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Abstract

This article presents an attempt to estimate electricity demand through various functional forms in the case of Pakistan using household level data. A number of articles on electricity demand estimate and interpret the results through different functional forms, such as linear, log linear and translog functional forms. However, none of the studies presents a comprehensive analysis based on the all three functional forms, especially in the case of Pakistan. The present article is an attempt to fill this gap by using household level data from Pakistan. Our findings show that total expenditure, house size, household size, heating degree days and temperature above threshold level may increase the demand for electricity. On the other hand, the price of electricity may decrease demand for electricity. An elasticity analysis shows that gas is a statistical substitute for electricity.

Keywords: Electricity Demand, Residential Sector, Pakistan

JEL Classification: Q41, R22

1. Introduction

Energy is a key determinant of economic growth in modern times. An uninterrupted and affordable supply of energy is very important in maintaining the pace of economic growth. Significantly, Mehrotra and Tuomas (2005) point out that the level of energy consumption is one of the basic components of economic growth along with the other determinants. There are various renewable and non-renewable sources of energy available, but electric energy is one of the most important. Since electricity is used in almost all human activities the demand for electricity has increased dramatically in the residential and industrial sectors over the last two decades both in developed and developing countries.

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The use of electricity has increased overwhelmingly in Pakistan, as in many other developing countries. Specifically, the annual average consumption of electricity has risen by more than 22 times over the last four decades. This sharp rise in demand for electricity has changed the dynamics of the economy of Pakistan and has generated an imbalance between supply and demand of electricity in the residential as well as the industrial sectors. Furthermore, this imbalance is becoming increasingly severe with the passage of time. Therefore, a study based on scientific analysis may provide a timely guide for those policy makers in the energy sector handling this imbalance of electricity demand and supply.

The present study is an attempt to estimate the demand for electricity in the residential sector of Pakistan through different functional forms using household level data. Specifically, we estimate the impact of variables which are the reasons for fluctuations in demand for electricity at the household level. To the best of our knowledge, this is not a well-researched area despite its importance. Chaudary (2010), Khattak et al. (2010) and Jamil and Ahmad (2011) are the major studies that look at the determinants of household electricity demand using household level data. The study of Khattak et al. (2010) focuses on a region of Khyber Pakhtoon Khwa by using multinomial logistic model and Chaudary (2010) analyzes demand for electricity among households in the province of Punjab by using an endogenous switching model. Since the estimates of these studies cannot be generalized for the entire residential sector of Pakistan, both studies have limited scope at national level. Therefore, there is a need for a study at the national level exploring the determinants of household electricity demand. The present study aims to bridge this gap.

We conduct a national level analysis by using micro level data from 30,203 households. This analysis is based on household level data; by utilizing monthly data from the years 2004-05 and 2007-08, it provides grass roots information regarding the determinants of electricity demand by households. In addition, this article also estimates the energy demand system for Pakistan to determine what type of energy resources can substitute for electricity in the household sector.

The rest of the article is organized as follows. Section 2 will give a brief literature review on the subject. We shall set some functional forms in

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2 Author’s calculations based on Economic Survey of Pakistan (various issues)
Section 3. The construction of variables and data sources will be discussed in Section 4. A detailed discussion of empirical results will be presented in Section 5 and, finally, Section 6 will conclude the study.

2. Literature Review

Prior research provides an abundance of studies on estimating energy demand functions using a variety of functional forms and data sets. A careful survey of the literature on electricity demand reveals that this area of research is well developed in terms of selection of functional form, choice of variables and choice of estimators. Prior researchers have used income, price of electricity and price of substitute energy sources as the conventional determinants of electricity demand.

A number of important studies are summarized in Table 1. The studies are classified by data set type as cross sectional, time series or panel data sets. The negative impact of own price on the electricity demand shows that electricity is a normal good in almost all the regions of the world (see Table 1). Importantly, the magnitude of the coefficient also reveals that the electricity is a necessity good in almost all the cases. The other important determinants which impact the demand of electricity are the household size and cooling degree days (Anderson, 1973). Importantly, Siddiqui (2004) notes that fuel adjustment surcharges may also reduce electricity demand in the case of Pakistan. The price of oil is also a significantly negative factor in the demand equation in the case of the southeast area of the United States (James et al., 1981).

On the other side, household income level, temperature, price of other energy substitutes, demand for electric appliances, household education level, weather, and urbanization are factors which increase the demand for electricity (see Table 1). However, the coefficient for these indicators varies from country to country and study to study. For example, Jamil and Ahmad (2011) present a review of the signs and magnitudes of income elasticity. The magnitudes of income elasticity and coefficient vary from country to country. Interestingly, there is no consensus about the magnitudes of the income elasticities for the same country in different studies (Silk and Joutz, 1997; Dergiades and Tsoulfidis, 2008).
### Table 1: Summary of the Studies Estimating Household Electricity Demand

<table>
<thead>
<tr>
<th>Study</th>
<th>Region</th>
<th>Data and Period</th>
<th>Findings (Effect on Electricity Demand by Household)</th>
<th>Positive Effect</th>
<th>Negative Effect</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Cross Sectional Studies</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Anderson (1973)</td>
<td>USA</td>
<td>HHLD 1968-69</td>
<td>Household income, Cost of gas, Fraction of population in non-metropolitan areas</td>
<td>Household size, Marginal cost of residential customers</td>
<td>Prices of electricity</td>
</tr>
<tr>
<td>Jarnes et al. (1981)</td>
<td>USA</td>
<td>HHLD 1972-73</td>
<td>Electric appliances, Household income</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Burney and Akhtar (1990)</td>
<td>Pakistan</td>
<td>HHLD 1985-86</td>
<td>Households income</td>
<td>Price of electricity</td>
<td></td>
</tr>
<tr>
<td>Maddock et al. (1992)</td>
<td>Colombia</td>
<td>HHLD 1986-86</td>
<td>Personal characteristics of household, Households income</td>
<td>Price of electricity</td>
<td></td>
</tr>
<tr>
<td>Zarnikau (2003)</td>
<td>USA</td>
<td>HHLD 1993-94</td>
<td>Households income, Heating degree days, Price of natural gas, House size, Household size</td>
<td>Price of electricity</td>
<td></td>
</tr>
<tr>
<td>Reiss and White (2005)</td>
<td>California</td>
<td>HHLD 2000-01</td>
<td>Electric appliances, Heating degree days, Households income, Highest education level among members of households as a proxy, House size, Dummy for weather, Household income</td>
<td>Price of electricity</td>
<td></td>
</tr>
<tr>
<td>Khattak et al. (2010)</td>
<td>(Pakistan)</td>
<td>HHLD Nov-Dec 2009</td>
<td>Household income, Urban region, Electric appliances</td>
<td>Price of electricity</td>
<td></td>
</tr>
<tr>
<td><strong>Time Series Studies</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Anderson (1973)</td>
<td>California</td>
<td>1947-69</td>
<td>Household income, Temperature, Cost of gas, Fraction of population in non-metropolitan areas</td>
<td>Household size, Real cost to residential costumers</td>
<td></td>
</tr>
</tbody>
</table>
An Econometric Analysis of Electricity Demand for the Residential Sector of Pakistan

Table 1: continued

<table>
<thead>
<tr>
<th>Study</th>
<th>Region</th>
<th>Data and Period</th>
<th>Findings (Effect on Electricity Demand by Household)</th>
<th>Positive Effect</th>
<th>Negative Effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dergiades and Tsoulfidis</td>
<td>USA</td>
<td>1965-05</td>
<td>Stock of electric appliances, Household income, Price of oil</td>
<td>Price of electricity</td>
<td></td>
</tr>
<tr>
<td>Khan and Qayyum</td>
<td>Pakistan</td>
<td>1970 - 2006</td>
<td>Real income, Number of customers, Temperature</td>
<td></td>
<td>Price of electricity</td>
</tr>
</tbody>
</table>

Panel Data Studies

<table>
<thead>
<tr>
<th>Study</th>
<th>Region</th>
<th>Data and Period</th>
<th>Findings (Effect on Electricity Demand by Household)</th>
<th>Positive Effect</th>
<th>Negative Effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nelson (1965)</td>
<td>Sample markets in Nebraska, Different samples for Queba,</td>
<td>1946-60</td>
<td>Home appliances, Household income</td>
<td>Own price of electricity</td>
<td></td>
</tr>
<tr>
<td>Bernard et.al. (1996)</td>
<td>OECD countries</td>
<td>1970-93</td>
<td>Heating degree days, Household income</td>
<td>Own price of electricity</td>
<td></td>
</tr>
</tbody>
</table>

Note: HHLD means House Hold Level Data

3. Econometric Specification and Estimation Strategy

A quick review of the literature on the subject suggests a number of factors which may drive the demand for electricity. For example it can be expressed as a function of household income, electricity price, prices of substitute energy resources, stock of energy, temperature and ownership of electric appliances. Keeping these predictors in mind, Zarnikau (2003) and Xiao et. al. (2007) suggest linear, log-linear and transcendental logarithmic (translog) models for quantifying the impact of these variables on electricity demand.

The present article follows Zarnikau (2003) and Xiao et. al. (2007) in using linear and log-linear functional forms to find how household electricity demand is explained by the price of electricity, household income, household size, house size, temperature and ownership of electric appliances in the case of Pakistan. Since the linear and log-linear functional forms are single equation models these equations look at electricity demand in isolation. In order to incorporate the role of other energy sources and other expenditures we shall estimate a translog model as well.

In linear functional form, the explanatory variables are assumed to affect energy demand in a simple linear fashion. Some alternative specifications may be expressed as:

$$KWH_i = \alpha_0 + \alpha_{PE}PE_i + \alpha_{HY}HY_i + \alpha_{HS}HS_i + \alpha_{HHS}HHS_i + \alpha_{HDD}HDD_i + \alpha_{D}D_i + u_i \quad (1)$$
\[ KWH_i = \alpha_0 + \alpha_{pe} PE_i + \alpha_{hy} HY_i + \alpha_{hs} HS_i + \alpha_{HHS} HHS_i + \alpha_{TAT} TAT_i + \alpha_D D_i + u_i \quad (2) \]

In log-linear functional form the dependent variable is transformed into logarithmic form.

\[ \ln(KWH_i) = \alpha_0 + \alpha_{pe} PE_i + \alpha_{hy} HY_i + \alpha_{hs} HS_i + \alpha_{HHS} HHS_i + \alpha_{HDD} HDD_i + \alpha_D D_i + u_i \quad (3) \]

\[ \ln(KWH_i) = \alpha_0 + \alpha_{pe} PE_i + \alpha_{hy} HY_i + \alpha_{hs} HS_i + \alpha_{HHS} HHS_i + \alpha_{TAT} TAT_i + \alpha_D D_i + u_i \quad (4) \]

Where \( KWH_i \) is household’s electricity consumption, \( PE_i \) is the average per unit price faced by a household, \( HY_i \) is the household’s income, \( HS_i \) stands for the house size, \( HHS_i \) represents the household size, \( HDD_i \) is the number of heating degree days, \( TAT_i \) is the temperature above the threshold level and \( D_i \) is a dummy variable for owning the air conditioner. Its value is one if a household own an air-conditioner(s) and zero otherwise. In log-linear functional form the coefficients of explanatory variables give the percentage change in the dependent variable due to a unit change in the explanatory variable. An outcome of this transformation is that it does not show the constant effect of one unit change in the value of an explanatory variable over the dependent variable at all values of the explanatory variables.

The single equation model has certain limitation, as it looks at demand for electricity in isolation. Therefore, we shall estimate the system based on a translog model to incorporate the role of other energy sources and other expenditures. The translog model is more acceptable due to its flexibility. This model is mostly used in production analysis. However, its application in consumer theory is also common. As mentioned above, Uri (1982), Watkins (1992), Zarnikau (2003) and Xiao et al. (2007) have used it to estimate demand for energy resources. The translog expenditure function is based on a second order Taylor’s expansion of the indirect utility function in logarithmic form. Using Roy’s identity, the budget shares are given as:

\[ S_i = \alpha_i + \sum_{j=1}^{n} \alpha_{ij} (\ln P_j) + \alpha_{TE,i} (\ln TE) \quad (5) \]

Where, \( S_i \) is the share of household’s total expenditures on \( i \)th energy source. \( P_j \) is the average per unit price of \( j \)th energy source, faced by a household and \( TE_i \) is the household’s total expenditure.

The shares add up to one and possess following restrictions:
\[ \alpha_{ij} = \alpha_{ji} \text{ (Symmetry condition)} \]  

\[ \sum_{i=1}^{n} \alpha_i = 1, \sum_{i=1}^{n} \alpha_{ij} = 0, \sum_{i=1}^{n} \alpha_{TE,i} = 1 \text{ (Adding up condition)} \]  

These restrictions ensure the homogeneity, symmetry and adding-up properties of demand functions. We consider three energy sources, electricity, gas and other energy sources. Other energy sources include kerosene oil and firewood. Along with three energy sources a fourth share equation will be of consumption expenditures other than energy sources.

We estimate the system of equations using Iterative Zellener efficient (IZEF) procedures. This procedure takes the least squares to estimate the system of equations and construct a consistent estimate of the covariance matrix from the least square residuals. The regression parameters are then estimated by using the estimated covariance matrix in first step and a new covariance is constructed. This procedure continues to iterate from estimates of parameter to estimate the covariance matrix until convergence achieved.

4. Variable Construction and Data

To accomplish our task, we use the micro level data taken from Pakistan Social Living Standard Survey (P SL M) for the years 2004-05 and 2007-08. These surveys are conducted by the Federal Bureau of Statistics, Government of Pakistan. This gives us comprehensive data from 30,203 households. The exact information of the monthly survey is also available. So, we have data from 24 months with an average of 1258 observations for each month. The information on monthly income, electricity consumption, consumption of other energy sources, household size, house size and number of electric appliances is taken from the PSLM.

The data on prices is taken from the monthly consumer price indices which are also constructed by the Federal Bureau of Statistics, Government of Pakistan. The data on monthly temperatures for each region is taken from Pakistan metrological department. Finally to work out the quantity of electricity consumed by each household we took the rate brackets from the Government of Pakistan Economic Survey (2009-10).

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3 PSLM 2007-2008 is the most latest version
4 www.pakmet.com.pk
Following Zarnikau (2003) and Xiao et. al. (2007), we use quantity of electricity consumption by the household on the dependent side of the electricity demand regressions. However, the direct information on quantity of electricity consumed by a household is not available in our data sources. The only available information is total expenditures made by a household on electricity. This includes pure electricity cost, general sales tax, and electricity line meter rent and television fee. Therefore, we calculated the electricity consumption from this information in two stages. In the first stage we deducted the general sales tax, meter rent and television fee from the total spending and in second stage the units of electricity consumed were worked out by using the rate brackets for the surveyed years.

The expenditure shares of each energy source in total expenditures on energy made by each household is another important variable which is helpful in determining the relation between different energy sources. These energy sources are divided into three groups; electricity, gas and other energy sources. Other energy sources include firewood and kerosene oil. The expenditure on each energy source is reported in the PSLM. The share of expenditure on each energy source is calculated by dividing expenditure on each source by household total expenditures.

In most of the regions of Pakistan the climate does not remain the same throughout the year. Even in tropical regions winters are cold. Since the consumption of electricity varies with climate it may be an important predictor of residential demand for electricity. The literature suggests that temperature is the fundamental unit for measuring climate. Consequently, the present study takes temperature as a proxy for climate. The data on the temperature of major cities is taken from the Pakistan Meteorological department. We have measured it in two ways; heating degree days (HDD) and temperature above the threshold level (TAT).The temperature of 34.90c is taken as threshold level. Heating degree days indicates the number of days in a month when temperature gets above 34.90c. The temperature above the threshold level means the number of degrees centigrade above 34.90c.

Ownership of electric appliances is another factor that affects the demand for electricity. Air-conditioners, refrigerators, electric irons, electric heaters and other high voltage appliances are the primary users of electricity.
5. Empirical Results

We utilize different functional forms to get an idea of the statistical magnitude of electricity demand in the residential sector of Pakistan. For this purpose, we estimate both single equation and system based models. As mentioned above, the single equation based models are proposed in the linear and log linear specifications. Linear and Log linear models are estimated following Xiao et. al. (2007). In linear and log linear models, we use the alternative measures (HDD and TAT ) for capturing the impact of temperature. These are Heating Degree Days and Temperature above Threshold level (see Table 2).

Table 2: Parameters of Single Equation Models

<table>
<thead>
<tr>
<th></th>
<th>Linear Model</th>
<th>Log-Linear Model</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>With HDD</td>
<td>With TAT</td>
</tr>
<tr>
<td>Intercept</td>
<td>210.92***</td>
<td>197.34***</td>
</tr>
<tr>
<td>Price of electricity</td>
<td>-142.13**</td>
<td>-125.58**</td>
</tr>
<tr>
<td>Total expenditure</td>
<td>0.0061**</td>
<td>0.0061**</td>
</tr>
<tr>
<td>Heating degree days</td>
<td>0.694**</td>
<td>NA</td>
</tr>
<tr>
<td>Temperature above</td>
<td>NA</td>
<td>0.077*</td>
</tr>
<tr>
<td>Household size (HS)</td>
<td>4.784**</td>
<td>4.51**</td>
</tr>
<tr>
<td>Household size (HHS)</td>
<td>0.105***</td>
<td>0.105***</td>
</tr>
<tr>
<td>Dummy variable</td>
<td>90.35**</td>
<td>91.02***</td>
</tr>
<tr>
<td>Diagnostic check</td>
<td></td>
<td></td>
</tr>
<tr>
<td>R²</td>
<td>0.4769</td>
<td>0.4744</td>
</tr>
<tr>
<td>Adjusted R²</td>
<td>0.4768</td>
<td>0.4742</td>
</tr>
</tbody>
</table>

Note: *, **, *** implies that the coefficients are significant at 10 percent 5 percent and 1 percent respectively. The standard errors are White’s heteroscedascity consistent.

