, \ldots, N \tag{5}$$

Where, 'i' stands for i^{th} farm and 'j' stands for j^{th} input. However, 'D' represents the dummy variables and β_0, β_j and β_m denotes intercept, coefficients of different variables and dummy variables, respectively. 'y_i' represents output of rice for the i^{th} farm, x_{ij} is a vector of k inputs (or cost of input) and the detail of independent variables is summarized as follows:

X_{i1} = Area planted for rice

X_{i2} = Plowing hours/farm

X_{i3} = Irrigation hours/farm

X_{i4} = Labour hours/farm[2]

X_{i5} = Plant protection cost or pesticide cost (Rs/farm)

X_{i6} = NPK, Nutrients/farm

D_{i1} = Dummy for planking, if practiced then 1, otherwise 0

D_{i2} = Dummy for puddling, if practiced then 1, otherwise 0

D_{i3} = Dummy for seed dressing, if practiced then 1, otherwise 0

β_j is a vector of k unknown parameters, ε_i is an error term.

Education and age (proxy for experience) are important variables that help to improve the managerial ability of the farmer and both are expected to contribute positive role in the improvement of technical efficiency. It supports the hypothesis that education and experience are basically inputs that are useful for dealing with rapid change in farming system. Therefore, both have included in technical inefficiency effect model. The impact of farm size is ambiguous on inefficiency. The large planting area is likely to have negative effects on inefficiency because larger the planting area, the greater likely is the opportunity to apply modern technologies such as tractors and irrigation. Therefore, farmers with large planting area could be more efficient or less inefficient. Another group of researchers is

[2]Labour hours include labour for transplanting, weeding, fertilization and spraying pesticide while labour for plowing and irrigation is not included because separate variable exists for these operations. Moreover, labour for harvesting is also not included because harvesting labour is not affecting the output.

arguing that small farmers could be more efficient in utilizing limited available resources for their survival because of economic pressure.

In order to get higher output farmers try to decrease the distance between plants during the transplanting of rice. However, if they have known the mechanics of rice plant and process of nutrients uptake then they would have follow the recommendations of extension department to maintain a standard distance of 9 inches between plants. The accurate distance could play a significant role to improve technical efficiency and that is why we attempted to study the impact of distance between plants on technical inefficiency. As it is assumed that tractor plow deeper than bullocks and therefore, could have positive affect on plant growth. In order to address this hypothesis we study the impact of tractor use on technical inefficiency.

Technical inefficiency (U_i) could be estimated by subtracting technical efficiency from one. The function determining the technical inefficiency effect is defined in general form as a linear function of socio economic and management factors as discussed below:

$$U_i = \delta_0 + \sum_{j=1}^{5} \delta_j Z_{ji} \tag{6}$$

Where, δ_j is the coefficient of explanatory variables and

Z_{1i} = Age of the household head (years), *i.e.* farm decision maker

Z_{2i} = Education, *i.e.* No of schooling of the farmer (years)

Z_{3i} = Farm size (acre)

Z_{4i} = Plant to plant distance

Z_{5i} = Dummy for tractor, *i.e.* if tractor owned then $Z_{5i} = 1$, otherwise 0

Various software packages exist to estimate Maximum Likelihood Estimates (MLE) parameters of the stochastic production function described in equation (5). We employed Frontier 4.1 developed by Coelli (1994). However, it should be noted here that technical efficiency model and inefficiency effect model is not estimated step by step as discussed above rather study employed Frontier 4.1 software which can estimate the coefficient of production function and inefficiency effect model altogether.[3]

[3]Frontier 4.1 under the option of inefficiency model allows to estimate the Maximum Likelihood Estimates (MLE) of the production function and inefficiency effect model in one step as proposed by Wang and Schmidt (2002).

TABLE 1

Summary Statistics for Different Variables of Rice Farmers in Pakistan, Punjab

Variables	Mean Value	Unit
Age	49	Year
Education	8	Year
Yield/Acre	35	Maund
Farm Size	21	Acre
Area	15	Acre
Plowing	5	No
Fertilizer (NPK)	94	Kg
Plant Protection Cost	459	Rs
Irrigation	30	Hour
Labour	184	Hour
Plants	66021	No/acre
Plant to Plant Distance	10	Inches

The average age of the farm decision maker is observed to be 49 years of old (Table 1), indicating that majority of the old people are involved in farming activities. Average year of schooling of farmer's family member is eight years. It is presumed to be low because of limited available facility of schooling in the vicinity. Mean farm size is 21 acres. The average fertilizer (NPK) rate is 94 kg per acre which is lower than the recommended level of 114 kg of NPK. However, proper combination of N, P, and K (as recommended) is not being followed by the farmers. Average number of plants grown per acre is 66021. Farmers have access to both canal and own tube well water and average hours of irrigation is 27 hours/acre. The average rice yield is 35 mounds [4]per acre with a range of 15 to 60 mounds per acre. High variation in yield could be due to difference in number of plants, planting time, soil quality, different level of input use and random shocks etc. This huge gap of 25 mounds per acre between average and highest farm yield is suggesting that there are constraints on the farmer's side which create hurdles for increasing rice yield from a given set of technology and resources.