The signs of the coefficients for price of electricity, total expenditures, house size and households’ sizes match our expectations. The negative sign for price of electricity in all four models implies that the demand for electricity will decrease as the price of electricity increases. Similarly, the demand for electricity may rise as household size or house size increases. Importantly, all these coefficients are statistically significant in the regression.
The $R^2$ shows that almost 48 percent of the variation in the dependent variable is explained by the independent regressor of the equation.

The difference between Model 1 and Model 2 is that we replace TAT with HDD. The second column of Table 2 gives the linear model estimates with TAT (see Model 2). The replacement of HDD by TAT has no effect on the signs of the other coefficients and its coefficient is also positive. This indicates that high temperature causes an increase in electricity demand whether measured by TAT or number of HDD. However both variables have different interpretations. The coefficient of HDD shows an average increase in electricity consumption due to increase in HDD in a month. The coefficient of TAT gives the increase in electricity consumption due to one unit increase in temperature above 34.90c. The coefficient of TAT is 0.077 indicating that on average during a month if temperature on any day gets above 34.9c, then a 0.1c increase in temperature increases consumption of electricity by 0.077 units. The coefficient of HDD is 0.694. It indicates that on average during a month each additional heating day causes a 0.694 unit increase in consumption of electricity.

5.1 Results of Translog Model

The four models estimated in the last section are single equation models and describe the demand for electricity in isolation. They do not show the impact of other energy sources on electricity demand. To avoid this problem we use a translog model to estimate the complete demand system of the consumer. In our analysis, we included three energy sources: electricity, gas and other. The ‘other’ category includes kerosene oil and firewood. Along with the three energy sources we treated all other commodities as a single commodity group. The system has four equations. In order to impose the cross-equation symmetry restrictions, we dropped the fourth equation. The parameters of the dropped equation were estimated through restrictions. The translog model was estimated in two ways. First, we took all prices and total consumer expenditures. Later on variables of household size, house size and climate are also incorporated.

Translog demand function basically explained through indirect utility function which is the function of expenditure and prices. Therefore in first part of our analysis we just took price and expenditure. The results of these analyses are given in Table 3.
All intercepts except the share of electricity are significant. Most of the price coefficients and all expenditure coefficients are significant. The intercept terms and coefficients of total expenditure are strictly positive, while the price coefficients have mixed signs. However, the important outcome of this analysis is the corresponding elasticities. The elasticities are reported in Table 4.

### Table 3: Translog Estimates with Prices and Total Expenditure

<table>
<thead>
<tr>
<th></th>
<th>Share of electricity</th>
<th>Share of gas</th>
<th>Share of other energy sources</th>
<th>Share of rest of commodities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>0.003</td>
<td>0.026**</td>
<td>0.021**</td>
<td>0.95***</td>
</tr>
<tr>
<td>Price of electricity</td>
<td>0.041**</td>
<td>-0.002</td>
<td>-0.022***</td>
<td>-0.017**</td>
</tr>
<tr>
<td>Price of gas</td>
<td>-0.002</td>
<td>-0.002</td>
<td>0.018**</td>
<td>-0.014**</td>
</tr>
<tr>
<td>Price of other energy sources</td>
<td>-0.022**</td>
<td>0.018**</td>
<td>-0.00098</td>
<td>0.005</td>
</tr>
<tr>
<td>Price of rest of commodities</td>
<td>0.022*</td>
<td>-0.005***</td>
<td>-0.02*</td>
<td>0.003</td>
</tr>
<tr>
<td>Total expenditure</td>
<td>0.001***</td>
<td>0.001***</td>
<td>-0.007</td>
<td>0.0005***</td>
</tr>
</tbody>
</table>

Note: *, **, *** implies that the coefficients are significant at 10 percent 5 percent and 1 percent respectively. The standard errors are White’s heteroscedascity consistent.

### Table 4: Own and Cross Price Elasticities (with only prices and expenditure)

<table>
<thead>
<tr>
<th></th>
<th>Electricity</th>
<th>Gas</th>
<th>Other energy resources</th>
<th>Rest of commodities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electricity</td>
<td>0.11</td>
<td>-0.23</td>
<td>-0.68</td>
<td>0.05</td>
</tr>
<tr>
<td></td>
<td>(3.25)</td>
<td>(-6.35)</td>
<td>(-18.80)</td>
<td>(1.49)</td>
</tr>
<tr>
<td>Gas</td>
<td>-0.23</td>
<td>-1.16</td>
<td>1.04</td>
<td>-0.04</td>
</tr>
<tr>
<td></td>
<td>(-6.35)</td>
<td>(-117.51)</td>
<td>(105.90)</td>
<td>(-4.94)</td>
</tr>
<tr>
<td>Other energy sources</td>
<td>-0.68</td>
<td>1.04</td>
<td>-1.00</td>
<td>0.002</td>
</tr>
<tr>
<td></td>
<td>(-18.80)</td>
<td>(105.90)</td>
<td>(-37.40)</td>
<td>(0.20)</td>
</tr>
<tr>
<td>Rest of commodities</td>
<td>0.05</td>
<td>-0.04</td>
<td>0.002</td>
<td>1.06</td>
</tr>
<tr>
<td></td>
<td>(1.49)</td>
<td>(-4.94)</td>
<td>(0.20)</td>
<td>(1.14)</td>
</tr>
</tbody>
</table>

Note: *, **, *** implies that the coefficients are significant at 10 percent 5 percent and 1 percent respectively. The standard errors are White’s heteroscedascity consistent.

Own price elasticity of demand for gas and other energy sources is negative and that of electricity and rest of the commodities is positive. This indicates that when electricity demand is analyzed along with the demand for
other energy sources, it has a positive relation with price. The cross price elasticity between most of the energy sources is negative. This indicates that energy sources are complementary which again is a strange finding.

Next we estimate a full model including climate, house size and household size. Climate is measured in two ways; through TAT and HDD. Among these, HDD is more simple and comprehensible. It simply gives the effect on energy consumption due to each additional heating degree day. Therefore in our final analysis we take HDD as our measure of climate. The results of the estimated Translog share equations are given in Table 5.

<table>
<thead>
<tr>
<th>Variables</th>
<th>Share of electricity</th>
<th>Share of gas</th>
<th>Share of other energy sources</th>
<th>Share of rest of commodities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>0.012</td>
<td>0.02**</td>
<td>0.009</td>
<td>0.959***</td>
</tr>
<tr>
<td>Price of electricity</td>
<td>0.04**</td>
<td>0.005*</td>
<td>-0.016**</td>
<td>-0.029*</td>
</tr>
<tr>
<td>Price of gas</td>
<td>0.005*</td>
<td>-0.004**</td>
<td>0.017***</td>
<td>0.018***</td>
</tr>
<tr>
<td>Price of other energy sources</td>
<td>-0.016*</td>
<td>0.017**</td>
<td>-0.017***</td>
<td>-0.016</td>
</tr>
<tr>
<td>Price of rest of commodities</td>
<td>-0.001</td>
<td>-0.029**</td>
<td>0.038**</td>
<td>-0.005</td>
</tr>
<tr>
<td>Total expenditure</td>
<td>0.01**</td>
<td>0.02**</td>
<td>-0.08***</td>
<td>0.05**</td>
</tr>
<tr>
<td>Heating degree days</td>
<td>0.00015**</td>
<td>-0.00007**</td>
<td>-0.0004**</td>
<td>0.0003**</td>
</tr>
<tr>
<td>House size</td>
<td>0.0006**</td>
<td>0.001**</td>
<td>0.0003**</td>
<td>-0.002***</td>
</tr>
<tr>
<td>Households’ size</td>
<td>-0.0007***</td>
<td>-0.0004***</td>
<td>0.0006**</td>
<td>0.0005**</td>
</tr>
</tbody>
</table>

Note: the t-statistics are presented in the parenthesis

The coefficient of HDD is positive for electricity and negative for the other two energy sources. This result matches our expectations. In the hot season demand for high voltage appliances like air-conditioner increases, so consumption and thus share of electricity in total expenditure also increases. Gas, kerosene oil and fire wood are mainly used for cooking and heating. Consequently, the negative sign on HDD for gas and firewood makes sense. The coefficient for house size is positive for all commodities. It indicates that as house size increases the demand for energy sources also increase which also is unsurprising. The coefficient for household’s size is negative for electricity and gas, which indicates that as household size increases the share of these two energy sources decreases. The coefficient of total expenditure in all case is near to zero. It indicates that as total expenditure increases, the allocation of the expenditure remains almost unchanged. To be more accurate,
the share of expenditure spent on electricity, gas and other commodities shows a minor increase and the expenditure share spent on other energy sources decreases.

We may now turn to the elasticities obtained through the share equations of the translog model. The elasticities are given in Table 6. All own price elasticities are negative except electricity. This indicates that demand for all energy sources, and the rest of commodities showed negative relation with price. However the system results show that price has a positive impact on the demand for electricity.

<table>
<thead>
<tr>
<th>Cross and own elasticity</th>
<th>Electricity</th>
<th>Gas</th>
<th>Other energy resources</th>
<th>Rest of commodities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electricity</td>
<td>0.12</td>
<td>0.63</td>
<td>-0.58</td>
<td>-5.86</td>
</tr>
<tr>
<td></td>
<td>(4.50)</td>
<td>(17.03)</td>
<td>(-16.02)</td>
<td>(-161.01)</td>
</tr>
<tr>
<td>Gas</td>
<td>0.63</td>
<td>-1.46</td>
<td>0.64</td>
<td>-0.02</td>
</tr>
<tr>
<td></td>
<td>(17.03)</td>
<td>(-147.92)</td>
<td>(65.48)</td>
<td>(-2.24)</td>
</tr>
<tr>
<td>Other energy sources</td>
<td>-0.58</td>
<td>0.64</td>
<td>-1.63</td>
<td>0.06</td>
</tr>
<tr>
<td></td>
<td>(-16.02)</td>
<td>(65.48)</td>
<td>(-60.54)</td>
<td>(2.54)</td>
</tr>
<tr>
<td>Rest of commodities</td>
<td>-5.86</td>
<td>-0.02</td>
<td>0.06</td>
<td>-0.08</td>
</tr>
<tr>
<td></td>
<td>(-161.01)</td>
<td>(-2.24)</td>
<td>(2.54)</td>
<td>(-0.08)</td>
</tr>
</tbody>
</table>

Note: the t-statistics are presented in the parenthesis

The resulting cross-price elasticities show that cross price elasticity between electricity and gas is positive. It indicates that with an increase in price of any one the demand for the other also increases. Although electricity and gas are not substitutes of each other in the context of a household, in other substantial cases they do serve as substitutes for each other. For example gas can also be used for lightning; electricity can be used for cooking. Due to these relations the positive coefficient of cross price elasticity of demand between these two is understandable.

The coefficient of cross price elasticity of demand between electricity and other energy sources is negative. This implies that when the price of electricity increases then consumers are forced to decrease their demand for minor energy sources as well as their demand for electricity. The cross price elasticity of demand between gas and other energy sources is positive. This indicates that other energy sources are substitutes for gas. This is not a
surprise because in many areas of Pakistan firewood is being used as a substitute for natural gas in the residential sector.

The results of the single equation model show that household electricity demand has a negative relation with its own price and that all other variables including house size, household size, temperature, household income and ownership of air-conditioners have positive effect on household electricity demand. Results showed that house size and total expenditure have positive effect on consumption of all energy sources. Heating degree days leads to increase in the consumption of electricity and decrease in the consumption of gas. The own price elasticity for all energy sources is negative with the exception of electricity. This finding is contradictory with the results of the single equation models. The comprehensive version of the translog model showed that cross-price elasticity of demand between electricity and gas is positive and negative between electricity and other energy sources.

6. Concluding Remarks

This article is an attempt to investigate the determinants of electricity demand in the case of Pakistan by using household level data from 2004-05 and 2007-08. The other novelty of the paper is that we use three different functional forms in order to get a clear look at the patterns of the statistical parameters of electricity demand. These functional forms are linear, log linear and translog functional forms.

The linear and log linear models show that total expenditure, house size, household size, heating degree days, and temperature above threshold level may increase demand for electricity, and higher price of electricity may decrease the residential demand for electricity. The signs and significance of elasticities through translog parameters indicate gas is a close substitute for electricity in the case of Pakistan. The sign of all own price elasticities, except electricity, were negative.

The other important determinant is climate. Both TAT and HDD cause an increase in the demand for electricity and a decrease in the consumption of gas, kerosene oil and firewood. This finding is as per expectations that demand for air-conditioners increases in hot days and thus causes an increase in consumption of electricity. House size also leads to an increase in consumption of all energy sources and all other consumption goods, while household size has negative impact on the consumption of electricity and gas.
The results of the study show that energy prices, household income, household size, climate and house size all play an important role in determining the demand for electricity. Therefore, demand side policies can play a vital role in decreasing the gap between electricity demand and supply. Some determinants, like energy prices and household size, can be influenced by government policies. Energy prices, for example, can be influenced through the system of taxation, and household size through family planning programs. Recently, it has become standard practice in different European countries for government to educate households to decrease electricity consumption in order to conserve resources and avoid waste.
References


Pakistan’s Water Vulnerability and the Risk of Inter-State Conflict in South Asia

Rabia Aslam¹

Abstract

The paper addresses the issue of water scarcity and water vulnerability in Pakistan. It appears that wasteful agricultural practices; the dam centered internal politics and the recent construction of dams by the Indian government on the shared rivers has caused concern amongst certain quarters and created fears in some sections of society in Pakistan that India could redirect some of the water which rightfully belongs to Pakistan under the Indus Basin Treaty. If this indeed happens there could be serious water shortages in parts of downstream Pakistan. A game theoretic analysis of the situation suggests that, given the nature of induced water stress, the law of unlimited territorial sovereignty, if implemented in this case, could result in a Nash equilibrium of bilateral aggression for these nuclear neighbors. Institutional mechanisms therefore have to be put into place for monitoring river flows on both sides of the border and information sharing as stipulated under the Indus Basin Treaty to prevent tensions and develop a cooperative approach to the problem of growing water scarcity related with climate change.

Keywords: Shared Waters, Conflict, Game Theory

JEL classification: Q25

1. Introduction

According to a recent World Bank report, only 3% of the world’s water is fresh water and most of it is not directly available for use because it is either locked up in icecaps or deep aquifers or because it is polluted. At present, about 700 million people today live in countries experiencing water stress or scarcity and by the year 2035, the number is expected to reach 3 billion². Countries and regions with limited water availability often depend on shared water resources. Water demand is growing with population growth and

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economic development and tensions over water rights are increasing at the national and international level. At the same time water quality is deteriorating as water sources; such as rivers, lakes, aquifers and wetlands are encroached upon.

This study addresses the issue of water scarcity and water vulnerability in Pakistan that has emerged due to a number of factors such as reduced river flows related with climate change; increased water requirements resulting from population growth and economic development; and low water use efficiency in Pakistan. The decline in river flows resulting from global warming as predicted by the Inter-Governmental Panel for Climatic Change\(^3\) and inter-provincial disagreements that have hampered the construction of important dams in down-stream Pakistan are significant factors in creating the problem of reduced water availability at the farm level. These factors combined with low irrigation and application efficiencies and inappropriate agriculture practices drawn from a period when Pakistan was a water surplus country have further exacerbated the problem of water scarcity. This qualitative study on the subject analyzes the issue in a game theoretic framework and proposes a solution that might prevent this environmental scarcity from further deteriorating the already strained relations between the two countries jeopardizing regional stability.

The study begins by reviewing some of the previous studies related to water induced conflict. Section 2 provides background detail on the ongoing conflict and presents a review of the outstanding agreement over water resources between India and Pakistan. Section 3 presents an analysis of the situation using a game theoretic framework and discusses the possibility of cooperatively solving the dispute between the two countries. The final section concludes with policy prescriptions for reaching an agreement over shared rivers; a problem that is likely to affect millions of people in both countries in the coming decades.

2. **Shared Rivers and Alternative Theories**

During the last two decades a significant number of studies have addressed the issue of scarcity or abundance of natural resources and their correlation with the likelihood of militarized or non-militarized interstate disputes (Gleick, 1993; Rogers, 1997; Beaumont, 1997; Haftendorn, 2000; Gleditsch, 2001; Klare, 2001; Lonergan, 2001; Renner, 2002; Yoffe et al., 2004; Kalpakian, 2004; Abbink et al., 2009; Molen & Hildering, 2005; Hensel & Brochmann, 2008). Since water is one of the most essential resources, its relationship with the likelihood of conflict has been explored in a number of studies.

Studies of international water management focus mainly on water scarcity as a trigger for either conflict or cooperation (e.g. Dinar, 2007; Hamner, 2008; Dinar, 2009; Brochman & Hensel, 2009; Dinar, 2010). The existing studies on the subject can be divided into two categories on the basis of their ideology. According to the first group of researchers disagreements that emerge because of the environmental scarcities and degradation of resources are likely to result in violent disputes both within and across borders. Homer and Dixon (1994) posited that among the renewable resources water has the greatest potential for stimulating armed conflict. Hence the poor societies that are already suffering acute hardship from shortages of water, forests, and especially fertile land, will be particularly affected from environmental scarcities in general and water scarcity in particular. In a recent study Raleigh & Kniveton (2012) tested this claim using rainfall variability in East Africa to explore the marginal influence of the climate on conflict. Their study shows that in periods of extreme rainfall variation the rebel and communal groups often use force and violence to compete for scarce water resources.

Scholars such as Gleick (1993) and Rogers (2002) made similarly pessimistic forecasts, especially for countries that are highly dependent on water that originates beyond their borders; for example Egypt, Hungary, Mauritania and Pakistan. In this regard Haftendorn (2000) also identifies various sources of conflict over fresh water sources. Among them, misuse of the resource, pollution and altering the distribution of water via construction of a dam or the channeling of river flows, are the major sources of water instigated disputes.

Klare (2001) argues that the danger of international competition for adequate water resources will grow ‘inevitably’ and by the year 2050, the
increased demand for water could produce ‘intense competition for this essential substance almost everywhere on the planet. Several empirical studies (Toset et al., 2000; Furlong, Gleditsch & Hegre, 2006) found that sharing a river increases the probability of an armed conflict in pairs of countries over and above mere contiguity. It was also pointed out that water scarcity is associated with conflict, particularly when a river is shared across rather than along a border creating an upstream-downstream relationship among the riparian states.