III. RESULTS AND DISCUSSION

In order to select the type of production function that fits best to our data set we tested the null hypothesis H_0: $\beta_{jk} = 0$, *i.e.* the coefficient of square and interaction terms in translog production function are zero. After testing the hypothesis whether Cobb-Douglas production function is an adequate representation of the data, given

[4]1 mound = 40 kg

the specifications of the translog model we can finally choose the best production function that fits best to our data set. Both functions are estimated but in order to maintain the length of the paper within limits, results are reported only for Cobb-Douglas production function. The values of the log likelihood function for Cobb-Douglas and translog production functions are 115.34 and 140.1, respectively. By employing the log-likelihood ratio test (LR = –2*(117.6-140.1) = 45), we estimated the value of Log Likelihood Ratio (LR) equal to 45. This value is compared with the upper five percent point for the χ^2_{14} distribution, which is 23.68. Thus the null hypothesis that Cobb-Douglas frontier production function adequately represents the data is accepted, given the specifications of the translog frontier.

TABLE 2

OLS and Maximum Likelihood Estimates of the Cobb Douglas Stochastic Frontier Function

Production Coefficient	OLS Coefficients	MLE Coefficients
Intercept	2.66*** (9.20)	2.98*** (11.55)
ln (Area)	0.80*** (8.98)	0.86*** (10.84)
ln (Plowing hours)	–0.09*** (–2.18)	–0.06** (–1.53)
ln (Irrigation Hours)	0.31*** (6.15)	0.19*** (4.11)
ln (Labour Hours)	0.03^{ns} (1.09)	0.04** (1.52)
ln (Plant Protection cost)	-0.01^{ns} (–0.38)	0.02^{ns} (0.82)
ln (Fertilizer, NPK)	–0.05** (–1.56)	–0.06*** (–2.02)
Dummy for Planking	0.09*** (2.64)	0.06*** (1.94)
Dummy for Seed Dressing	0.14*** (4.79)	0.12*** (4.69)
Dummy for location	–0.10*** (–3.80)	–0.10*** (–4.30)
σ^2	0.02	0.06*** (3.01)
γ		0.83*** (10.24)
Log Likelihood function	102.27	117.63
Inefficiency Effect Model		
Intercept		0.61** (1.49)
Age of the Respondent		0.01*** (1.89)
Education		–0.02*** (–2.11)
Farm Size		0.003*** (2.34)
Plant to Plant Distance		–0.13** (–1.58)
Dummy for Tractor		–0.32*** (–2.14)

NOTE: Values in brackets represent t-ratio.

*** = Highly significant at 1% level, ** = Significant at 5% level, ns = Non significant

The results of Ordinary Least Squares (OLS) and Maximum Likelihood Estimates (MLE) for Cobb-Douglas production function are reported in Table 2 which can be used to test the null hypothesis H_0: $\gamma = 0$, *i.e.* no technical efficiency exists in rice production. It should be noted that the values of log-likelihood function for the full stochastic frontier model and the OLS fit are calculated to be 117.58 and 102.27, respectively and reported in Table 2. This implies that the generalized likelihood-ratio statistic for testing the absence of technical inefficiency effect from the frontier is calculated to be LR = –2*(102.27–117.58) = 30.62 which is estimated by the Frontier 4.1 and reported as the "LR" test of the one sided error. The degrees of freedom for this test are calculated as $q + 1$, where q is the number of parameters, other than γ specified to be zero in H_0, thus in our case $q = 9$. The value of "LR" test is significant because it exceeds from the tabulated value taken from Kodde and Palm (1986). The log likelihood ratio test indicates that inefficiency exists in the data set and therefore, null hypothesis of no technical inefficiency in rice production is rejected.

The coefficients of different input variables estimated with MLE technique are reported in last column of Table 2. The parameters of Cobb-Douglas production function can be directly illustrated as production elasticities of inputs in the production process. The parameters of sowing area, number of plowing, irrigation hours, labour hours and fertilizer nutrients (NPK) are significant and hence, playing a major role in rice production. The coefficient of sowing area is positive and highly significant according to the priori expectations. The coefficient of plowing hours is negative and significant at 6 percent probability level; indicating that nearly six percent output will decline with increase in one hour of plowing. It is not clear why this coefficient is significant with negative sign. In order to explain it more specific soil related information is required which are missing in our data set. From the results we can conclude that in our case plowing is less important than puddling, and therefore, farmers should concentrate more on puddling rather than plowing. Additional plowing is wasting the resources because it is just adding in total cost but not in revenue.

The coefficient of irrigation hours is positive and highly significant and it is highest after sowing area, implying that output of rice could be increased further by increasing the availability of irrigation water (canal water etc.) in the area. It is consistent with other studies (Ali and Flinn, 1989; Lingard and Jayasuriya, 1983) because rice is water intensive crop and required comparatively more water than other crops. The coefficient of labour hours is also positive and statistically significant at 10 percent level which is again according to the priori expectation.