The second group of researchers believes that cooperation over shared waters is a more likely outcome than conflict (e.g. Keohane & Ostrom, 1994). Wolf (2002) noted that more than 3,600 water-related agreements were signed between the years 805-1984; a statistic that offers substantial support to this argument. Countries sign treaties for various reasons, such as externalities relating to pollution, flood control, or hydropower (Just and Netanyahu, 1998); or for reasons such as economies of scale where parties anticipate being better off acting in a coalition rather than acting alone when faced with certain water scarcity situations (Dinar, 2009).

Several case studies from Nile, Tigris and Euphrates also suggested that water disputes do not cause serious conflicts and may actually initiate positive interaction and cooperation among countries (Kalpakian, 2004; Yoffee, Wolf, and Giordano, 2004). Other studies suggest that sharing a river is related to several general measures of positive interstate interaction (such as trade, alliances etc. and river-related treaties and institutions) increase peaceful efforts to resolve river claims reducing the risk of militarization (Brochmann and Gleditsch, 2006; Hensel and Brochmann, 2008, Hensel, Mitchell and Sowers, 2006).

Studies also explore the impact of different water availability levels on the stability of treaties and cooperation between states (Ambec and Sprumont, 2002; Ambec and Ehlers, 2008; Beard and McDonald, 2007; Janmatt and Ruijs, 2007; Bernauer and Tobias, 2012). Tir and Stinnet (2012) argue that the probability of armed conflict over fresh water decline when the river in question is governed by a formal agreement. The authors note that joint monitoring, conflict resolution; treaty enforcement and delegation of authority to inter-governmental organizations will reduce the risk of armed conflict over shared rivers. Assessing the impact of water supply variability on treaty cooperation between international bilateral river basin riparian states, Dinar, Blankespoor & Kurukulasuriya (2010) argue that small to moderate
increases in water supply variability induced by climate change creates an impetus for cooperation, however large increases in water variability would reduce incentives for treaty cooperation. Using large scale economic and international relations data the authors prove that stronger diplomatic and trade relations support cooperation, while uneven economic power inhibits cooperation across the basin riparian states.

2.1 A Brief History of Water Conflict between India and Pakistan

When the Indian subcontinent was partitioned in 1947, the Indus river basin which was previously serving the entire sub-continent was divided between India and Pakistan. The rivers serving Pakistan’s irrigation supplies originate on the Indian side of the border. In 1948 India claimed sovereign rights over the waters passing through its territory and tried to divert the waters away from Pakistan. Pakistan tried to resolve the issue through dialogue but failed and the dispute threatened war. At that point the World Bank resolved the dispute via arbitration and the Indus Water treaty was signed between the two countries in 1960.

According to the treaty, India was offered the three Eastern rivers (Ravi, Beas and Sutlej)\(^4\), while Pakistan was offered the three Western rivers (Indus, Jehlum and Chenab)\(^5\). The Chenab River in Pakistan combines the waters of four rivers, the Jehlum, the Sutlej, the Beas and the Ravi, to form a single river system which then joins the biggest Indus River in Pakistan. The Indus River is hence considered the lifeline of Pakistan’s economy and livestock industry. The treaty also allowed the construction of storage dams and link canals in Pakistan to divert water away from the Eastern rivers and replacement works were supposed to be financed by Australia, Canada, Germany, New Zealand, United Kingdom, Italy and United States.

The three rivers that serve the Indian agricultural system contain only about one-fifth of the system’s total flow. To boost India’s share of the resource up to around 30 per cent of the total, the World Bank arbitrators proposed that the Indus Water treaty also let India extract a certain amount of water from two of Pakistan’s rivers before they departed Indian Territory.

\(^4\) The Sutlej originates in Tibet, flows through Himachal Pradesh and Punjab before joining the Chenab, while Beas and the Ravi originate in Himachal Pradesh state and flow into Pakistan, emptying into the Chenab

\(^5\) The Indus River originates in Chinese-controlled Tibet and flows through Jammu & Kashmir. The Chenab originates in India’s Himachal Pradesh state, travels through Jammu & Kashmir whereas the Jehlum originates in Jammu & Kashmir and flows into Pakistan, finally joining the Chenab.
This proposal was reluctantly accepted by Pakistan. The Indus Water treaty established a permanent Indus Commission made up of one commissioner from each country. The commission is required to meet regularly and both parties are required by the rules to notify the other of plans to construct any engineering works which might affect the other party (Barret, 1994).

2.2 Water Stress and Pakistan’s Vulnerability

The signing of Indus Treaty paved the way for construction of Mangla and Terbela dams in Pakistan, which were commissioned in 1967 and 1974 respectively. Mangla dam has a storage capacity of 5.88 million acre feet and a power generating capacity of 1000 megawatts. Terbela on the other hand has a storage capacity of 9.7 million acre feet and can generate 3478 megawatts of power. Both dams contributed towards development of Pakistani agriculture and industry and helped bring a “Green Revolution” in Pakistan during 1960s and 1970s. However since 1974 no dam capacity has been added in Pakistan. With a very low 9% of water storage, the per capita, per annum availability of water has dropped from a high of 5000 cubic meters to 1329 cubic meters, very close to the danger level of 1000 cubic meters which will categorize Pakistan as a water-scarce country.

The Kalabagh dam project on the Indus River was proposed in the KPK and Punjab provinces of Pakistan during 1960s and approved by the World Bank experts for funding during 1970s and 1980s. The dam is expected to have a storage capacity of 6.1 million acre feet and a power generation capacity of 3600 megawatts. However, serious concerns were shown over the project by several political groups from Sindh and KPK provinces of Pakistan. Since the last thirty years, multiple studies have been done to address the proposed dangers and findings have ruled out almost every objection posed by the politicians from the area. Nonetheless, the intransigent attitude of some political groups is hampering the construction of this important dam which could easily prevent Pakistan from turning into a desert.

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7 It has been alleged that the dam is designed to deplete the normal flow of water in the river Indus and will deprive the Sindh province of its due share of water. It is also propagated that the reduced water flow will have an impact on the sea water intrusion, ground water quality, and mangrove forests and fish production in the Indus delta. In addition the KPK politicians assert that lands in the Peshawar valley and Nowshera town would be inundated in the event of recurrence of flood as a result of this dam.
Water scarcity in Pakistan is made worse by the outdated and obsolete irrigation and agricultural practices still prevalent in Pakistan. As compared to other countries in the region, Pakistanis use ten times more water for growing the same amount of crops. When India and Pakistan signed the Indus Water Treaty there was still plenty of water in the Indus river system for both countries. But due to the rapid population growth and expanding agricultural requirements particularly on the Pakistani side of the border, per-capita supply of water in Pakistan has fallen from over 5,000 cubic meters per person per year in 1947 to only about 1329 cubic meters per person, per year today\(^8\) which is close to the level defined by the United Nations as “high stress” (1000 cubic meters). In addition it was discovered about a decade ago that the glaciers up on the top of the Tibetan Plateau that feed the Indus river system have started to melt and according to the Chinese Academy of Sciences, some of the glaciers are expected to melt in less than 20 years (Wu & Zhu, 2008; Wei, 2008). Should this happen, river levels will drop permanently and the resulting increase in stress will touch both countries that are highly dependent on this system. By the year 2030, glacier melting is expected to reduce the flow of the Indus to almost half. Almost all of this loss will occur in Pakistan’s river system since the smaller Indian shared rivers do not depend heavily on glacier melt (Dyer, 2010).

The climatic change is expected therefore to increase India’s total share of the Indus water, while Pakistan’s agriculture has already begin to suffer\(^9\). In the 1990s India started the construction of Baglihar dam (a 450-megawatt hydroelectric power project on the Chenab River in the Doda district of Jammu & Kashmir). Furthermore the construction of Baglihar dam provides India a certain degree of control over Pakistani waters making it a “defense security concern” for Pakistan (Ahmad, 2009). The Government of Pakistan at the time thought that this was a storage dam (which would be in violation of this Indus Waters Treaty)\(^10\) and hence would adversely affect 13 million acre feet of irrigated land around the Chenab and Ravi rivers in the Punjab province of Pakistan, creating serious food shortages. Accordingly,

\(^10\) According to the Indus water treaty India is not permitted to build storage dams on the Indus, Chenab, and Jehlum rivers. It can only make limited use of their waters, including developing run of the river hydroelectric power projects. India is also obligated to provide Pakistan with the technical details of any water project it might want to undertake on the shared rivers before starting construction.
Pakistan challenged this project in the International court of Justice which initially ruled in favor of India in the key issue of spillway design but later halted the construction of this dam.

Pakistan also filed a ‘dispute’ in 2010 against the Kishanganga dam project, which is being constructed on the Kishanganga River in the Gulrez valley in India. Since the Kishanganga River is a tributary of the Jehlum River, which is a part of Indus Water System, the Kishanganga River also comes in the domain of the Indus Water Treaty. Pakistan decided therefore to challenge the construction of this dam in the third and highest category of contention in the Indus treaty’s language. A seven-member international arbitration panel is being assembled to hear the case, the first to be taken to such a level. The ruling is not expected for several years. However, in response to the request for interim measures, the international court of arbitration has barred India beginning September 2011 from any permanent works on this project. The discussion of water easily ignites popular passion in Pakistan and a failure to resolve the outstanding dispute on part of the World Bank can result in a political deadlock and even a potential outbreak of conflict between the two countries at some stage.

3. The Water Game

The games in this section are typical of games based on Haftendorn’s (2000) idea of transforming the non-cooperative games into the cooperative ones. Idea is to explore the possibility of cooperatively solving the fresh water conflict between India and Pakistan.

With regard to property rights, the law of international water resources offers two extreme rules. The doctrine of unlimited territorial sovereignty states that a country has exclusive rights to the use of waters within its territory. This means that a country may use its rivers as much as it wishes and in whichever way it wants. In contrast the doctrine of unlimited territorial integrity states that the quantity and quality of water available to a country cannot be altered by another country (Caponera, 1983). This rule implies that the upstream country cannot pollute or misuse the water of a shared river.

Now these two doctrines clearly imply very different pre-bargaining positions and several alternative normal form games are possible in this scenario. The Nash equilibrium depends upon the associated payoffs with every possible action that players take. The payoffs are assumed on the basis of the analysis done in the last section. The strength of choices made by each
player and the resulting pay-offs are conditioned by the volatile sentiments in the situation\textsuperscript{11}. For the Pakistan side, a sense of being deprived of its right to use fresh water, a feeling of being dominated and concerns over security determine its assumed pay-offs.

India on the other hand has a stance that the Indian water projects currently undertaken do not contravene the provisions of the 1960 Indus Water Treaty and that India can construct dams within the technical specifications outlined in the Indus Water Treaty\textsuperscript{12}. In the India-Pakistan interaction gamed in this paper it is assumed that India aims to establish supremacy over the neighbouring countries by controlling the water resources in the region while at the same time maximizing its hydro electric capacity and agriculture productivity. These assumed considerations are the main determinants of the assumed pay offs in the game theoretic model of this paper. The asymmetric nature of pay-offs indicate differences in international credibility, the structure of governance, internal political stability and an ability to pursue economic gains in the agriculture sector in the two countries.

The games described in this section turn out to be “mixed motive” and non-constant sum games in general. It is assumed that each player has perfect information about the strategies and pay-offs of the other player. There is however some exogenous un-certainty involved in this game. This uncertainty is attributed to the actions of a third party which in this case would be “nature”. Severe water stress can be the result of natural phenomena such as glacier melting and a reduction in rainfall and will affect the outcome of the game. These natural phenomena are beyond the control of the players and “nature” is indifferent to the outcomes of the game. The probability of water stress can be predicted somewhat by the meteorologists but it is assumed that this knowledge is common to both players.

Consider the game form described by the Matrix 1 in the appendix section. In the simplest “one shot” game, we assume that both players have perfect information and decisions are taken in real time. The two strategic

\textsuperscript{11} Lately Pakistan has expressed deep concern over the fact that the 1960 Indus Water Treaty has been working primarily to the advantage of India especially in phase of changing climatic conditions. India is controlling the water flow of the Indus, Chenab and Jhelum rivers, seriously affecting Pakistani agriculture increasing its dependence on imported food and deteriorating the balance of payments.

\textsuperscript{12} In compliance with the treaty therefore India has so far not constructed any storage dam on the Indus, Chenab and the Jhelum rivers. The hydroelectric projects India is developing are on the run-of-the-river waters of these rivers, projects which according to India, it is permitted to pursue according to the treaty.
players are the government of Pakistan and the government of India. Each player has more than one possible strategy to choose from. The available strategy profiles to the government of India are:

1) Simply abide by the Indus Water Treaty and leave the growing water demands to “nature” hoping that it will work to the advantage of India. This strategy has been termed as “Do Nothing” in the matrix.

2) Engage in dialogue with Pakistan and call for World Bank mediation to resolve the water issue peacefully via dialogue and arbitration. This strategy is termed as “Arbitration” in the matrix.

3) Pursue the storage dam projects as and when desired, regardless of the Indus Basin Treaty and thereby indirectly implementing the idea of unlimited territorial sovereignty. (The Indus Basin Treaty implies the idea of limited sovereignty in the case of water sharing between upper and lower riparian states). In the matrix this strategy is termed as “Build Storage Dams”.

In response to these actions, the available action profile to the government of Pakistan is:

1) Simply ignore the problem of water scarcity. This action profile assumes that the government takes no action to improve irrigation and application efficiencies; and ignores the possibility of increasing water use efficiency through new institutional mechanisms. These include pricing water and changing relative prices of crops for incentivizing farmers to generate a higher GDP per unit of water used. The strategy is termed as “Do Nothing” in the matrix.

2) Continue political dialogue with India on the subject and try to resolve the matter peacefully by seeking arbitration from World Bank and other international agencies. This strategy is again termed as “Arbitration” to signify peaceful resolution of the problem.

3) Retaliate against construction projects at all levels to prevent hegemonic control over water resources by the Government of India, which is assumed to be the basis of its water policy. This strategy is termed as “Aggression” on the part of Pakistan.

The game in Matrix 1, assumes that there is no severe water stress affecting the strategies chosen by the players. Consider the pay-offs associated with each action. It is assumed that being upstream India does not face the
danger of resource depletion to an extent that Pakistan does. Hence “doing nothing” leads to a negative pay-off for Pakistan in contrast to India who gets zero points by not reacting in any way. Under normal circumstances India gains a highest pay-off of 20 points by building dams to ensure ample water supplies for future generations. If India abides by the Indus water treaty, unilateral aggression will not benefit Pakistan in any way since it only leads to a loss of credibility on the international front and will yield negative pay-offs of -20 and -10 respectively. This pay-off from aggression increases to 0 points if India decides to carry out its projects, yet it is still not as superior a strategy for Pakistan as compared to arbitration i.e. challenging the projects in the international court of justice or going to the world bank. Therefore Nash equilibrium in this case is (Arbitration-Arbitration) as it maximizes the joint pay-offs for both countries.

The real problem arises in Matrix 2, which assumes a situation of severe nature induced water stress. In this case the pay-offs change in a way so that if India violates the agreement by building dams, Pakistan will gain more by taking aggressive retaliatory measures instead of unilaterally insisting on arbitration.

Matrix 3 has been obtained by multiplying the payoffs from the first two matrices with their respective probabilities (assuming that the probability of low stress is only 0.4 and the probability of high stress is 0.6) and summing up the respective payoffs. For example the payoff (16, 16) has been obtained by multiplying (10*0.4 + 20*0.6). It can be observed that even-though bilateral aggression still yields a lower pay-off for both countries as compared to dialogue, the game leads to a situation of multiple Nash equilibria; (Arbitration-Arbitration and Build-Aggression).

Arbitration-Arbitration is clearly a superior equilibrium if each country seeks to resolve the matter peacefully via arbitration giving the other its due share of water. However, in the games with multiple Nash equilibria the available information acts as a signal or clue that enables a unique equilibrium point for the players. Given the history of the armed conflict in the region, it seems probable that bilateral aggression might become a Schelling point\(^\text{13}\) in this case where India will continue to build dams and storage facilities on the shared rivers and Pakistan will retaliate to this

\(^{13}\) If signal or clue based on the available information or past behavior enables the players to determine a unique equilibrium for the game, the equilibrium that is more likely than the other is called the Schelling point.
exercise aggressively even though doing so would lower the joint pay-offs for both countries.

Actually bilateral aggression in this case also generates a risk dominant Nash equilibrium as by choosing aggression each party will be trying to avoid a lower pay-off just in case the other one chooses to take aggressive measures. Even if there were no clues to establish Schelling points, uncertainty becomes a predominant motive in the game and, according to some game theorists, there is a strong case for using the “maximin” solution as a rational response to uncertainty.\textsuperscript{14} Applying “maximin” approach in this case we observe that the minimum pay-off from arbitration is 0 for each country and the minimum pay-off from aggression is -20 for each country (see Matrix 2). So the “maximin” solution to this game also becomes bilateral aggression even though it is the worst of the two equilibriums.

It is possible to derive a unique dominant strategy Nash equilibrium when the game is setup in an extensive form. In a finitely repeated extensive game India has an option to move first and it can choose to build or not build the dams on the shared waters. In response to the choices made by India, Pakistan has an option to react passively or aggressively on the choices made. Also nature enters in the extensive setup as a third player inducing water shortages.

Consider the game form described in Figure 1. To understand how the nature affects the associated pay-offs, suppose that the probability of stress is higher and assumed to be 0.6 as compared to low stress probability which is 0.4. The extensive game is setup in the appendix section. Using the simple pruning method we can derive a unique Nash equilibrium for this game.\textsuperscript{15} The final pay-offs are obtained by multiplying the probabilities for high and low water stress with the final pay-offs after unreasonable equilibria are deleted from the gaming tree. It is reasonable to conclude that if India chooses to go for dialogue and arbitration, Pakistan will also opt for such a strategy. Nonetheless aggression remains the only option for Pakistan if water stress leads to crop failures and severe food shortages. Matrix 4 has been generated to help understand how resource abundance will change this situation. The payoffs in Matrix 4 have been obtained by assuming a low probability of water stress, multiplying the payoffs from the first two matrices with the respective probabilities (0.8 and 0.2) and summing up the results. Once again

\textsuperscript{14} Maximin approach implies avoiding the minimum pay-offs
\textsuperscript{15} See Figure 2 \& 3 for visual inspection of the game
a unique Nash equilibrium (Arbitration-Arbitration) results, validating Haftendorn’s idea that cooperation can be achieved if the dominant state relinquishes its hydrological advantage in return for specific rewards or payments thereby reducing the resource scarcity problem.

The games described in this section therefore validate the idea that whenever a state controls a river's source or upper flow, it places the lower lying riparian state at a disadvantage. In this particular case, India has so far opted to carry out the construction projects on the shared rivers, a situation that could lead to increased tensions and further deterioration in their already strained political relations.

4. Conclusion and Policy Implications

The increasing water scarcity in South Asia is an early warning and indication of the potential for increased political tensions in the region. Under the circumstances, peaceful sharing of the rivers is mandatory but becomes a complicated task when an upstream country has a superior economic, political and military capability. The paper presents a case study of Pakistan and India where such a relationship is analyzed in a game theoretic framework. Simple non-cooperative game theory models have been used to analyze the ongoing dispute and concerns over shared rivers in both countries. The more complex models of co-operative game theory which generate gains for both countries through collaboration for more efficient management of water resources and effective adaptation to the shared dangers of global warming, are not considered in the present study.

The analysis indicates that a high degree of water stress could entrap the countries in the Nash equilibrium of bilateral aggression. Even though a peaceful resolution of the problem could maximize the joint pay-offs for both countries. The direct or indirect violations of the Indus Water Treaty by the Indian government could still lead to an armed conflict between the two countries, jeopardizing regional stability.

To reduce the possibility of conflict arising out of the perception by the low riparian state that the upper riparian state is engaged in “water theft” in violation of the Indus Basin Treaty, Article III, Para 3 of this Treaty can be activated which stipulates that “….Each party agrees to establish such discharge observation stations as may be considered necessary by the Commission for the determination of the component of water available for the
use of Pakistan on account of the aforesaid deliveries by Pakistan\textsuperscript{16}. Using new satellite linked technologies for continuous real time monitoring of river flows in the discharge observation stations on both sides of the border, can objectively establish whether or not river water is being illegally appropriated\textsuperscript{17}. One prospective solution for reaching an agreement between the two countries therefore is linking this conflict to other aspects of bilateral or multilateral relationship. This could mean raising the stakes of aggression for both sides via increased direct or indirect opportunity cost (in terms of trade) etc. to coax the countries to cooperate with each other. If this kind of understanding develops between the involved parties the associated pay-offs will change in a way so as to reduce the gains from non-cooperation. To achieve such an outcome, India would need to help Pakistan to solve its domestic water mismanagement problems by providing financial assistance as well as technical support for this purpose. Pakistan in turn could compensate India for the reduced agricultural productivity by providing them trading routes to the central Asian states. Increased trade between both countries will also reduce incentives for military escalation on both sides. The role of arbitrators also becomes important in this case. If the arbitrators play their role responsibly a peaceful resolution of disputes that can arise on the water issue, will become the most likely outcome of this game. A multilateral effort is therefore required for the peaceful resolution of the potential for conflict between these two upper and lower riparian states. If tensions on this issue are allowed to build up, it could have disastrous consequences for millions of people in both countries in the years ahead.

\textsuperscript{16} The Indus Waters Treaty 1960, Article III, Para 3.
\textsuperscript{17} For a discussion on cross border dissemination of hydrological data, see, Connecting the Drops: An Indus Basin Roadmap for Cross-Border Water Research, Data Sharing, and Policy Coordination, Indus Basin Working Group, Stimson Centre, SDPI and Observer Research Foundation, 2013, page 25.
References


## Appendix

### Matrix 1: The Payoffs Associated with Low Water Stress

<table>
<thead>
<tr>
<th></th>
<th>Pakistan</th>
<th>Do Nothing</th>
<th>Arbitration</th>
<th>Aggression</th>
</tr>
</thead>
<tbody>
<tr>
<td>India</td>
<td>Do Nothing</td>
<td>(0, -10)</td>
<td>(0, 0)</td>
<td>(-10, -20)</td>
</tr>
<tr>
<td></td>
<td>Arbitration</td>
<td>(10,-10)</td>
<td>(10, 10)</td>
<td>(0, -10)</td>
</tr>
<tr>
<td></td>
<td>Build Dams</td>
<td>(20,-20)</td>
<td>(0, 10)</td>
<td>(10,0)</td>
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### Matrix 2: The Payoffs Associated with High Water Stress

<table>
<thead>
<tr>
<th></th>
<th>Pakistan</th>
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<th>Arbitration</th>
<th>Aggression</th>
</tr>
</thead>
<tbody>
<tr>
<td>India</td>
<td>Do Nothing</td>
<td>(0,-10)</td>
<td>(0, 10)</td>
<td>(-20, 0)</td>
</tr>
<tr>
<td></td>
<td>Arbitration</td>
<td>(10,-10)</td>
<td>(20, 20)</td>
<td>(0, 10)</td>
</tr>
<tr>
<td></td>
<td>Build Dams</td>
<td>(20,-20)</td>
<td>(10, 0)</td>
<td>(10,10)</td>
</tr>
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</table>
Matrix 3: **Resulting Payoffs when the Probability of High Water Stress = 0.6**

<table>
<thead>
<tr>
<th>Pakistan</th>
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<th>Arbitration</th>
<th>Aggression</th>
</tr>
</thead>
<tbody>
<tr>
<td>India</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Do Nothing</td>
<td>(0, -10)</td>
<td>(0, 6)</td>
<td>(-16, -8)</td>
</tr>
<tr>
<td>Arbitration</td>
<td>(10, -10)</td>
<td>(16, 16)</td>
<td>(0, 2)</td>
</tr>
<tr>
<td>Build Dams</td>
<td>(20, -20)</td>
<td>(6, 4)</td>
<td>(10, 6)</td>
</tr>
</tbody>
</table>

Matrix 4: **Reduced Overall Likelihood of Water Stress Results in a Unique Nash Equilibrium Probability of High Water Stress (0.2)**

<table>
<thead>
<tr>
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<th>Arbitration</th>
<th>Aggression</th>
</tr>
</thead>
<tbody>
<tr>
<td>India</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Do Nothing</td>
<td>(0, -10)</td>
<td>(0, 2)</td>
<td>(-12, -16)</td>
</tr>
<tr>
<td>Arbitration</td>
<td>(10, -10)</td>
<td>(12, 12)</td>
<td>(0, -6)</td>
</tr>
<tr>
<td>Build Dams</td>
<td>(20, -20)</td>
<td>(2, 8)</td>
<td>(10, 2)</td>
</tr>
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</table>
Pakistan’s Water Vulnerability and the Risk of Inter-State Conflict in South Asia

Figure 1: Extensive form Payoffs: (India, Pakistan)
Figure 2: Finding the Equilibrium Payoffs: (India, Pakistan)
Figure 3: Unique Nash Payoffs: (India, Pakistan)

A
India

Build Dams
0, 10

Arbitration
16, 16

Pakistan’s Water Vulnerability and the Risk of Inter-State Conflict in South Asia
Human Attitude toward Risk: Simultaneous Testing of ‘Allais Paradox’ and Risk Aversion

Muhammad Mazhar Iqbal

Abstract

In real life, human attitudes toward risk are mixed. However, economists have been using risk aversion as rational behavior in economic modeling ever since. The Expected Utility Hypothesis (EUH), which assumes risk-averse behavior but can also be used for risk-loving attitudes, comes into common use. Allais discovered a systematic violation of the EUH known as the ‘Allais paradox’, which initially discredited the EUH a great deal but was accepted, later on, as an exception to the EUH. A possible reason for ignoring the ‘Allais paradox’ could be that Allais himself and many studies which followed tested the EUH without reflecting risk aversion in particular. Therefore, this study tests the EUH and risk aversion simultaneously. The results are interesting. The greatest number of respondents verified the EUH based on risk aversion, but a majority of them showed a mixed attitude. This result, therefore, highlights the need for economic theorizing on the assumption of risk-loving and mixed attitudes as well.

Keywords: Choice under Uncertainty, Expected Utility Hypothesis, Risk Aversion, Allais Paradox, Certainty Effect

JEL Classification: D81

1. Introduction

In real life, human attitudes toward risk are mixed. On one hand, there are people who pay a certain amount of money to assume risk; they buy lottery tickets, they try their luck in casinos, they bet on horse races and other games, and they go to gambling dens. In every such activity, the expected return is usually less than the amount paid for it. Therefore, people who participate in games of chance are categorized as risk-loving. On the other hand, there are people who buy insurance to get rid of uncertainty regarding future outcomes. They pay insurance premiums, which are usually greater than the actuarial value of future loss. Such people are therefore categorized as risk-averse. There are yet some other people who may be called loss-averse

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because they hesitate to invest their money in a project in which there is any possibility of loss without caring much about its whole risk return profile.

Besides lotteries, games of chance, and insurance, people often confront uncertainly while apportioning their wealth into various categories of assets like bank accounts, bonds, stocks, real estate and business investment. Out of these options, bank accounts and bonds are less risky than stocks, real estate or business investment as returns on the former are fixed and their principal amount remains intact, whereas the returns on the latter are variable and their principal amount may also decline over time. Therefore, loss-averse and more risk-averse people prefer to deposit their money in banks and to hold bonds, whereas relatively less risk-averse people buy stocks and invest in real estate and business ventures.\(^2\) On the same lines, people who prefer fixed-income jobs over comparable commission-based ones and self-employment with overall expected income being greater from the latter options can be classified as risk-averse individuals.

It is also interesting to note that an individual is neither exclusively risk-loving nor risk-averse in his/her practical life; rather he/she is both at the same time. In any society, one can easily find a person who, on one side, takes up a fixed-income job, but, on the other side, lives in an uninsured house, does not purchase any insurance policy and invests in stocks and real estate. One can also find, with the same ease, another person who, on one side, prefers self-employment over a fixed income job but, on the other side, gets his/her house and life insured and keeps his/her wealth in bank accounts and bonds. Moreover, Samuelson (1963) pointed out that one of his colleagues turned down an offer of coin toss to win Rs.200 on a head and to lose Rs.100 on a tail that shows an extremely risk-averse behavior. However, he expressed his willingness to accept 100 such bets if offered all together. This indicates that a person’s degree of risk aversion also varies with the size of the bet.

Given such an intermingled and complicated state of human attitudes toward risk, it is really difficult to prove whether a typical individual is predominantly risk-loving or risk-averse. However, exposition of the ‘St. Petersburg paradox’ in the second half of eighteenth century and then its resolution through the Expected Utility Hypothesis (EUH) supported the risk-

\(^2\) Since higher risk for the latter type of assets is compensated with higher return for them, therefore their holders are categorized as risk-averse rather than risk-loving. Technically a person is categorized as risk-loving if he/she invests in a venture for which expected return is less than the principal amount invested in it.
averse attitude so much that since then it has become the norm or rational behavior in economic modeling. The ‘St Petersburg paradox’ refers to a betting game on the flipping of a coin. Participants in the game receive a payoff of $1 if the coin shows head on the first flip, $2 if it turns out head in the second flip too, and $2^i$ if it turns out head uninterruptedly till the $i^{th}$ flip. The game ends as soon as the coin shows tail. It means that, on one extreme, the game may end after the first flip without the player winning any money and, on the other extreme, it may continue for a large number of flips, winning an infinite amount of money for the player. The expected payoff of this game is an infinite amount of money. When potential players were asked to bid for getting the right to play this game, however, paradoxically none of them offered even a moderate amount of money, much less a large amount of money closer to the expected value of this game.

The paradox was resolved with the argument that it is not the amount of the payoff that people care about; rather it is the utility, which they derive from the payoff that concerns them. Furthermore, the utility of wealth, like the utility of any good or service, increases at a decreasing rate. In other words, in a bet or risky investment, the disutility of losing a dollar is always greater than the utility of winning a dollar. It clearly means that a utility maximizer is a risk averter who would never play a game for which expected payoff is equal to the price paid for it. He/she would be willing to play a game only if its expected payoff is sufficiently greater than its price. The difference between expected payoff and price represents his/her compensation for the assumption of risk. The novel idea of linking money with its utility was further developed to the present axiomatic form of the EUH by von Neumann and Morgenstern (1944). According to the EUH, every decision maker under uncertainty has a specific concave utility-of-wealth function in his/her mind. To evaluate competing investment opportunities or alternative games, a unique utility index in accordance with his/her utility function is assigned to each possible outcome and then the expected value of such utility indexes is worked out.

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3 See Machina (2008) for further details.
4 Assuming a log utility function and an initial wealth of $50,000 of a potential bidder of St Petersburg game and expressing its payoffs and probabilities as $2^{i-1}$ and $1/2^i$ respectively, Machina (1987) worked out $9 as the offer price for this game.
Whichever investment opportunity or game has the highest expected utility is ranked at the top and so on.\textsuperscript{5}

Risk aversion that explains the very logic of the EUH is reflected only implicitly from an increasing concave utility function, whereas an upward sloping straight line and an increasing convex utility function reflect risk-neutral and risk-loving attitudes, respectively. On the other hand, the mean-variance criterion reflects risk aversion explicitly as variance, one of its two parameters, is itself the most widely used measure of risk. This criterion, however, has two shortcomings. One is that it requires the comparison of two parameters, mean and variance, of competing projects. The other is that it is not helpful if both parameters of one project are greater than those of the other. For example, if project A has 2 possible payoffs, 0 and 10, with equal probability and project B has 2 possible outcomes, 0 and 30, with equal probability, then the mean-variance criterion is not helpful to rank these projects even though a common man who knows nothing about finance would prefer project B over project A. The EUH is free from these shortcomings. It is probably for these reasons that the EUH has always been preferred over the mean-variance criterion in the literature.

One of the earliest and most widely cited systematic violations of the EUH is ‘Allais Paradox’.\textsuperscript{6} The results of his experimental study showed that people consistently violate the EUH. However, interestingly, his results contradicted an increasing concave utility function as much as they contradicted an upward sloping line and an increasing convex utility function. In other words, ‘Allais paradox’ highlighted a notable violation of the EUH but it did not specifically contradict risk aversion. That is why many authors still try to defend the EUH and risk-averse attitudes as the norm. Their main argument is a ‘certainty effect’ that when a certain option is placed vis-à-vis a probable option, people are biased towards the certain option. Hence, the EUH does not work. However, if people have to choose from two probable options, then they rank them in accordance with the EUH. Since Allais included a certain option in the first option-pair of his experiment, he got paradoxical results. Many studies which retested ‘Allais paradox’ included similar questions. It seems that the main concern of previous studies had been verification or nullification of the EUH without bothering about its underlying

\textsuperscript{5} Mathematically, possible payoffs of an investment project or a game are expressed as $x_1$, $x_2$, …, and $x_n$, and their respective probabilities as $p_1$, $p_2$, …, and $p_n$ such that $\Sigma p_i = 1$ and its expected utility as $EU = \Sigma U(x_i) p_i$ where $U(x_i)$ denotes the utility index of each payoff.

\textsuperscript{6} See Allais (1953).
idea of risk aversion. On the other extreme is a study by Levy and Levy (2001) that tested only risk aversion without testing the EUH. Its results though showed evidence against risk aversion, yet it could not generate substantial reverberations in economic profession because the EUH was not challenged directly.

It is therefore desirable to test both the EUH and the mean-variance criterion simultaneously. That is the main objective of the present study. It is achieved by modifying competing options in Allais-like choice-sets in such a way that simultaneous testing of both the EUH and the mean-variance criterion becomes possible. Of course, implications of this study would be far-reaching; if its results verify both the EUH and the mean-variance criterion, then the EUH will continue to occupy a good space in microeconomic textbooks in spite of its systematic violations and its logical problems. On the other hand if its results verify the ‘Allais paradox’ and contradict the mean-variance criterion, then not only will the EUH become more doubtful but the very belief of risk aversion will also become debatable. Hence, the whole edifice of Economics will be shaken as already concluded by Levy and Levy on the basis of their results.

Following this introduction, this paper presents an appraisal of the ‘Allais paradox’ based on selected previous studies on the topic. Section three presents the distinguishing features of the experimental design of this study. Section four discusses the results of this study and compares them with those of previous studies. The last section is reserved for concluding remarks.

2. Appraisal of the ‘Allais Paradox’

In his widely cited experiment, Allais asked selected subjects first to choose from a certain and a probable option, A and A* respectively, and then from two probable options, B and B*, as given below in Table 1.

A Majority of respondents chose option A from option-pair AA* and option B* from option-pair BB*. It means that expected utilities of options A and A* lead to following Inequality 1

\[ U(1) \geq 0.01 U(0) + 0.89 U(1) + 0.1 U(5) \]

or

\[ 0.11 U(1) \geq 0.01 U(0) + 0.1 U(5) \]  

Inequality 1

Similarly, the expected utilities of options B and B* lead to following Inequality 2: -

\[ U(1) \geq 0.01 U(0) + 0.89 U(1) + 0.1 U(5) \]

or

\[ 0.11 U(1) \geq 0.01 U(0) + 0.1 U(5) \]  

Inequality 2
\[ 0.89 \, U(0) + 0.11 \, U(1) \leq 0.9 \, U(0) + 0.1 \, U(5) \]
or \[ 0.11 \, U(1) \leq 0.01 \, U(0) + 0.1 \, U(5) \]

### Inequality 2

**Table 1: Original Questions in ‘Allais Paradox’**

<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
<th></th>
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<th></th>
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<tbody>
<tr>
<td>A</td>
<td>1</td>
<td>1.00</td>
<td>0</td>
<td>0.01</td>
<td>0</td>
<td>0.89</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0</td>
<td>0.90</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>0.89</td>
<td>1</td>
<td>0.11</td>
<td>5</td>
<td>0.10</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>0.10</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: Allais (1953).