The coefficient of pesticide cost is positive but insignificant. It might be due to the reason that heavy pest infestation has occurred which is making the spray ineffective. The coefficient of fertilizer is negative and significant and it is clearly indicating that farmers are using improper combination of different nutrients as discussed in above section. However, total amount of fertilizer (NPK) being used is less than the recommended level and, therefore, negative coefficient of NPK cannot

be referred to higher use of fertilizer as usually argued rather coefficient of NPK in our case is negative because of improper combination of NPK.[5] The improper combination of NPK will not only affect the productivity of soil but it could also affect the quality of ground water in the long run (Nyuyen, 1999; Nguyen *et al*., 2000; NFDC, 1998; Sarah and Brad, 1993). Both soil and ground water are important sources of production and therefore, these resources should be sustained for the future generation in order to maintain their welfare level. Therefore, policy should be adapted to preserve our natural resources by maintaining the output level. Hence, the role of the extension department should be strengthened in the study area to guide the farmer so that they can use the different nutrients of fertilizer in a combination recommended by the Ministry of Food, Agriculture and Livestock, Federal Water Management Cell (1997). Another approach to achieve the similar objective is through input price mechanism.

The coefficient of planking dummy is positive and significant at 1 percent probability level, showing that farmers who plank their field have higher output than those who don't. The coefficient of dummy for seed dressing is also positive and highly significant; supporting the hypothesis that if seed is dressed chemically before plantation then probability of getting disease significantly reduced which appears in terms of higher output. The location dummy is included in the production function to capture the resource based differences in two tehsils of Sheikhupura district. The negative sign of tehsil dummy indicates that output would be less in Ferozewala tehsil compare to Sheikhupura tehsil. It means Sheikhupura tehsil has more conducive soil and climatic conditions for rice production compared to Sheikhupura tehsil.

It is observed that MLE for γ is 0.83 and highly significant (Table 2). It is consistent with the theory that true γ-value should be greater than zero. The value of γ-estimate is significantly different from one, indicating that random error is playing significant role to explain the variation in rice production and this is normal especially in case of agriculture where uncertainty is assumed to be a main source of variation. This implies that stochastic frontier model is significantly different from deterministic frontier, which does not include random error. However, it should be noted that 83 percent variation in output is due to technical inefficiency and 17 percent is due to stochastic random error.

In order to investigate the determinants of inefficiency we estimated the technical inefficiency model elaborated in equation (6), where inefficiency is assumed to be dependent variable. We used age of the respondent as an independent variable and its coefficient is positive and statistically significant, implying that if old people are involved in the farm decision making process then it will lead to

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[5]Farmers are using only 21 kg of P while the recommended level is 34 kg per acreage. In addition to that farmers are also using 25 kg of P_2O_5 while the recommended level of P_2O_5 is zero.

higher technical inefficiency. It might be due to the reason that physically they are not very fit to handle the laborious job at their farms. According to our expectations coefficient of education is negative and highly significant, implying that investment on human capital is a powerful tool to improve efficiency in rice producing area. We also try to explore the impact of farm size on farm inefficiency and results indicate as farm size increases inefficiency increases (Table 3). It might be due to the fact that farmers have limited supply of labour especially during the peak time of rice transplantation and moreover rice is labour-intensive crop (this lead to poor management with increase in farm size). Availability of large amount of timely financial resources at large farms could be another constraint; therefore, big farm size is finally resulting in higher technical inefficiency. The negative coefficient of plant to plant distance shows that as distance between plants increases efficiency increases. It might be due to the reason that farmers are facing problem in weed removing process because of small distance between plants or might be distance between two plants is too small that each plant is competing for the limited availability of nutrients in the soil. However, future research needs to focus on optimal plant to plant distance according to each zone. The coefficient of own tractor dummy is also negative and significant, implying that existence of modern technology at their own farms allow them to perform all operations timely and finally this appears in terms of higher technical efficiency. The results of tractor dummy in inefficiency model suggest that investment on tractor will appear in terms of higher farm productivity and profitability. Hence, agencies responsible for credit supply (such as Agriculture Development Bank) should tie up the availability of credit facility with the purchase of tractor because it is positively contributing in the enhancement of agricultural productivity. However, results cannot be generalized for all crops in different regions of the country and therefore, role of farm assets need to be further explored in other crops more intensively in order to develop a consolidated credit policy for agriculture sector of Pakistan.

TABLE 3

Frequency Distribution of Technical Efficiency for Individual Farms

Efficiency interval	Frequency
$0.900 < TE < 1.00$	151
$0.800 < TE < 0.900$	31
$0.700 < TE < 0.800$	12
$0.600 < TE < 0.700$	5
$0.500 < TE < 0.600$	1
Average	0.91
Minimum	0.53
Maximum	0.98

The frequency distribution of technical inefficiency is reported in Table 3. The maximum and minimum values of technical efficiency are 98 and 53 percent, respectively. The mean technical efficiency in rice production is 91 percent and 151 farmers are more than 90 percent technically efficient and 31 farmers are more than 80 percent but less than 90 percent technically efficient. Twelve farmers are less than 80 percent but more than 70 percent technically efficient.

IV. CONCLUSION

Plowing hours and fertilizer have negative and significant impact on output but plant protection cost is insignificant with positive sign. Fertilizer is being used in improper combination which is not only creating the soil degradation problem but also affecting the quality of ground water. Soil and ground water are two important natural resources that need to be protected for sustainable development. The deterioration of ground water has severe implications on soil productivity (Sarah and Brad 1993). The protection of natural resources is the central theme of present policy matrix and therefore, resources allocated for the protection of these natural resources should be increased. The role of the extension department needs to be strengthened in the study area which seems to be very poor in the present situation. Coefficient of irrigation is positive and highly significant, implying that improvement in irrigation facilities could significantly enhance the production of rice in the study area. Therefore, Government should increase the investment on water management related activities to provide better irrigation facilities to the farmers.

The results of inefficiency model suggest that investment on education and mechanization process should be increased. Therefore, private sector should be encouraged to invest on education in the rural areas and Government institutions (such as Banks) could tie up their credit supply policy with the purchase of tractor to improve mechanization. Old farmers are technically inefficient and therefore, young generation needs to be motivated to participate in agricultural related activities because young generation has better ability to adopt modern technology and to make timely decisions.

On an average farmers are 91 percent technically efficient implying that little potential exists that can be explored to improve resource use efficiency in rice production. Therefore, in order to improve rice productivity in the long run, production function needs to be shifted upward with the help of new production technologies. It implies that research institutes should focus for the development of high yielding and more qualitative varieties and this required more investment on research related activities.

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AN ECONOMETRIC ESTIMATION OF TRADITIONAL IMPORT DEMAND FUNCTION FOR PAKISTAN

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Abstract. Many studies have estimated the aggregate import demand function for Pakistan by using non-stationary data.[1] Their findings suffer from the so-called 'spurious regression' problem. This study attempts to estimate the aggregate import demand function for Pakistan by employing Johansen and Juselius cointegration technique on the annual data for the period 1975-2005. Our results show that there is long-run equilibrium relationship among variables and the stability tests indicate that import demand function remains stable over the sample period and hence the estimated results are appropriate for policy implications.

I. INTRODUCTION

In recent years, because of the popularity of globalization, the interdependence among countries at world level has increased. Every country wants to achieve rapid pace of economic development through getting the maximum benefits from international trade and use of modern techniques in the production process. The implementation of WTO rules and substantial reduction in trade restrictions, the imports of most of developing countries are rising rapidly. The economy of Pakistan is not an exception as it depends on the rest of the world and this degree of interdependence has increased in the past few years. The value of imports as a percentage of GDP has shown upward trend which has increased from 13.3 percent in 1999-2000 to 19.4 percent in 2005-06. This increase in imports is mainly due to strong growth momentum that Pakistan economy has experienced during the last half decade. The domestic demand has increased substantially during this period which is the major cause of increased investment demand in the economy. The

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[1]For example, Sarmad (1989), Afzal (2001), etc.

imports demand has increased due to high demand of machinery and raw material. Therefore, the share of machinery in total imports has increased from 13.9 percent in 1999-2000 to 18 percent in 2005-06. The increase in imports demand has further worsened the position of Pakistan's trade balance. The deficit in trade balance has almost doubled from Rs. 4,352 million in 2004-05 to Rs. 8,259 million in 2005-06. As percentage of GDP, trade deficit has increased from 2.1 percent in 1999-2000 to 6.6 percent in 2005-06. The effectiveness of Pakistan's trade policy has slowed down the pace of import growth and has declined to 2.1 percent in 2006-07 (US $ 28.6 billion to US $ 28 billion). This reduction in import growth is mainly due to tight monetary policy to shave off the excess demand, decline in import of fertilizer etc. The effectiveness of any country's international trade policy in relation to its balance of payments and development mostly depends on the magnitude of income and price elasticities of its export and imports. Thus, the empirical work on this issue has great importance for policy makers who formulate trade policies. This study is an attempt to estimate the income and price elasticities for Pakistan by using annual data for the period 1975-2005.

In section II, a brief background of the Pakistan's imports is presented. Section III gives important features of traditional import demand function and model specification for this study. The empirical results of the study are presented in section IV and in section V, conclusion and policy implication are drawn from the study.

II. BACKGROUND

The importance of foreign sector has increased with the globalization of the world in recent years. The countries having higher degree of involvement in the global economy through trade and investment improved their economies significantly and reduced the level of poverty. The Pakistan's trade has also played a very crucial role in the development of its economy. Pakistan's trade as percentage of GDP has an upward trend since 1999-2000 except 2001-02[2] as shown in the Figure 1.