Since the expressions on both sides of inequalities 1 and 2 are same but the sign is reversed, therefore it shows a contradiction of the EUH. According to the EUH, they should have chosen either AB or A*B*. For choice-pattern AB*, it can be argued that respondents showed risk-averse behavior by preferring option A with less payoff over option A* with greater expected payoff only because the risk (variance) of the former was also less. Had they shown same attitude while choosing from option-pair BB*, they should have chosen option B. To put it differently, respondents showed a risk-loving behavior by preferring option B* with a smaller coefficient of variation (expected mean / variance) over option B only because the risk of option B* was greater. Had they shown the same risk-loving attitude while choosing from option-pair AA*, they should have chosen option A*. Moreover, had respondents been risk neutral, they should have chosen A*B* because expected returns of these options are greater than those of their counter options AB. This means that the choice-pattern AB* contradicted the EUH irrespective of the shape of the utility function. This is, respondents’ behavior was neither risk-averse, nor risk-loving, nor even risk neutral consistently; rather it was mixed.

The results did not, however, contradict the ‘mean-variance’ criterion because it is not helpful to rank either option-pair as both the mean and variance of options A and B are less than those of option A* and B* respectively. To explain this paradox, it is argued that people attach significantly greater utility to a certain option while comparing it with a probable one whereas they show no such bias while comparing two probable
options. As option A is certain, that is why his experiment contradicted the EUH.

Later on, Kahneman and Tversky (1979) retested ‘Allais paradox’ from different angles. They included four choice-sets in their experimental survey as given below in Table 2.

Table 2: Retesting of Allais Paradox by Kahneman and Tversky

<table>
<thead>
<tr>
<th></th>
<th>A</th>
<th>A*</th>
<th>B</th>
<th>B*</th>
<th>Choice Pattern (%)</th>
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<tr>
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<td>Prob.</td>
<td>Payoff</td>
<td>Prob.</td>
<td>Payoff</td>
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<tr>
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<td>2400</td>
<td>1.00</td>
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<td>0.01</td>
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<tr>
<td></td>
<td>(82%)</td>
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<tr>
<td></td>
<td>3000</td>
<td>1.00</td>
<td>0</td>
<td>0.20</td>
<td>0</td>
</tr>
<tr>
<td>2</td>
<td>Payoff</td>
<td>Prob.</td>
<td>Payoff</td>
<td>Prob.</td>
<td>Payoff</td>
</tr>
<tr>
<td></td>
<td>4000</td>
<td>0.80</td>
<td>3000</td>
<td>0.25</td>
<td>4000</td>
</tr>
<tr>
<td></td>
<td>(85%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Payoff</td>
<td>Prob.</td>
<td>Payoff</td>
<td>Prob.</td>
<td>Payoff</td>
</tr>
<tr>
<td></td>
<td>0</td>
<td>0.10</td>
<td>0</td>
<td>0.55</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>(73%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Payoff</td>
<td>Prob.</td>
<td>Payoff</td>
<td>Prob.</td>
<td>Payoff</td>
</tr>
<tr>
<td></td>
<td>3000</td>
<td>0.90</td>
<td>6000</td>
<td>0.45</td>
<td>3000</td>
</tr>
<tr>
<td></td>
<td>(67%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: Kahneman and Tversky (1979).

The majority choice for each option-pair is given in percentage form in parenthesis below the payoff column, and the choice-pattern of respondents is given in the last four columns of the Table. Majority of respondents chose option A ranging from 78% to 86% from option-pair AA* and option B* ranging from 63% to 85% from option-pair BB*. Majority choice-pattern was AB* ranging from 52% to 68% in all choice-sets. These results confirmed ‘Allais paradox’. In the first two choice-sets, respondents violated the EUH but not the ‘mean-variance’ criterion. In choice-set 3, the mean-variance criterion cannot be tested because payoffs are in kind, not in monetary terms. However, in choice-set 4, they violated not only the EUH but also the ‘mean-
variance’ criterion partially. They confirmed the ‘mean-variance’ criterion in option-pair AA* but contradicted it in option-pair BB* as expected payoffs of these options are equal but variance of option B* is greater.

Furthermore, they tested each option-pair in choice-sets 2 and 4 in Table 2 above against its mirror image having only negative payoffs as shown below in Table 3.

<table>
<thead>
<tr>
<th></th>
<th>A</th>
<th>A*</th>
<th>B</th>
<th>B*</th>
<th>Choice Pattern (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>3000</td>
<td>1.00</td>
<td>0</td>
<td>0.20</td>
<td>-3000</td>
</tr>
<tr>
<td></td>
<td>4000</td>
<td>0.80</td>
<td>-4000</td>
<td>0.80</td>
<td>(80%)</td>
</tr>
<tr>
<td>6</td>
<td>0</td>
<td>0.75</td>
<td>0</td>
<td>0.80</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>3000</td>
<td>0.25</td>
<td>4000</td>
<td>0.20</td>
<td>-3000</td>
</tr>
<tr>
<td>7</td>
<td>0</td>
<td>0.10</td>
<td>0</td>
<td>0.55</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>3000</td>
<td>0.90</td>
<td>6000</td>
<td>0.45</td>
<td>-3000</td>
</tr>
<tr>
<td>8</td>
<td>0</td>
<td>0.998</td>
<td>0</td>
<td>0.999</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>3000</td>
<td>0.002</td>
<td>6000</td>
<td>0.001</td>
<td>-3000</td>
</tr>
</tbody>
</table>

Source: Kahneman and Tversky (1979).

In this case, a majority of respondents showed an interesting behavior. Whatever option they chose with positive payoffs, they chose exactly the opposite option with negative payoffs. From option-pairs with positive payoffs, AA* in all these choice-sets, they contradicted the mean-variance criterion only in choice-set 8. However, from option-pairs with negative payoffs, BB* in all these choice-sets, they contradicted the ‘mean-variance’ criterion in choice-sets 5 and 7. Therefore, the authors concluded that the certainty effect does not support the conviction of risk aversion. People are rather risk-loving in case of negative payoffs. Hence, in their view, a utility function is convex for negative payoffs and concave for positive payoffs.
While considering option-pairs with negative payoffs at serial number 5 and 6 in table 3 as one Allais-like choice-set and at serial number 7 and 8 as another one, a majority of respondents chose A*B, which is totally opposite of their choice-pattern AB* in the case of positive payoffs. Choice-pattern A*B also contradicted the EUH. On the basis of this evidence, the authors concluded, “In the positive domain, the certainty effect contributes to a risk averse preference for a sure gain over a larger gain that is merely probable. In the negative domain, the same effect leads to a risk seeking preference for a loss that is merely probable over a smaller loss that is certain.”

Kahneman and Tversky also noted that academia believe in risk-averse attitude mainly due to the fact that a large number of people purchase insurance policies knowing that the premium, which they pay, is significantly greater than the expected actuarial value of loss. They, however, objected this idea with the argument that people often prefer insurance policies that offer limited coverage with low or zero deductibles over those policies that offer maximal coverage with slightly higher deductibles, which contradicts the idea of risk aversion. To put it differently, had people been truly risk averse, a majority of them would have preferred comprehensive insurance policies over minimal ones. To sum up, their study not only verified ‘Allais paradox’ in many different experiments but it also highlighted some violations of the fundamental mean-variance criterion.

In his survey article, Machina (1987) commented that the EUH had been the most useful theory for choice under uncertainty at least from its axiomatic presentation by von Neumann and Morgenstern (1944) until the finding of ‘Allais paradox’. Although ‘Allais paradox’ initially damaged the EUH, it was later on accepted as an exception to the EUH that manifests, in plain words, certainty effect and, in technical language, either a fanning out of linear indifference lines or the non-linearity of indifference curves in a unitary probability triangle. However, other challenges to the EUH, like the response mode effect and the effect of framing, or the wording of questions on a respondent’s choice have discredited the EUH further. That is why the author remarked that the EUH, having been a ‘success story’ roughly until 1970s, was then turned out a field in flux.

Conlisk (1989) retested Allais questions as such and got same results as Allais did. He also tested modified Allais questions and found evidence favoring the certainty effect against fanning out and non-linearity of indifference curves in a unitary probability triangle. However, in case of
actual payoffs of $0, $5 and $25 in lieu of hypothetical ones of $0, $1 million and $5 million with same probabilities as in original Allais questions, a majority of respondents chose options A* and B*. That is, a majority of respondents did not violate EUH, but showed a relatively less risk-averse behavior as both the mean and variance of the chosen options were greater than those of the rejected ones. The author, however, was not sure whether the switch over of respondents from more risk-averse to less risk-averse or risk-seeking attitudes was due to the replacement of hypothetical payoffs with real ones or due to the replacement of payoffs in millions to payoffs in numbers. In any case, his experiment with cash payoffs clearly demonstrated that both the certainty effect and risk aversion are not as profound as they appear from the original ‘Allais paradox’.

Rabin and Thaler (2001) criticized the EUH strongly on logical grounds. In their view, which is also in line with Arrow’s (1971) formal limit result, all utility maximizers at any level of wealth are virtually risk-neutral for small stakes and are risk-averse only for large stakes. However, if small stakes are offered in isolation without highlighting their impact on overall wealth level, then many people show a risk-averse attitude which, in turn, implies an unbelievable risk-averse attitude for large stakes. To illustrate their argument, they supposed that an individual being a risk-averter rejected a 50:50 lose $10 or gain $11 gamble. It means that for this person \( U(W) - U(W - 10) \geq U(W + 11) - U(W) \). In plain words, he/she valued, on the average, each of the next 11 dollars beyond his/her current wealth at no more than 10/11 of each of his/her current wealth’s last 10 dollars. If the same rate of risk aversion continues as the EUH suggests, then by iteration the value of the 900th dollar beyond his/her current wealth should be at most 2 percent of the value of her current wealth’s last 10 dollars. This rate of decline in the value of money is simply not possible in real life.

The authors particularly criticized Samuelson (1963), a Nobel laureate in Economics, who had reported another major anomaly of the EUH that one of his colleagues refused to accept a 50:50 lose $10 or gain $200 bet when offered to play only once but he showed his willingness to accept 100 such bets if offered all together. Samuelson could not deduce the right implication of this anomaly which the authors did as stated above. Samuelson and many others speculated that his colleague violated the EUH by showing his willingness to accept 100 bets all together. On the contrary, the authors emphasize that his colleague violated the EUH by rejecting the bet when offered to play only once. In their view, had Samuelson offered his colleague
a coin flip bet that would either increase equity in his home by $200 or decrease it by $100, he would likely find this bet more attractive than the bet he was actually offered. They also objected to the EUH because, on one side, it suggests that the utility of winning $10 is less than twice as much as the utility of winning $5 but, on the other side, it suggests that utility of a 10 percent chance of winning $100 is twice as much as the utility of a 5 percent chance of winning $100. Furthermore, they argued that people do not display a consistent coefficient of relative risk aversion; therefore it was a waste of time to measure it.

Levy and Levy (2001) tested only risk aversion because, in their view, there is a lack of consensus on the shape of the utility function. They noted that although a majority of economists believe in risk aversion or the concavity of utility function for all levels of wealth, many renowned economists and psychologists support the convexity of utility function over specified levels of wealth. For example, Friedman and Savage (1948) argued that a typical utility function is concave up to roughly the current level of wealth of an individual and then it becomes convex for additional wealth. Markowitz (1952) claimed that a utility function has two concave and two convex segments. Kahneman and Teversky (1979) concluded that a utility function is convex for loss possibilities and concave for profit opportunities.

Levy and Levy asked their respondents to choose from two different option-pairs. However, only option-pair A*A of their study as given below in table 4 was meant to test risk aversion.

<table>
<thead>
<tr>
<th>Payoffs</th>
<th>Probability</th>
<th>Payoffs</th>
<th>Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>-500</td>
<td>1/4</td>
<td>0</td>
<td>1/2</td>
</tr>
<tr>
<td>500</td>
<td>1/4</td>
<td>2000</td>
<td>1/2</td>
</tr>
<tr>
<td>1000</td>
<td>1/4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2000</td>
<td>1/4</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 4: Testing of Risk Aversion (Levy and Levy)


The result was startling in that a majority of respondents (56%) showed risk-loving behavior as they chose option A, which has the same
expected value as option A* but has greater variance than that of option A*. Therefore, the authors concluded that many of our economic and finance models which are based on the fundamental assumption of risk aversion need to be re-examined.

It is clear from above discussion that the EUH had been ubiquitously used in economic modeling for a long period because it requires a single parameter, expected utility, and is applicable to evaluate even those competing projects for which the mean-variance criterion is of no help. Even after having found colossal evidence of ‘Allais paradox’ against the EUH, it is still surviving. One possible reason could be that previous researches mostly focused on the EUH without testing the risk aversion which is the very logic of the EUH. Later on, Levy and Levy (2001) went to the other extreme; they tested risk aversion without testing the EUH. Though their results clearly contradicted risk aversion, they could not challenge the EUH because they did not test it directly. Moreover, the option-pair they asked their respondents to choose from is not representative of reality, as explained in the next section. Therefore, the objective of this study is to perform an experiment regarding the human attitude toward risk through choice-sets which allow the testing of risk aversion and the retesting of ‘Allais paradox’ simultaneously.

3. Experiment Methodology

This study is different from previous ones in three respects; number of respondents, background of respondents and nature of questions. The number of respondents is 500, which is greater than that of any previous study quoted above. With regard to the background of respondents, in previous studies they were primarily students and teachers. Students and teachers, no doubt, have fresh textbook knowledge of decision-making under uncertainty, but they certainly lack practical experience in this field. Therefore, to have a fair representation from all walks of life in this study, ten categories of respondents were identified; automobile dealers, property dealers, factory managers, shopkeepers, street vendors, money changers, stock brokers, bank officers, graduate students and common people. Initially the plan was to select equal number of respondents from each category. However, it could not be followed strictly due to administrative problems. Despite these problems, respondents of this study had a more diverse background, and a majority of them did not have formal knowledge of the topic, but had some sort of practical experience of decision-making under uncertainty.
All the respondents were approached in commercial areas of the twin cities of Rawalpindi and Islamabad on a ‘first contacted, first interviewed’ basis, provided that a potential respondent contacted first was willing to answer the questionnaire. The cover page of questionnaire indicated its objective was to test human attitudes toward risk. It was printed in two languages, Urdu and English, and each respondent was allowed to chose the language of his/her choice. Team members assured him/her of the secrecy of the information and its use exclusively for academic purposes. Every respondent was requested to fill in the questionnaire on the spot.

Regarding the nature of questions, four choice-sets, each comprising of two option-pairs and each option-pair comprising of two options, were included as shown below in Table 5. In all questions of this study, it was ensured that the flaws and shortcomings of previous studies were not repeated. For example, to avoid certainty and even certainty-like effect, none of the options in this study included either a probability of one, or a probability of less than 0.1 or greater than 0.9. Also, each competing option in the first 2 choice-sets had both negative and positive payoffs whereas each competing option in the last 2 choice-sets had a zero payoff instead of negative payoffs. Such payoffs are closer to reality than all positive or all negative payoffs as used in many previous studies discussed above.

Payoffs in competing options in Levy and Levy (2001) are also objectionable because one option has negative and positive payoffs whereas the other has zero and positive payoffs as shown in Table 4 above. In our view, both options should have either positive and negative or zero and positive payoffs. The payoffs which they used might have induced loss-averse individuals to reject option A outright without carefully comparing its whole risk and return profile with that of option A* because to such people losses hurt significantly more than gains give pleasure. They prefer to deposit their money in banks or to buy government bonds and refuse to invest their money in business and stocks even though expected return on the latter have been significantly greater than their risk. Therefore, zero and positive payoffs have not been pitted against negative and positive payoffs in any option-pair of this study.

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7 See Benartzi and Thaler (1995) and Siegel and Thaler (1997) for loss aversion.
Table 5: Simultaneous Testing of ‘Allais Paradox’ and Risk Aversion

<table>
<thead>
<tr>
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<th></th>
<th></th>
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<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>10</td>
<td>0.167</td>
<td>-10</td>
<td>0.333</td>
<td>-10</td>
<td>0.333</td>
<td>-10</td>
<td>0.667</td>
<td>42</td>
<td>14</td>
<td>20</td>
<td>24</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>0</td>
<td>0.500</td>
<td>-10</td>
<td>0.333</td>
<td>-10</td>
<td>0.333</td>
<td>-10</td>
<td>0.167</td>
<td>43</td>
<td>13</td>
<td>14</td>
<td>32</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>10</td>
<td>0.1</td>
<td>0</td>
<td>0.2</td>
<td>0</td>
<td>0.4</td>
<td>0</td>
<td>0.6</td>
<td>31</td>
<td>20</td>
<td>24</td>
<td>25</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>5</td>
<td>0.5</td>
<td>0.75</td>
<td>0.4</td>
<td>0.4</td>
<td>0.8</td>
<td>0.4</td>
<td>0.2</td>
<td>43</td>
<td>13</td>
<td>20</td>
<td>24</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: Survey conducted by the author.