Like other developing countries, Pakistan has tried to achieve the benefits from growth of world economy. Pakistan has experienced an average growth of almost 16 percent in exports and 29 percent in import over the last four years. This rise in exports was mainly due to the rapid improvement in the trading environment at international level. This healthier trade environment was the product of most striving and victorious round of multilateral trade negotiation in Uruguay under the umbrella of General Agreement on Tariffs and Trade (GATT). The rise in domestic demand due to strong economic growth increased the level of investment which ultimately increased the country's import demand. Pakistan's total imports distribution shows that the shares of Petroleum group and raw materials are almost same (22.3% and 22.7% respectively). The major categories of Pakistan's imports are shown in Table 1.

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[2]Government of Pakistan, *Economic Survey*.

FIGURE 1

Trade as Percentage of GDP

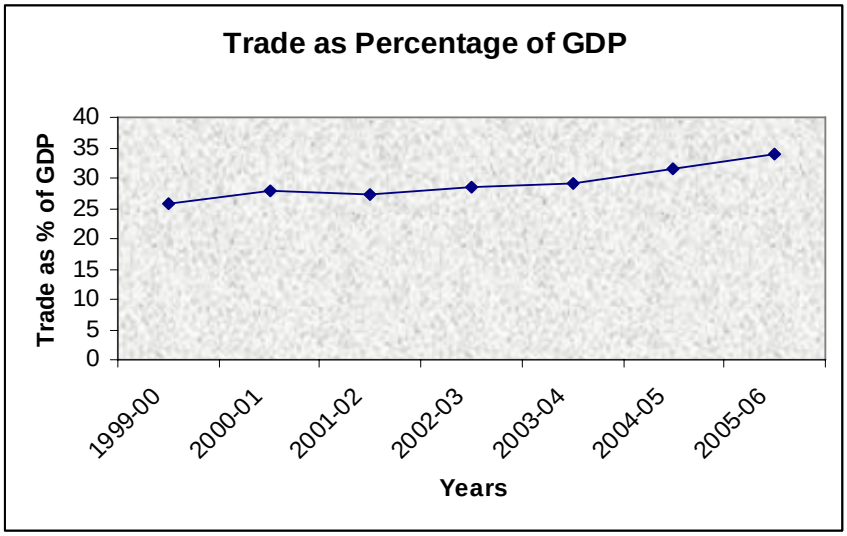

TABLE 1

Pakistan's Major Imports

(*Percentage Share*)

Commodities	1999-2000	2000-2001	2001-2002	2002-2003	2003-2004	2004-2005	2005-2006	2006-2007□
Machinery*	13.9	19.3	17.1	18.5	17.8	22.5	18.0	22.5
Petroleum Group	27.2	31.3	27.1	25.11	20.3	19.4	22.3	22.5
Chemicals**	17.5	20.0	15.9	15.1	16.1	15.5	13.4	12.7
Transport Equipments	5.5	4.0	4.8	5.6	5.6	6.2	7.7	8.0
Foodstuff	6.0	5.0	5.3	6.2	5.4	4.8	3.6	3.6
Iron & Steel	3.0	2.6	3.3	3.3	3.3	4.3	5.1	5.0
Fertilizers	1.9	1.6	1.7	2.1	1.8	2.0	2.4	1.2
Others	25.0	16.2	24.8	24.1	29.7	25.3	27.5	24.5
Total	100	100	100	100	100	100	100	100

Source: Government of Pakistan, *Economic Survey*, 2006-07.

*Excluding Transport Equipments, **Excluding Fertilizers, □July-March (Provisional).

These seven categories accounted for 75 percent of total imports during the year of 1999-2000 which reduced to 72.5 percent in 2005-06 but again increased to 75.5 percent for the first nine month of current fiscal year. The share of machinery, transport equipments, iron and steel and fertilizer has increased by 29 percent, 40 percent, 70 percent and 26 percent respectively in total imports during the period of 1999-2000 to 2005-06. The share of remaining three categories: petroleum group, chemicals and foodstuff has reduced by 18 percent, 23 percent and 40 percent respectively during the same period. The level of imports has increased by the rise in share of four categories to 41.25 percent and decrease in imports due to reduction in share of three categories to 27 percent. Therefore, the net increase in total imports was only 14.25 percent.

III. LITERATURE REVIEW

It is essential for policy makers to understand that how imports react to changing economic conditions for the effective implementation of trade policies. It is generally believed that imports react more rapidly than exports to trade liberalization. Therefore, it is necessary to predict imports demand more accurately to achieve the maximum benefits from the growing world economy. Various researchers tried to estimate the import demand function for different countries for policy purposes. Islam and Hassan (2004) estimated the aggregate import demand function for Bangladesh using quarterly time series data. They applied the Johansen and Juselius multivariate cointegration technique. Their results indicate that import demand function is mainly determined by income and relative prices. The income elasticity was positive and greater than unity showing that imports are 'luxury' goods. The coefficient of relative prices is negative but less than unity; means Bangladesh imports are not much sensitive to prices.

Bahamani and Kara (2003) estimated the import and export demand function for nine industrial countries like Australia, Canada, Denmark, US and etc. by using quarterly data for the period 1973-98. They used ARDL approach for estimation. Their results show that long-run income elasticities are greater in import demand function than in the export demand function. The price elasticities were smaller than unity, indicating that import and export demand functions are relatively inelastic. They fail to provide any specific answer to the policy question that which policy has the quickest impact on trade. According to them, trade flows of different countries do react differently.[3]

Sarmad (1989) estimated the import demand function for Pakistan for the period 1959-60 to 1985-86 at both aggregate and disaggregate level. His results show that there is strong evidence to support the use of log linear form as the appropriate functional form of import equation, both at the aggregate and disaggregate levels. The estimated price and income elasticities appear to be

[3]For detail, see Bahamani and Kara (2003).

different from similar estimates of developed countries and for middle-income countries.

Afzal (2001) estimated the import demand function for Pakistan using annual data for the period 1960-99. He used OLS and TSLS techniques for estimation. His results show that the signs of the price coefficient and income coefficient were as expected but price coefficient was insignificant. He concluded that the liberalization policy does have positive impact on the import demand. Shabbir and Mahmood (1991) analyzed the stability of the import demand function for Pakistan. They applied the maximum likelihood-based switching regression technique to examine the timing and nature of the structural change. Their conclusion was that both income and price elasticities were altered during end 1971-beginnig 1972.

The study by Afzal (2001) and Sarmad (1989) suffer from methodological problem in that they used non-stationary data in estimating import demand function for Pakistan. This means their findings suffer from the so-called spurious regression problem. The present study is an attempt to estimate the aggregate import demand function for Pakistan, using annual data for the period 1975-2005, employing error correction model and conintegration techniques that provide more accurate and reliable estimates.[4]

IV. MODEL SPECIFICATION AND EMPIRICAL RESULTS

Following Doroodian *et al.* (1994) the following import demand model for Pakistan is estimated.

$$\ln M_t = \phi_0 + \phi_1 \ln Y_t + \phi_2 \ln P_{mt} + \phi_3 \ln P_{dt} + \phi_4 \ln M_{t-1} + u_t \qquad \text{(A)}$$

$\ln M$ = log of volume of imports

$\ln Y$ = log of real income

$\ln P_m$ = log of import prices

$\ln P_d$ = log of domestic prices

The log-linear form is considered most appropriate by various empirical studies.[5] This functional form gives elasticity coefficients directly. Moreover, log-linear form reduces the problem of heteroscedasticity in an empirical analysis. Therefore, empirical results estimated by this model are appropriate for policy implication.

This study uses Johansen and Juselius (1990) multivariate cointegration technique to examine the long-run equilibrium relationship. For cointegration tests, it is necessary that all data series must have same integrating order. We applied the

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[4]All data series are collected from International Financial Statistics (IFS) CD ROM.

[5]For more detail, see Khan and Ross (1977) and Boylan *et al.* (1980).

Augmented-Dickey Fuller (ADF) and Phillips-Parren (PP) tests to determine the order of integration.[6] The results are presented in Table 2.

TABLE 2

Unit Root Tests Results

Variables	ADF		PP	
	Level	1st Diff.	Level	1st Diff.
Imports	–2.563792	–5.058116*	–2.532054	–5.091492*
Real Income	–3.278836	–5.301758*	–3.324544	–6.479923*
Domestic Prices	–1.434978	–3.553260**	–1.051940	–4.114939*
Import Prices	1.707775	–4.941590	2.253155	–6.821448*

* and ** shows the level of significance at 1% and 5% respectively.

In Augmented-Dickey Fuller test, we use the Schwarz Information Criterion, Akaike Information Criterion and Hannan-Quinn Criterion for the selection of optimal lag length. But in Phillips-Parren we use the Bartlett Kernel, Parzer Kernel and Quadratic Spectral Kernel in special estimation method and for optimum bandwidth; we use the Newey-West Bandwidth and Andrews Bandwidth. All results indicate that almost all data series are having unit root at level form but not at first difference. This means all series are non-stationary at level but stationary at first difference.

The Johansen and Juselius multivariate trace and maximal eigen value cointegration test (1990) is applied to the variables of equation (A) and results are presented in Table 3.

Both trace and eigenvalue tests give the same results; means the null hypothesis of no cointegration is rejected for $r = 0$ for both trace and eigenvalue tests at 5% level of significance. This implies that there is one cointegrating vector. Therefore, we conclude that although the individual data series are non-stationary but their linear combination is stationary, so the level estimates are appropriate for policy implications.[7] We apply the Error Correction Model to estimate the short-run

[6]Visual analysis of the series shows that all data series are non-stationary at level form. It also shows that all data series have intercept and trend.

[7]For detail, see Engle and Granger (1987).

as well as long-run elasticities. The adjustment coefficient is negative and significant (–0.50); suggests that 50% adjustment in total import demand towards equilibrium path occur in each period for the sample used in this study.