Furthermore, all choice-sets of this study are designed in such a way that they allow simultaneous testing of the EUH and risk aversion. To test the EUH, payoffs and their probabilities are set in such a way that the expected utilities of both options in each option-pair of a given choice-set give exactly the same expression on both sides of the inequality as illustrated above in context of ‘Allais paradox.’ So if the inequality sign that is to be determined on the basis of survey results comes out the same in both inequalities, then it verifies the EUH and if the inequality sign turns out opposite, it confirms ‘Allais paradox.’ To test risk aversion, payoffs and their probabilities are set in such a way that expected payoffs of both options in each option-pair turn out equal but their variances turn out different. Hence, if majority choice is for the option with lesser variance it confirms risk aversion, otherwise it violates it.
In these choice-sets, choice-pattern AB is in accordance with a concave utility function or risk-averse attitude, choice-pattern A*B* is in accordance with a convex utility function or risk-loving attitude and choice-patterns A*B and AB* show the mixed attitude, risk-averse as well as risk-loving. According to the EUH, for a risk-averse individual the following inequalities 3 and 4 must be true for option-pairs AA* and BB* respectively; for a risk-loving individual the sign ‘>’ in inequalities 3 and 4 must be replaced with the ‘<’ sign; and for the mixed attitude, the sign in inequalities 3 and 4 must be opposite. For illustration, the expected utilities of options A and A* in choice-set 1 lead to following Inequality 3:

0.167 U(-10) + 0.667 U(20) + 0.167 U(50) > 0.333 U(-10) + 0.333 U(20) + 0.333 U(50) or 0.333 U(20) > 0.167 U(-10) + 0.167 U(50)

Inequality 3

Similarly, the expected utilities of options B and B* in choice-set 1 lead to the following Inequality 4:

0.333 U(-10) + 0.667 U(20) > 0.667 U(-10) + 0.333 U(50) or 0.667 U(20) > 0.333 U(-10) + 0.333 U(50)

dividing both sides of this inequality by 2, we get

0.333 U(20) > 0.167 U(-10) + 0.167 U(50)

Inequality 4

The same pattern emerges for the expected utilities of competing options in other choice-sets.

4. Results and Discussion

The results of this study are quite interesting. Looking at majority choice for each option-pair that is given in percentage form in parentheses below the outcomes in Table 5, it is clear that a majority of respondents ranging from 51% to 56% preferred option A over option A* and a majority ranging from 55% to 63% preferred option B over option B* in all choice-sets. Since in each option-pair both options have an equal expected payoff but options AB have smaller variances than those of options A*B* respectively, it is concluded that a majority of respondents are risk averse. Although the majority is less than two-thirds in all cases and is closer to break-even point in some cases, the majority choice, at least in terms of percentage figures, supports the long-held paradigm that individuals are predominantly risk-averse.
However, a risk-averse attitude is not confirmed from the choice-pattern of respondents that emerges from their combined choice for both option-pairs in each choice-set as given in the last 4 columns of Table 5. Though the highest percentage of respondents, ranging from 31% to 43%, showed risk-averse behavior consistently in both options of each choice-set, this percentage significantly falls short of the 50% threshold. In other words, the majority choice-pattern apparently verified risk aversion but statistically it did not establish that risk aversion was the predominant behavior of individuals. Moreover, the next highest percentage of respondents, ranging from 24% to 32%, showed risk-loving behavior consistently as they chose both risky options A*B in each choice-set. In economic modeling, where a risk-loving attitude is usually disregarded as irrational or against the norm, this result further weakens the long-held belief that people are consistently risk-averse.

The percentage of respondents who showed the mixed attitude by choosing the riskier option from one option-pair and the less risky option from the other option-pair in each choice-set is also conspicuous. It is highest (20 + 24 = 44) in choice-set 3 and it is not insignificant (less than 27%) in any other choice-set. Logically, the mixed choice-pattern may be used to support both risk aversion and risk-loving attitudes equally. However, theoretically it should be counted against risk aversion. The reason is that the standard of risk aversion as the norm implies that the majority of people should show a risk-averse attitude not only for each option-pair but also for both option-pairs in each choice-set. If this is accepted, then the percentage of risk-lovers and people showing mixed behavior significantly exceeds that of risk averters. Hence, the conclusion derived on the basis of majority choice above that a majority of people ranging from 51% to 63% are risk-averse is totally reversed if judged on the basis of the majority choice-pattern. The majority choice-pattern ranging from 57% to 69% did not support risk-averse behavior consistently.

In previous studies, two choice-patterns, AB and A*B*, were in line with the EUH and the other two choice-patterns, A*B and AB*, were against the EUH or in line with ‘Allais paradox.’ However, in this study, only choice-pattern AB confirms the EUH and all other choice-patterns contradict it. Therefore, choice-pattern AB, with the highest percentage of respondents ranging from 31% to 43%, fails to verify the EUH because the aggregate percentage of respondents ranging from 57% to 69% chose choice-patterns which contradict the EUH. Hence, this result is in line with that of Levy and
Levy that a majority of people are not risk-averse and it also explains the remarks of Rabin and Thaler that people do not display a consistent behavior toward risk.

5. Concluding Remarks

In real life, human attitudes toward risk are mixed. Some people are fond of gambling, lotteries and casinos while others hate these activities and pay money to get insured against uncertainty of future; some people prefer investing in stocks, property and business while others like to deposit their money in banks and buy bonds; some people line up for salaried jobs while some others look for commission-based jobs and self-employment. Even a single person may show opposite behavior at different times and venues. Ignoring such a diversity of human attitude, economists have, however, long accepted that a risk-averse attitude is the norm or rational attitude for decision-making under uncertainty.

There are two main criteria based on risk aversion, mean-variance and the EUH, to evaluate competing investment projects or games of chance. The merits of the mean-variance criterion are that it reflects risk explicitly and does not require decision-makers to think of any utility function. Its demerits are that it requires two parameters, mean and variance, for each of the projects or games under consideration and it is not applicable if both the mean and variance of one project or game are greater than those of the other. On the contrary, the merits of the mean-variance criterion are the demerits of the EUH and the demerits of the former are the merits of the latter. In any event, the EUH has been used more extensively in economic theorizing than the mean-variance criterion.

The EUH continued to be the dominant theory even after the discovery of ‘Allais paradox’ which, based upon an experimental survey, pointed out a systematic violation of the EUH. Many studies reexamined this paradox and found similar results. One possible reason for ‘Allais paradox’ not having deleterious effect on the EUH as expected initially seems to be that Allais himself as well as most of the subsequent researchers on the topic concentrated on the EUH and neglected risk aversion. That is, they included questions in experimental surveys which were useful to verify or nullify the EUH but were not helpful in testing risk aversion. On the other extreme, a few studies tested only risk aversion without testing the EUH. This study, therefore, took up the task of testing both the EUH and risk aversion simultaneously. For this purpose, questions were framed carefully. Two
option-pairs were included in each Allais-like choice-set. However, unlike previous studies, the expected payoffs of both options in each option-pair were set to be equal, and their variances were set to be different which facilitated the testing of risk aversion and the EUH simultaneously. Respondents were selected from diverse backgrounds. Most of the respondents had some sort of practical experience of decision-making under uncertainty.

While compiling the results, the majority choice in each option-pair was used to test risk aversion and the majority choice-pattern for both option-pairs in each choice-set was used to test ‘Allais paradox.’ The results of this study are quite revealing. A simple majority of respondents, not a resounding one, showed risk-averse behavior in each of the total eight option-pairs included in this study. This result verifies the fundamental idea of risk aversion. Their choice-pattern in two option-pairs of each choice-set apparently verifies the EUH because the highest percentage chose options A and B which reflects a consistently risk-averse behavior. However, the next highest percentage of respondents chose options A* and B* in each choice-set which reflects a consistently risk-loving behavior. Also, a significant percentage of respondents showed a risk-averse attitude in one option-pair and a risk-loving attitude in the other. Since risk-loving and mixed attitudes contradict risk-averse behavior, their percentages may be summed up. Consequently the aggregated percentage exceeds the percentage of risk-averse respondents. Hence, the above conclusion drawn on the basis of the majority choice for each option-pair and on the basis of the choice-pattern of the highest percentage of respondents for both option-pairs of each choice-set is reversed. That is, a majority of respondents did not show risk-averse behavior consistently.

An important implication of this research is that due to evidence against risk aversion in this study and in previous studies, it should not be treated as the only norm or exclusive behavior of decision-makers under uncertainty; it can be used at best as a good working assumption for choice under uncertainty, as perfect competition is assumed in commodity markets. Economists should rather attempt to develop decision-making criteria which takes into account mixed and risk-loving behaviors as well as they did with monopolistic competition and other imperfections in commodity markets.
References


Role of Foreign Direct Investment and Remittances in the Economic Growth of Pakistan

Fatima Shahid, Sarfraz Hassan, Khuda Bakhsh and Nazia Tabasam

Abstract

Foreign direct investment and remittances play an important role in the economic growth of a country by bringing the latest technology, promising better infrastructure, providing foreign capital and generating employment opportunities. The policy environment, macro-economic stability, a sound domestic financial system, good law and order conditions and the availability of cheap energy and skilled manpower are all assumed to be some of the important pre-conditions for foreign direct investment. Remittances, being a reliable alternate source of capital, serve the country well in distressed economic situations. The present study is designed to explore the role of foreign direct investment and remittances on the economic growth of Pakistan by using the Engle Granger Cointegration method. Empirical results suggest that there is a long run relationship between the dependent and independent variables included in the model. Remittances and gross fixed capital formation variables have a positive impact on economic growth in the long-run. However, foreign direct investment has a negative effect on the growth because pre-requisites are missing in Pakistan. Result suggests that there is disequilibrium among the variables in the short-run. The disequilibrium that occurs in the previous time period is very rapidly adjusted in the current time period. Improving conditions for attracting foreign direct investment could further increase economic growth in the country.

Keywords: FDI, Remittance, Economic Growth, ECM, Pakistan

JEL Classification: C22, E22, O1, O11

1. Introduction

Capital has an important role in economic growth and development of an economy. Economists argue capital is a necessary element of economic growth. Development economists consider capital crucial for growth and development whether its origin is foreign or local (Denault, 2011). Pakistan has low capital formation due to a low saving rate, high population growth

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rate, huge debt burden and a relatively low level of managerial and technical skills (Azam & Khatkam, 2005). Foreign direct investment (FDI) and remittances have an important contribution in capital formation particularly in developing economies and Pakistan is no exception in this regard. FDI is considered to give rise to increased size and effectiveness of investment. It increases available knowledge and improves quality of knowledge as well. It helps local firms to take advantages of the technology and knowledge of foreign firms, to learn the new techniques, and to get benefits from their experience (Rivero, 2007; Hermes & Lensink, 2003). Host countries devise various policies to attract FDI. Such policies include partial or complete exemption from corporate taxes and import duties. These policies get approval after long debate and great consideration. Such policies are applied to all foreign firms, fulfilling certain rules and regulations (Hanson, 2001).

FDI is accompanied by both benefits and costs. The effectiveness of FDI on the economic growth of the host country depends on a given country’s general conditions (such as macroeconomic and political stability) and policy environment (including such factors as includes diversification, absorption capacity, linkages between FDI and domestic investment) (Adams, 2009; Hermes & Lensink, 2003).

Pakistan is a large consumer market with 190 million people and is blessed to have huge deposits of natural resources and a diverse natural environment. The lack of capital and relatively poor management and technical abilities in Pakistan, has made it feasible for foreign investors to invest in the country. Although Pakistan has great potential to attract FDI, it has never been able to exploit full benefits of FDI (Government of Pakistan, 2012). Figure 1 shows FDI inflows in Pakistan overtime.

Very low inflow of FDI from the beginning can be observed from Figure 1. FDI increased after the year 1988 mainly due to privatization and trade liberalization policies of the Government of Pakistan. It reached a maximum in 1995 and then started decreasing. The decline in FDI after 1995 can be attributed to sanctions imposed on Pakistan after the nuclear test of that year and the Asian crisis. It started increasing again as a result of liberalization in foreign investment and renewal of Pak-US relationships after 2000. FDI reached its maximum in 2008 and then showed a steep decline thereafter due to a lack of trust and confidence in Pak-US relationships and changes in country specific conditions such as political and macro-economic stability, the
energy crises, and deteriorating law and order conditions. FDI inflows and the annual economic growth rate are given in Table 1.

Figure 1: Trend of Foreign Direct Investment (Real) Inflows to Pakistan 1975-2012

An examination of Table 1 indicates that FDI started declining in the past few years. FDI inflows in 2012 are half of that received in 2011. Annual growth in FDI also declined steeply, even showing negative growth in FDI from 2009 onward. Khan (2011) and Khalid et al. (2012) argue that this abrupt decline in FDI inflows is attributable to several factors including: political and macroeconomic instability, a declining law and order situation, inconvenient government policies, lack of infrastructure, a growing energy crisis and an illiterate labor force.

Another source of capital formation is remittances. Remittance is the part of a migrant’s income that is sent back to their home country (Buch, 2002). In case of natural disasters namely earthquakes and floods, immigrants send remittances to their home country to serve the country (Sorenson, 2004). The benefits of remittances include allowing a country to spend more on consumption, increase imports, and improve investment in the economy (Cornnell & Conway, 2000). Other benefits of remittances include reducing poverty and improving the quality of human life through quality education, better medical facilities (Calaro, 2008; Faini, 2002; Kemal, 2001), reducing the debt burden, lowering the savings investment gap, improving the balance of payments and minimizing current account deficit (Iqbal & Sattar, 2005; Arif, 1999). Orozco & Fedewa (2005) and Beck et al. (2007) showed that remittances result in financial development, thereby reducing poverty and inequality and promoting economic growth.
Table 1: FDI Inflows in Pakistan from 2001-2012

<table>
<thead>
<tr>
<th>Years</th>
<th>FDI inflow (Million$)</th>
<th>Annual growth rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>2001</td>
<td>324.4</td>
<td></td>
</tr>
<tr>
<td>2002</td>
<td>484.7</td>
<td>49.4143</td>
</tr>
<tr>
<td>2003</td>
<td>798</td>
<td>64.63792</td>
</tr>
<tr>
<td>2004</td>
<td>949</td>
<td>18.92231</td>
</tr>
<tr>
<td>2005</td>
<td>1524</td>
<td>60.59009</td>
</tr>
<tr>
<td>2006</td>
<td>3521</td>
<td>131.0367</td>
</tr>
<tr>
<td>2007</td>
<td>5139.6</td>
<td>45.96989</td>
</tr>
<tr>
<td>2008</td>
<td>5410.2</td>
<td>5.265001</td>
</tr>
<tr>
<td>2009</td>
<td>3719.9</td>
<td>-31.2428</td>
</tr>
<tr>
<td>2010</td>
<td>2205.7</td>
<td>-40.7054</td>
</tr>
<tr>
<td>2011</td>
<td>1292.9</td>
<td>-41.3837</td>
</tr>
<tr>
<td>2012</td>
<td>666.7</td>
<td>-48.4338</td>
</tr>
</tbody>
</table>

Source: Government of Pakistan (2013)

Pakistan was the fifth largest country in terms of remittance received in 2011. Worker remittances experienced 10.8 percent growth in South Asia compared to 25.8 percent in Pakistan during the year 2011 (Government of Pakistan, 2012). Figure 2 summarizes remittance inflows in Pakistan. During the 1970s, remittance inflows were considerably higher in Pakistan than other countries, as it was the larger country sending its workers to the Middle East. The significant increase in remittances in the 1980s was due to an increase in number of migrant, which were 107,000 in the 1980s, compared to 79,000 in the 1970s. The decade of the 1990s experienced a decline in worker remittances. Important reasons for this decline in worker remittances include a decrease in oil prices which caused a slowing in economic activities of the labor importing countries, especially the Middle East countries, and freezing of foreign currency accounts. After 9/11 remittances considerably increased because migrants started sending the remittances using formal channels of banks.
The above discussion helps explain why remittances are increasing over time in recent years. Similarly FDI inflow and its impact on economic growth are well-documented. The world financial crisis of 2007 had a substantial effect on different economies of the world, including both developing and developed nations. The need to determine the effect of FDI and remittances on the economic growth in Pakistan is thus apparent given the consequences of the financial crisis. The present study is designed to help answer this question by determining the impact of FDI and remittances on economic growth in Pakistan. The study used the time series data. The findings of the study are used to help formulate policies to channel remittances in productive enterprises.

2. Brief Literature Review

FDI and remittance play a crucial role in building physical capital and their contribution to economic growth is well-documented. This section reviews important prior studies that relate contribution of FDI (Borensztein et al., 1998) and remittance (Buch et al., 2002; Buch et al., 2004; Akçlö & Ucal, 2003) in the economic development of the recipient country. De Mello (1999) also argues that FDI plays a key role in capital accumulation and increasing total factor productivity. Stable political conditions attract FDI and help maximize the benefits of FDI (Alfaro et al. 2000). However, Alfaro et al. (2003) found that FDI had an ambiguous impact on economic growth as FDI in the primary sector had a negative impact, whereas in the manufacturing sector, it had a positive impact on growth. But ambiguous results were found
for the services sector. Johnson (2006) determined the impact of FDI on the economic growth of the host country and results of the study showed that FDI promoted economic growth in developing countries. Koko (2006) investigated the impact of FDI on developing countries and found that FDI resulted in bringing new technology in those countries and it was a channel to approach new and advanced technologies.

Available empirical studies provide evidence that remittances have two opposite effects. Firstly, they increased the income of the unemployed in the home country. Secondly, remittances are able to reduce the financial constraints in the migrant countries thereby increasing investment (Giuliano & Ruiz-Arranz, 2005; Mim & Ali, 2005; Pradhan et al., 2008). However, Chami et al. (2005) argue that remittances have negative impact on economic growth. The reason provided is that the remittances were not used in capital formation. Catrinescu et al. (2006) found that remittance inflows to developing recipient countries show an increasing trend. Contradictory findings were observed in relating remittance to economic growth. The study also revealed that remittances had a long term impact on economic growth when there existed a favorable economic environment and policies.

Remittances are also found to decrease poverty in recipient countries. Adams et al. (2006) showed a decline in poverty because of internal and international remittances in Ghana. However, international remittances had a greater impact on poverty compared to internal remittances. Similarly, Koechlin and Leon (2006) estimated the relationship between remittances and income inequality and found a non-monotonic relation between remittances and income inequality. They also found substantial effects of trade and institutions on economic growth. The study indicated that institutions accelerated economic growth while remittances restricted it. Conversely, Ruiz et al. (2009) showed that remittances have positive impact on economic growth.

Jawaid and Raza (2012) determined the relationship between economic growth and worker remittances in China and Korea and found that there was a negative relationship between remittances and economic growth in the long-run for China, and a positive relationship in the long-run for Korea.