TABLE 3

Multivariate Cointegration Results

Test	Null Hypothesis	Cointegration Test Statistics	Critical Value
Trace Test	H_0: $r = 0$	95.74819*	47.85613
	H_0: $r \leq 1$	24.45916	29.79707
	H_0: $r \leq 2$	5.573078	15.49471
	H_0: $r \leq 3$	0.291587	3.841466
Maximal-eigenvalue Test	H_0: $r = 0$	71.28903*	27.58434
	H_0: $r \leq 1$	18.88608	21.13162
	H_0: $r \leq 2$	5.281491	14.26460
	H_0: $r \leq 3$	0.291587	3.841466

*denotes rejection of the hypothesis at the 0.05 level of significance.

The estimated coefficients show that elasticities of import demand with respect to that variable. The elasticities estimated by ECM are presented in Table 4.

TABLE 4

Short-run and Long-run Elasticities

Variables	Short-run elasticity	Long-run elasticity
Real Income	0.2631 (0.6324)	0.0.6947 (2.6645)*
Domestic Price Level	–0.2905 (–0.6281)	–0.3602 (–1.3271)
Import Prices	–0.1661 (–0.6832)	–0.5043 (–2.0507)*

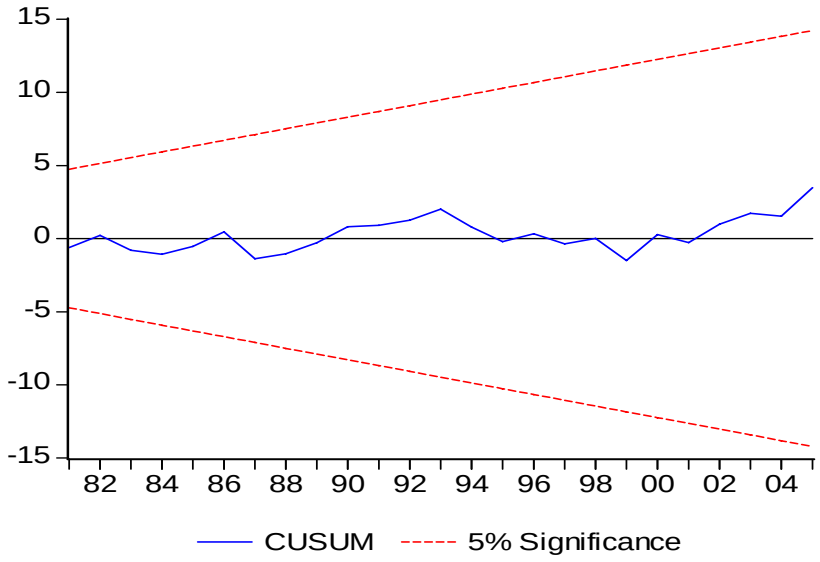
*denotes rejection of the hypothesis at the 0.01 level of significance.

The results shown in Table 4 indicate that only income and import price elasticities in the long run are significant. The sign of real income elasticity coefficient is positive that indicates an increase in income leads to increase in imports in long run and *vice versa*. The inelastic long-run income elasticity implies that imports are regarded as necessary good in Pakistan. Similarly the sign of import prices show a negative relationship between import prices and level of imports in the long run. But in short run the level of imports is not affected by the level of real income, domestic price level and import prices. The coefficients also indicate that the imports are less elastic with respect to income and import prices in the long run. In regression analysis, the stability of coefficients is considered to be essential for policy purposes. Therefore, the stability tests are performed.

V. STABILITY TESTS

The stability of import demand function is very important for the effectiveness of trade policy. In stability test, we see whether the estimated import demand function has shifted or not over the time period included in the sample of the study. We have applied CUSUM and CUSUM of Squares (Brown, Durbin and Evans, 1975) Tests and Recursive coefficients to check the stability of the import demand function. The CUSUM test (Brown, Durbin and Evans, 1975) is based on the cumulative sum of the recursive residuals.