Considering Pakistan, studies also show an important role of FDI in the economic growth (Atique et al., 2000). Khan and Khan (2011) found that FDI has different effects on economic growth in various sectors in Pakistan. Inflow of FDI increased growth in the primary and services sector. Tiwari
(2011) examined the effect of FDI, export receipts and tourism on growth of various countries, including Pakistan, China, India and Russia. Tiwari found that FDI was negatively related with economic growth whereas the effect of tourism was positive on economic growth. Falki (2009) examined the effect of FDI on the growth of Pakistan’s economy. Results indicate a negative and insignificant effect of FDI on the economic growth of Pakistan. FDI was not found contributing enough to promote economic growth in Pakistan, so researchers stressed that the government should devise policies attracting FDI, rather than retarding it. The researchers also suggested to develop and improve infrastructure, human capital and domestic market to attract FDI in the country. Khan and Nawaz (2010) studied the factors affecting FDI in Pakistan, and found volume of exports, GDP growth rate, price index and tariff on imports as the important determinants.

3. Methodology and Sources of Data

The primary objective of the study is to determine the impact of foreign direct investment and remittances on the economic growth of Pakistan. The study used yearly time series data from 1975 to 2012. Data were collected from various sources. They included the Hand Book of Pakistan Economy 2010 published by the State Bank of Pakistan and various issues of the Economic Survey of Pakistan.

The impact of FDI and remittances on economic growth was estimated in both the long-run and short-run using the Engle Granger (1987) Cointegration Technique. Using this technique, the analysis was completed in two steps. In the first step, the authors ran a regression on the level form to obtain the residuals. After this, the stationarity of the residuals was determined using an ADF test. If the residuals were stationary, it indicated that the variables were co-integrated (had a long run or equilibrium relationship among themselves). Co-integrated variables imply that an error correction mechanism is there which can be introduced in the short-run equation.

To estimate the long-run relationship between dependent and independent variables, a multiple regression model was used. This model was based on the work of Rivero (2007) and is given below:

\[
\ln Y_t = \beta_0 + \beta_1 \ln REM_t + \beta_2 \ln FDI_t + \beta_3 \ln AID_t + \beta_4 \ln LBR_t + \beta_5 \ln GFCF_t + \mu_t
\]

Where \( \ln \) is natural logarithm, \( Y_t \) is real value of annual GDP in million dollars, \( REM \) shows the real value of remittances inflows in million dollars, \( FDI \) indicates real value of foreign direct inflows in million dollars,
AID is foreign aid inflows to the country in million dollars, LBR represent total labor force in millions, GFCF shows gross fixed capital formation in millions of dollars, \( t \) is time period in years (1,2,3,……n) and \( \mu_t \) is an error term which is assumed to be independently and identically distributed with zero mean and constant variance.

The functional form was decided by constructing scatter plots between dependent and independent variables. Different functional forms were estimated but the double long model mentioned above suited the data well. All the monetary variables used in the analysis are in real form.

The Granger Theorem states that if two variables, namely X and Y are found to be cointegrated, the relationship between the two variables can be named as error correction mechanism (ECM). If the two variables are cointegrated i.e. long run relationship between them exists. It is possible that variables may be in disequilibrium in the short-run. To determine relationship in the short-run, the ECM was first used by Sargan and Bhargawa (1983) and later on by Engle and Granger. The short-run relation for ECM is given as:

\[
\Delta \ln Y_t = \alpha_o + \alpha_1 \Delta \ln RE Mt + \alpha_2 \Delta \ln FDI_t + \alpha_3 \Delta \ln AID_t + \alpha_4 \Delta \ln LBR_t + \alpha_5 \Delta \ln GFCF_t + \varepsilon_t
\]

(2)

Before estimating relationship in the long-run, we estimated the stationarity of the time series included in the analysis. Most time series data sets are non-stationary (i.e. their mean, variance and covariance vary over time). A time series data set is considered to be stationary if the mean, variance and covariance are constant over time. If the time series is non-stationery, OLS is not applicable because this leads to spurious regression (Granger and Newbold, 1974). The stationarity of the regression was tested using an Augmented Dickey Fuller (ADF) test. The Augmented Dickey Fuller test was applied by estimating following regression equation.

\[
\Delta Y_t = \beta_0 + \beta_1 t + \delta Y_{t-1} + \alpha_i \sum_{i=1}^{m} \Delta Y_{t-i} + \varepsilon_t
\]

(3)

Where \( \Delta Y_t \) is the first difference of a time series and \( \Delta Y_{t-i} \) is its lag value and \( \beta_0, \beta_1, \delta \) and \( \alpha_i \) are parameters to be estimated and \( \varepsilon_t \) is the white noise error term. To determine the cointegration, an Engle-Granger (EG) or augmented Engle-Granger (AEG) test was used, which is similar in nature to that of Dickey-Fuller (ADF) or augmented Dickey-Fuller test. The only
difference is that we compare the estimated value with the critical values provided by the Engle and Granger.

4. Empirical Results

As time series data is employed in the present study, it was necessary to determine the stationarity of the data. The Augmented Dickey Fuller (ADF) test was used for this purpose. The test was applied on all variables at level forms and at first difference. Results in Table 2 showed that the null hypothesis of unit root ($\delta=0$) cannot be rejected for any variable at level form. However, the null hypothesis ($\delta=0$) was rejected for all the variables at first difference at a 5% level of significance. This indicates that the variables are integrated of order 1.

<table>
<thead>
<tr>
<th>Variables on level</th>
<th>ADF-stat</th>
<th>Variables on first difference</th>
<th>ADF-stat</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>GDP</td>
<td>-1.53</td>
<td>$\Delta$GDP</td>
<td>-4.60*</td>
<td>1(1)</td>
</tr>
<tr>
<td>REM</td>
<td>-1.84</td>
<td>$\Delta$REM</td>
<td>-3.34*</td>
<td>1(1)</td>
</tr>
<tr>
<td>FDI</td>
<td>-1.86</td>
<td>$\Delta$FDI</td>
<td>-4.02*</td>
<td>1(1)</td>
</tr>
<tr>
<td>AID</td>
<td>-0.01</td>
<td>$\Delta$AID</td>
<td>-3.34*</td>
<td>1(1)</td>
</tr>
<tr>
<td>LBR</td>
<td>-0.23</td>
<td>$\Delta$LBR</td>
<td>-4.02*</td>
<td>1(1)</td>
</tr>
<tr>
<td>GFCF</td>
<td>-1.79</td>
<td>$\Delta$GFCF</td>
<td>-4.25*</td>
<td>1(1)</td>
</tr>
</tbody>
</table>

*Indicates 5% level of significance

We also used the auto-correlation, partial auto correlation function and Q-statistic to determine the stationarity of variables. Test statistics showed non-stationarity of all variables at level form, but stationary in first difference form.\(^2\) After making all variables stationary using the first difference, relationship in the long-run between them was determined using ordinary least square (OLS). The results are given in Table 3.

\(^2\) Due to space limit, results of these tests are not reported.
Table 3: Long Run Regression Results

<table>
<thead>
<tr>
<th>Variables</th>
<th>OLS estimation</th>
<th>T-statistics</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>3.94</td>
<td>5.79</td>
<td>0.00</td>
</tr>
<tr>
<td>In REM</td>
<td>0.10</td>
<td>4.51</td>
<td>0.00</td>
</tr>
<tr>
<td>In FDI</td>
<td>-0.07</td>
<td>-2.78</td>
<td>0.00</td>
</tr>
<tr>
<td>In AID</td>
<td>-0.02</td>
<td>-0.48</td>
<td>0.63</td>
</tr>
<tr>
<td>In LBR</td>
<td>-0.04</td>
<td>-0.37</td>
<td>0.71</td>
</tr>
<tr>
<td>In GFCF</td>
<td>0.51</td>
<td>6.44</td>
<td>0.00</td>
</tr>
<tr>
<td>F-value</td>
<td>81.63</td>
<td></td>
<td>0.00</td>
</tr>
<tr>
<td>R-square</td>
<td>0.93</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Adjusted R²</td>
<td>0.92</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The value of R² is 0.92, indicating that 92 percent of the total variation in the dependent variable is due to the explanatory variables included in the model. The F statistics is 81.62 and it is significant at a one percent. So we rejected the null hypothesis that all regression coefficients were simultaneously zero. The significance of the individual regression coefficients was tested by the usual t-test.

The estimated coefficient of remittances is found positive and statistically different from zero at a one percent level of significance. It implied that a one percent increase in remittances results in a 0.10 percent increase in the economic growth rate of Pakistan in the long-run. Giuliano et al. (2005) and Fayissa and Nsiah (2005) also found the same results.

The coefficient of foreign direct investment is statistically significant and negative with a value of 0.07. Many studies conducted in Pakistan also indicated a negative effect of FDI on economic growth (Tiwari, 2011; Khan, 2007; Atique et al., 2004; Agrawal, 2000; Falki, 2009). Studies conducted outside Pakistan also confirm our results (Adams, 2009; De Mello, 1999). The reason for the negative impact of FDI is that FDI contributes positively to the economic growth of a host country provided that it has a stable financial system (Alfaro et al., 2004). However, the financial system in Pakistan is neither diverse nor efficient (Khan, 2007). An educated labor force is also an
Role of Foreign Direct Investment and Remittances in the Economic Growth of Pakistan

important factor, allowing the country to benefit from FDI spillovers (Borensztein et al. 1998; De Gregorio, 1992), whereas most of the labor force of Pakistan is illiterate, incompetent and unskilled (Khan, 2007; Khalid et al. 2012). According to De Gregorio (1992) and Alfaro et al (2004) FDI contributes positively to economic growth under certain suitable local conditions (i.e. political and macro-economic stability, physical and human capital). Unfortunately these conditions are not present in Pakistan. The law and order situation in the country is discouraging to foreign investors. Furthermore, FDI improves economic growth in the rich host country (Blomstrom et al. 1994), whereas Pakistan is not a rich country.

The estimated coefficient of aid (Ln AIDt) is -0.019. Although the coefficient is negative but it is non-significant. Guillaumont and Chauvet (1999) argue that external and climatic environment is critical for aid effectiveness. Svensson (1999) concludes that aid has a positive impact in countries where institution supremacy is intact and the institution keeps check on the performance of the government, which is not the case with Pakistan.

The estimated co-efficient of gross fixed capital formation (Ln GFCFt) is 0.508 and it is positive and statistically different from zero. The value of the coefficient implies that a one percent increase in GFCF results in a 0.5088 percent increase in economic growth. Bouoiyour and Saloua (2002) and Tiwari (2010) also find a positive impact of physical capital, including GFCF, and the government’s final consumption spending on economic growth.

The estimated coefficient of labor (Ln LBRt) is -0.045. This coefficient is found to be negative but non-significant. It implies that in long-run, the labor force does not play any role in the economic growth of Pakistan. This is so because the labor in Pakistan is abundant and mostly illiterate and unskilled.

To determine the degree of cointegration between the dependent and independent variables, the augmented Engle and Granger (1987) test was applied and its result is given in Table 4. The estimated value of the tests statistic is -3.9396 and is statistically different from zero at a one percent level of significance. Therefore, the null hypothesis of unit root is rejected leading to accept the alternate hypothesis i.e. stationarity of the series. Hence, the variables are cointegrated with each other and there exists a long-run relation among them.
Table 4: Augmented Engle-Granger (AEG) Test Results for Residuals

<table>
<thead>
<tr>
<th>Series</th>
<th>AEG test-stat</th>
<th>Test critical values</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>1%</td>
</tr>
<tr>
<td>Res (saves residuals)</td>
<td>-3.94</td>
<td>-3.63</td>
</tr>
</tbody>
</table>

4.1 Results of the Short-Run Analysis

After confirming the long-run relationship among variables, we estimated the short run model and the results of the ECM are given in Table 5. The short-run results indicate that labor and Gross Fixed Capital Formation variables have a positive and statistically significant impact on economic growth, while remittances and aid have no effect on economic growth. The FDI variable has a negative impact on economic growth and its coefficient is statistically significant. The lagged residuals from the first equation were used as an error correction variable in this model. The coefficient of the ECM ($\mu_{t-1}$) term has a negative sign according to our expectation and it is statistically significant. The ECM coefficient indicates that the adjustment process is very fast. It implies that 70 percent of disequilibrium that existed in the variables in the model in the previous time period is adjusted in the present time period.

Table 5: Short Run Regression Result (ECM)

<table>
<thead>
<tr>
<th>Variables</th>
<th>Coefficients</th>
<th>Standard error</th>
<th>t-stat</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>-0.03</td>
<td>0.01</td>
<td>-2.68</td>
<td>0.01</td>
</tr>
<tr>
<td>Rem</td>
<td>0.02</td>
<td>0.04</td>
<td>0.49</td>
<td>0.62</td>
</tr>
<tr>
<td>FDI</td>
<td>-0.05</td>
<td>0.02</td>
<td>-2.30</td>
<td>0.03</td>
</tr>
<tr>
<td>Aid</td>
<td>-0.02</td>
<td>0.03</td>
<td>-0.59</td>
<td>0.56</td>
</tr>
<tr>
<td>Lbr</td>
<td>0.99</td>
<td>0.08</td>
<td>11.80</td>
<td>0.00</td>
</tr>
<tr>
<td>GFCF</td>
<td>0.59</td>
<td>0.07</td>
<td>8.45</td>
<td>0.00</td>
</tr>
<tr>
<td>ECM</td>
<td>-0.69</td>
<td>0.21</td>
<td>-3.35</td>
<td>0.00</td>
</tr>
</tbody>
</table>

5. Conclusion

Cointegration results reveal that there exists a long-run relationship between the dependent and independent variables. The results indicate that there is a positive relationship between remittances and economic growth in
the long-run. The results also provide evidence of a positive long-run relationship between GFCF and economic growth. However, the analysis shows a negative long-term relationship between FDI and economic growth. The literature suggests that the host country should fulfill certain pre-requisites and conditions (e.g. financial development, macroeconomic and political stability, better law and order situation, educated and skilled labor force and supportive infrastructure) for FDI to be positively related with the economic growth. According to Asiedu (2006), macroeconomic and political instability, and corruption are hurdles in investment and have negative impact on FDI. Hence, for FDI to have significant and positive effect on economic growth, Pakistan has to focus on political stability, law and order, macroeconomic stability, and supportive infrastructure, among others. The results show that remittances are found positively contributing to economic growth. Remittances are an important source of transfer of resources from the developed nations to the developing countries. There exists a positive correlation between capital flows and remittances but remittances are less volatile then the capital flows (Buch et al., 2002). Greater effects should be made by the Government of Pakistan to facilitate this capital flow. Efforts should also be made to redirect remittances from informal to formal channels. Incentives must be provided so that these remittances can be converted into productive investments. Gross Fixed Capital Formation also has a long-run positive effect on the economic growth so effort is required to encourage GFCF.

Results of the Error Correction Model show rapid speed of convergence towards equilibrium if disequilibrium shock appears. The short-run effect of remittances on economic growth is non-significant. While FDI, GFCF and the size of the labor force all have a significant impact on economic growth in the short-run, foreign aid does not cause economic growth even in the short-run.
References


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Single Stock Futures Trading and its Impact on Feedback Trading and Volatility: A Case Study of Pakistan

Imran Riaz Malik, Attaullah Shah and Safiullah Khan

Abstract

In this paper, we examine the possibility of an impact of the resumption of trading in Single Stock Futures (SSFs) on the dynamics (positive feedback trading and price volatility) of the underlying stocks in Pakistan’s market. Specifically, we test the hypothesis that trading in SSFs promotes or inhibits positive feedback trading in the spot market. Analyzing SSFs has several advantages over investigation of index futures. First, any impact of futures is more likely to be evident in the behavior of SSFs than index futures. Second, with SSFs it is possible to trade directly in the underlying stocks, and the endogeneity issue can be taken care of by using a relatively weighted portfolio of non-SSFs stocks. The findings of our study suggest that there is a statistically insignificant presence of positive feedback trading in both pre-SSFs period to post-SSFs period for both SSFs-listed stocks and a matching group of non-SSFs stocks. Furthermore, the unconditional volatility has significantly changed in both SSFs and non-SSFs, while asymmetry coefficient is statistically insignificant for SSFs but significant for non-SSFs. Overall our findings suggest that resumption of SSFs neither promotes nor inhibits feedback trading in the underlying spot market in Pakistan.

Keywords: Feedback Trading, SSFs, GJR-GARCH, GED

JEL Classification: G1, G13, G14, G17

1. Introduction

Asset prices reflect information held by two types of active traders in the market. One type is the well informed trader, who trades on relevant information. Another type is the uniformed trader, who trades on price variability itself misinterpreting randomness and assuming it to be information (Black, 1986). According to the academic literature, there are two types of speculators: rational speculators and noise traders. The standard view (Friedman 1952) views rational speculators as trading on fundamentals, which

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in turn will stabilize the market and reduce excessive short term price fluctuation. As long as trading in futures attracts rational speculators, then, the introduction of future markets should move prices closer to their fundamental value and thus stabilize asset prices. On the other hand, noise trading is an essential part of the market, in the sense that it provides the market with necessary liquidity. On the other hand, it also increases the volatility of the underlying market. Consequently, the informed trader may hesitate to take a position, which might be required to exploit arbitrage opportunities. The argument that asset prices are significantly affected by noise trading is achieving wide acceptance in the literature (Thaler, 1999). Shiller (1989), for example, has observed that asset price volatility cannot be explained solely by dividends and earnings. Similarly, De long et. al. (1990a) shows that the unpredictability of noise traders’ philosophy can increase the risk in asset prices which, simultaneously, will deter the participation of rational arbitrageurs. In these cases risk-averse arbitrageurs will not take positions to exploit available arbitrage opportunities leading asset prices to move away from their fundamental values, even in the absence of fundamental risk. This allows noise traders to earn higher than expected rates of return by bearing disproportionate amounts of risk.