FIGURE 3



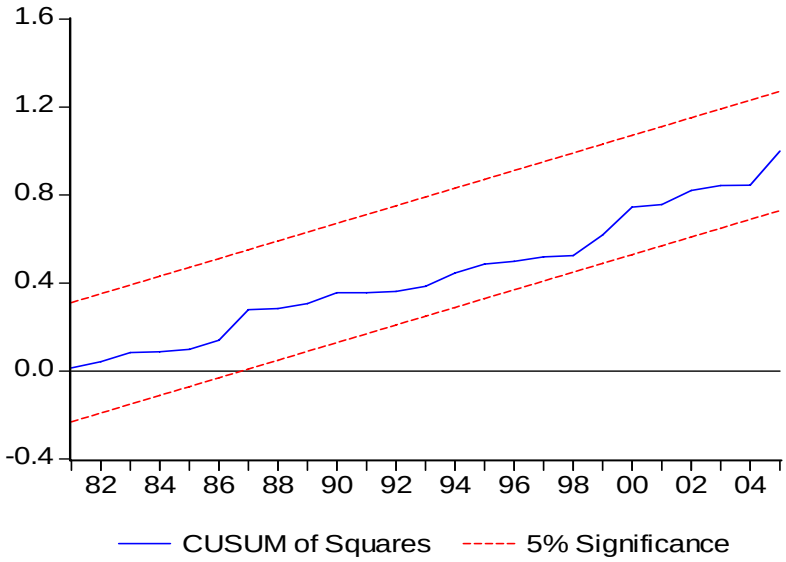


Figure 3 shows that import demand function is stable during the sample period because the cumulative sum does not go outside the area between two critical lines. The CUSUM of Squares Test (Brown, Durbin and Evans, 1975) is based on the test statistic.[8] Like CUSUM test, the diagram indicates that residual variance is stable over the sample period because cumulative sum of squares line does not go outside the 5% critical lines. The Recursive Coefficient test enables us to trace the evolution of estimates for any coefficient as more and more of the sample data are used in the estimation. In this test two standard error bands are plotted around the estimated coefficients. If the coefficient displays significant variation as more data is added to the estimating equation, it is a strong indication of instability. The following diagrams (Figure 3) show that all estimated coefficients are lying within the bands, so all coefficients estimated in the imports demand function are stable.

VI. CONCLUSION AND POLICY IMPLICATIONS

Following Doroodian *et al.* (1994), the import demand function for Pakistan is estimated. By employing Johansen and Juselius cointegration test, the long-run equilibrium relationship among variables is observed using annual data for the period 1975-2005. For estimating the short-run and long-run elasticities, the Error Correction Model is estimated. Furthermore, various stability tests are employed to observe the impact of various changes on the stability of import demand function of Pakistan.

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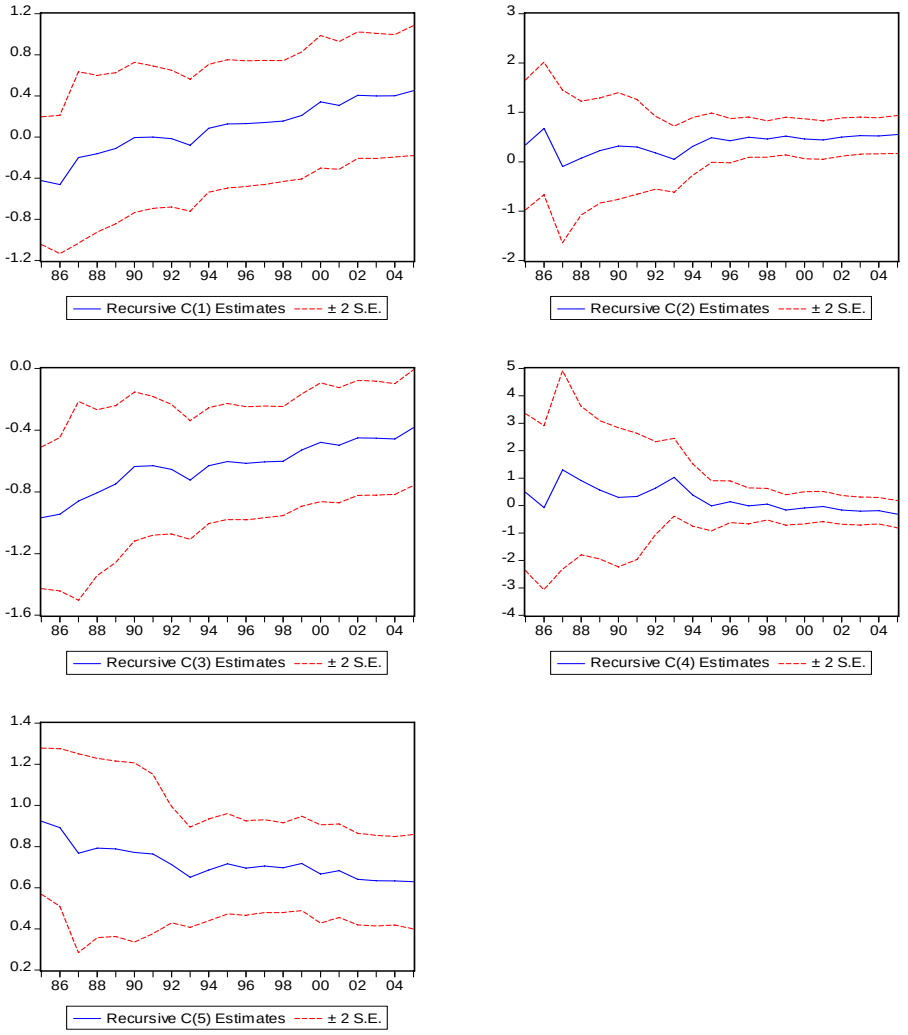
[8]For a table of significance lines for the CUSUM of squares test, see Brown, Durbin and Evans (1975) or Johnston and DiNardo (1997).

FIGURE 4



The estimated results show that there is long-run equilibrium relationship among variables. The results of stability tests predict that the import demand functions remain stable during the sample period so the results are appropriate for policy implications. The estimated elasticities indicate that changes in real income and import prices significantly affect the import demand in the long run. But variations in domestic price level and import price level do not affect significantly the imports demand in the short run. The inelastic long-run income elasticity implies that imports are regarded as necessary goods in Pakistan.

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