Positive and negative feedback trading strategies refer to different types of destabilizing noise trading. In positive (negative) feedback trading, an investor buys when asset prices move up (down) and sells (buys) when prices moves down (up). Such strategies are consistent with technical analysis, stop loss orders, portfolio insurance, and extrapolative expectations. When the market is dominated by the positive feedback traders it is optimal for rational speculators to follow the trend. Moreover, such purchases by rational speculators encourage feedback traders and enhance their influence to move the asset prices further away from their fundamental values, in the short run. Feedback trading is then influential for the short run behavior of asset prices even when asset prices revert to fundamental values in the long run (Delong et. al., 1990b). Cutler et. al. (1990) argue that the implied presence of serial correlation in an asset should be incorporated into models that attempt to gauge the influence of feedback traders. Sentana and Wadhwani (1992) proposed a model that extends the logic of Cutler et. al. (1990) to check the relationship between volatility and serial correlation. Their empirical results depict stock returns that show positive serial autocorrelation when volatility is low and negative autocorrelation when the volatility is high. Using Dow Jones index returns from 1885 to 1988, they show results consistent with the notion
that feedback trading strategies exist in practice. These findings are robust across different periods and measures of volatility.

Another string of studies develop a relationship between trading in derivatives and volatility in the underlying market. Extensive research is now consistent that trading in derivatives encourages speculation which, in turn, destabilizes the spot market (measured by greater spot market volatility). For example, Kuprianov (1995) studies the highly publicized and costliest cases of derivative related losses and argues that derivative trading poses a serious threat to the international financial system. Yet, in spite of the extensive empirical literature, the influence of derivatives and their impact on the underlying market has not been sufficiently conceptualized, since changes in volatility could be attributed to (de)stabilizing speculation or fluctuations in the information flow. Kawaller, Koch and Koch (1987) have examined the intraday temporal price relationship between S&P 500 futures and S&P 500 index. Their work provides evidence that futures prices consistently lead the index movements by twenty to forty five minutes whereas the index seldom affects the futures price for over one minute. Similarly, Stoll and Whaley (1990) find that S&P 500 and MM index futures lead stock index returns by five minutes to ten minutes, with an average lead of five minutes. A mild positive predictive impact was also noticed. Although the lead-lag relationship does depict the ability of futures to process information faster than underlying spot markets, this should not be interpreted as destabilizing.

The impact of trading in futures markets on spot market volatility is not fully captured by existing theoretical models. For example, an argument could be made in favor of derivative trading in general, and futures trading in particular, that they bring more investors to the spot market and thus increase market liquidity. This increase in liquidity may result in a decrease in spot market volatility. Cox (1976) found empirical results consistent with an increased information flow to the spot market coming from futures trading activity. In this regard Ross (1989) shows that in an arbitrage free economy, volatility in the market is directly related to the speed of information flow to the market. Here, trading in futures is viewed as increasing the information flow to the spot market which, as a result, increases the volatility of the spot market. There is thus a benefit and cost relationship between market efficiency and volatility in the spot market upon the introduction of derivative trading. With an increase in market efficiency, volatility will also increase and vice versa. For most financial economists an increase in informational efficiency at a cost of a simultaneous increase in volatility is a positive
development, unless the information content is noise as defined by Black (1986). However, as a result, futures markets will tend to attract noise traders, in particular. In such a case destabilization becomes highly probable, because trading in futures markets is relatively economical, with lower margin requirements and lower costs. Critics of the futures markets appear to argue that such markets will attract noise traders in general and positive feedback traders, in particular, which will increase the volatility of the futures markets. Subsequently, arbitrage mechanism transmits this volatility to the spot market.

Thus far there has been little work examining whether feedback traders migrate from spot market to futures market. Such a study would be of interest to domestic and international investors who rely on futures markets to arbitrage, hedge and speculate. By examining the extent and nature of serial correlation and the change in volatility from the pre to post futures period, a more reliable conclusion could be drawn. It should also better inform the debate regarding policy and regulation of futures markets; the rules regarding margin requirements, market halts, and taxes on transactions can be better analyzed if the role and significance of the futures markets is well understood.

Antoniou et al. (2005) use data from six industrialized nations to investigate the influence of futures in inhibiting or promoting feedback trading in spot markets. To do so they adopt the model of Sentana and Wadhwani (1992), which considers the consequences of futures markets for the promotion or inhibition of positive feedback trading and volatility. Antoniou et al. (2005) find that future markets helped to stabilize the spot market by reducing the influence of feedback traders. This, in turn implies futures markets attracted more rational investors who increased market efficiency. Mackenzie et al (2001) states that studies of impact of index futures are helpful in identifying market wide dynamics. In doing so, the index effect on individual stocks could not be identified, as the effect would be dissipated across the many constituent stocks of the index. Moreover, the index itself is not directly traded unlike individual stocks. Therefore the effect of futures on positive feedback trading and volatility should be more obvious in relation to individual stocks. Indeed, the fear that Single Stock Futures (SSFs) might have a serious effect on the dynamics of underlying stocks has resulted in the imposition of more rigid constraints on SSFs than index futures.

One way to evaluate the impact of derivatives is to first identify their users and their intentions upon entering derivative trading. Hedgers, arbitragers and speculators are the three broad categories of users of
derivatives in the OTC (Over the Counter) or exchange traded markets. Hedgers are firms or individuals who trade futures for the purpose of establishing a known price (locking in the price) in advance. In this way they protect themselves against unfavorable price changes during the interim. Arbitragers are ad hoc organizations or professionals, who simultaneously purchase and sell to profit from price differentials, in underlying or different financial markets. Speculators are firms or individuals who, on the basis of technical and/or fundamental analysis, take uncovered positions with large risk, in the hope of making short term profits. Instead of using the market to produce, process, and handle, they buy and sell on the basis of price predictions. Speculators’ activities create bubbles, but also provide necessary liquidity to the market.

Since futures encourage speculative activity, an important policy concern has been whether the futures market’s inherent ability to attract speculators will destabilize the spot market. This debate has intensified in Pakistan following the market crash in 2005 where futures markets were blamed for the hyper volatility that persisted in the market because of their ability to attract noise traders. To assess this case, it is necessary to study the futures market’s ability to inhibit or promote positive feedback trading, volatility, liquidity and market efficiency in the spot market and to identify any causal link among the futures market and underlying spot market.

Although considerable empirical analysis has been done on the issue of whether trading in futures stabilizes or destabilizes the underlying spot market, the results do not permit a solid conclusion because researchers differ in their view of how speculators impact asset prices. Cox (1976), on the other hand, argues that since future markets are relatively cheap, have low margin requirements and minimal transaction costs, the introduction of these markets will increase the total number of active traders and, in itself, provide additional information flow to the market. Ross (1989) establishes that this increased information flow will eventually result in an increase in price volatility as prices respond to the greater diversity in the flow of information. Hence, potential destabilization comes from increased volatility which also comes with greater informational efficiency.

The academic literature accepts that speculation based upon noise trading may destabilize the market. The critics of derivatives markets in particular argue that because of the low cost of transactions, the derivative markets will attract risk seeking noise traders, which lead prices away from
fundamental values and destabilize underlying markets. Positive feedback trading is one destabilizing form of noise trading.

Futures were introduced to the KSE (Karachi Stock Exchange), the most heavily traded local bourse in Pakistan, on 1st July 2001. Initially, one month SSFs were launched with trade accounting for only a small fraction of overall spot market volume and value. By late 2004 and the early part of 2005, SSFs trading activity had increased dramatically and, for a short span of time, had grown to almost 40% of spot market volume. However weak infrastructure and risk management measures meant that the market could not sustain their ever increasing leveraged position in the stock market (leading to the stock market crash in the 2005). After the stock market crisis, several new risk management measures were taken to reduce inherent risk and with these reformed features trading in 18 new stocks was resumed on July 27 2009. While still under transition, there has now accumulated enough experience to begin an assessment this new trading environment.

This study contributes to the literature by examining a recent financial hypothesis in relation to an emerging economy (for which theory has yet to be developed). In addition, the study is done for a market that has received little attention from researchers. Hence this study tackles an under-explored area of research from the perspective of an emerging economy. The specific objective is to assess whether SSFs inhibit and/or promote positive feedback trading in the spot markets of Pakistan. If feedback is positive and noise traders use derivative markets to leverage their trading strategies, an increase in positive feedback trading following the resumption of derivatives would be evident. If the increase in volatility arises because of feedback trading, such a finding would affirm the claim that trading in derivatives destabilizes the market. On the other hand, if derivative markets attract rational speculators who then use trading strategies to bring the prices close to fundamental values, then a reduction in positive feedback trading would be expected following the resumption of derivative markets. Sentana and Wadhwani (1992) provide evidence that serial correlation is inversely related to the volatility in US spot market data and interpret this as consistent with the notion that traders in the market follow feedback trading strategies. This is analogous to the evidence that the autocorrelation of futures’ returns is indirectly related to the different levels of volatility.

The rest of the paper is organized as follows: Section 2 summarizes the brief literature on the impact of future trading, elaborates the main
characteristics of the feedback trading model, and constructs the hypothesis to be tested. Section 3 discusses the data and methodology. Results are discussed in Section 4, and Section 5 concludes the study.

2. Feedback Trading

Concern with the impact of futures trading on the dynamics of the underlying spot market predates their introduction (Chau et. al., 2008). This extensive literature illustrates researchers’ interest in the theoretical reasons for the way financial futures can influence spot markets and has only intensified since their introduction in 1982. For our purposes, writers such as Shiller (1984, 1990) and Cutler et. al. (1990) all associate the presence of positive feedback trading with positive serial autocorrelation. The assumption underlying this argument is that an average investor follows a positive feedback trading strategy for investment purposes. Still, the presence of low and insignificant autocorrelations in asset returns indicates that positive feedback trading models might not replace conventional martingale price models soon. Shrieller (1989) does argue that positive feedback trading can translate into negligible or even negative serial autocorrelation and, indeed, recent research show that patterns of serial autocorrelation in asset returns are more cumbersome that previously believed. For example, Lebaron (1992) explores the relationship between serial correlation and volatility for different stock return series for daily and weekly frequencies. He finds serially correlation changing over time with an inverse relationship with volatility at short horizon. In other words, first order autocorrelation of asset price changes is high during periods of tranquility and low during high market volatility. Campbell et. al. (1993) use U.S. stock returns to show that first order autocorrelation and traded volumes are inversely related with first order autocorrelation low on high volume days and high on low volume days. On occasion first order correlation has turned negative on high volume days.

By investigating the role of futures trading in promoting/inhibiting feedback trading, it is possible to determine whether changes in spot market dynamics are due to destabilizing speculation or improved information flow. While a number of studies have been done to determine the influence of future trading on the spot market, most of them have used index futures or single stock options. To date SSFs have received very little attention in the literature. Among the studies which have investigated the influence of future trading on volatility and market efficiency, only a couple of studies have examined the impact on feedback trading. Antoniou, Koutmous and Pericli (2005) using the
similar methodology found that introduction of future markets help in stabilizing the underlying market, in the sense that they reduce the impact of feedback traders, and make the market efficient by attracting rational traders. Furthermore, Chau, Holmes and Pudyal (2008) depict limited presence of feedback traders in USF (Universal Stock futures) on London International Financial Futures and Options Exchange (LIFFE). Their analysis suggests that the introduction of USF has reduced it even further.

2.1 The Heterogeneous Trading Model

Sentana and Wadhwani (1992) propose a model that assumes two types of investors who demand shares in the stock market--expected utility maximizers (Smart Money investors) and positive feedback traders. Expected utility maximizers base their investment decisions rationally upon expected returns subject to wealth constraint while positive feedback traders base their decisions on previous price changes and ignore fundamental values. The share of the market demand for stocks generated by feedback traders could be expressed as follows:

\[ F_t = \gamma R_{t-1} \]  

Where, \( F_t \) denotes the demand by feedback traders and \( R_{t-1} = \frac{P_{t-1}}{P_{t-2}} \) where \( P_{t-1} \) is the stock price in period t-1. The sign of \( \gamma \) discriminates between the two types of feedback traders. First, \( \gamma > 0 \) expresses the case of positive feedback traders, who buy when the price of a stock rises and sell when the price of a stock declines. Second, \( \gamma < 0 \) denotes the case of negative feedback traders, who sell after a price rise and buy after a price declines. Delong et. al. (1990b) points out that positive feedback trading in coordination with rational speculators will drag the prices away from their fundamental values. So, feedback traders of either type are held responsible for moving the prices away from what it needs to be. Eventually, if evidence is provided consistent with futures inhibiting/promoting the feedback trading, then regulations regarding futures need to be reviewed.

On the other hand, the share of the market demand for stocks generated by expected utility maximizers could be expressed as follows:

\[ S_t = \frac{(E_{t-1} R_t - \alpha)}{\mu \sigma_t^2} \]  

Where \( E_{t-1} \) is the expectation operator on use of available information at time t-1, \( \alpha \) is risk-free return, and \( \mu \sigma_t^2 \) is risk premium. \( \mu \sigma_t^2 \) is positive
function of \( \mu \) co-efficient of risk aversion and \( \sigma_t^2 \) is the conditional variance of stock price. If these two types of traders constitute the whole market, then market equilibrium will be achieved, if and only if all the stocks are held by these two types of traders, as follows:

\[
F_t + S_t = 1
\]  

(3)

Incorporating Equation 1 and 2 in 3, and if we assume rational expectation, then we get the following equation:

\[
R_t = \alpha + \mu \sigma_t^2 - \gamma \mu \sigma_t^2 R_{t-1} + \varepsilon_t
\]  

(4)

Where \( \varepsilon_t \) is an innovation with zero mean, and rest of the terms are as defined above.

The presence of the lagged return \( R_{t-1} \) in Equation 4 means that stock returns will exhibit autocorrelation. The sign of \( \gamma \) (i.e. pattern of autocorrelation) points to the type of feedback trader present in the market. Positive feedback trading (\( \gamma > 0 \)) imply negative autocorrelation in returns, and negative feedback trading (\( \gamma < 0 \)) results in positive autocorrelation. Moreover, the level to which the underlying stock returns depict autocorrelation also fluctuates with volatility i.e. \( \mu \sigma_t^2 \). Finally, autocorrelation can also be the result of other factors besides feedback trading. To accommodate such factors as market frictions and inefficiencies, the empirical version of Equation 4 could be modified as follows:

\[
R_{it} = \alpha + \mu \sigma_t^2 + (\varphi_0 + \varphi_1 \sigma_t^2) R_{it-1} + \varepsilon_t; \ \varepsilon_t \sim N, t, or \ GED(0, \sigma_t^2)
\]  

(5)

where the \( R_{it} \) denotes the return to the underlying stock on day \( t \). The innovation \( \varepsilon_t \) is assumed to follow a normal, student’s t, or generalized error distribution (GED, to account for any non-normality present in the stock returns data) with zero mean and conditional variance \( \sigma_t^2 \). The coefficient \( \varphi_0 \) measures the autocorrelation introduced by other market frictions and inefficiencies and the coefficient \( \varphi_1 = -\gamma \mu \) captures autocorrelation arising as a result of persistent positive or negative feedback trading in the market. A negative \( \varphi_1 \) again implies the presence of positive feedback trading and a positive \( \varphi_1 \) is translated as being due to the persistence of negative feedback traders.

The model is completed by using a GARCH specification for conditional variance in Equation 5. The GARCH specification is expressed as GJR-GARCH (1, 1) and the analysis is done using the following equation
\[
\sigma_t^2 = \alpha_0 + \alpha_1 \varepsilon_{t-1}^2 + \beta \sigma_{t-1}^2 + \delta X_{t-1} \varepsilon_{t-1}^2
\]  
(6)

Where \(\sigma_t^2\) is the conditional variance at time \(t\), \(\varepsilon_{t-1}\) is an error term at time \(t-1\), and \(X_{t-1}\) is a dummy variable which takes a value of one for bad news (\(\varepsilon_{t-1} < 0\)), and zero for good news (\(\varepsilon_{t-1} \geq 0\)). \(\alpha_0\) indicates unconditional volatility, \(\alpha_1\) represents the impact of the most recent innovation—often called the news coefficient (\(\alpha_1\) is the impact of good news, and \(\alpha_1 + \delta\) the impact of bad news)—and \(\beta\) measures the persistence of conditional variance. A positive and statistically significant \(\delta\) indicates that a negative shock (i.e. bad news) has more influence on the future conditional volatility than a positive shock (i.e. good news) of the same magnitude. It confirms the presence of the leverage effect.

2.2 Hypothesis Development and Testing Method

To analyze whether the existence of a futures market has an effect on feedback trading, this study uses a model that links directly autocorrelation and volatility. Specifically, this study looks at the first and second moments of stock returns to answer the following questions: does the resumption of SSFs promote or inhibit positive feedback trading in the spot market and has the resumption of SSFs increased volatility?

The model expressed in Equation 5 and 6 is estimated for data pre-futures and post-futures separately. This permits a direct comparison of the pre and post scenario on the basis of their estimated coefficients. For the mean value equation, the following null hypotheses are tested:

\[
H_{01}: \text{Pre} \bar{\varphi}_0 = \text{Post} \bar{\varphi}_0
\]
\[
H_{02}: \text{Pre} \bar{\varphi}_1 = \text{Post} \bar{\varphi}_1
\]

For the conditional variance equation, the following null hypotheses are tested:

\[
H_{03}: \text{Pre} \bar{\alpha}_0 = \text{Post} \bar{\alpha}_0
\]
\[
H_{04}: \text{Pre} \bar{\alpha}_1 = \text{Post} \bar{\alpha}_1
\]
\[
H_{05}: \text{Pre} \bar{\beta} = \text{Post} \bar{\beta}
\]
\[
H_{06}: \text{Pre} \bar{\delta} = \text{Post} \bar{\delta}
\]

Formally the analysis tests the hypothesis that there is no difference in the coefficients (feedback trading, \(\varphi_1\), autocorrelation, \(\varphi_0\), and coefficients describing the conditional volatility, \(\alpha_0\), \(\alpha_1\), \(\delta\) and \(\beta\)) across the two periods.
The resumption of SSFs will have had no effect. On the other hand, if the resumption of futures does improve the information flow to the spot market and subsequent improvement in informational efficiency decreases the impact of noise traders, then the entire set of null hypotheses will be rejected. In such a situation, we would expect a reduction in $\phi_0, \phi_1, \delta$, and increase in $\alpha_1$. Alternatively, if the resumption of futures promotes feedback trading and conditional volatility, the opposite will be expected. Finally, $\alpha_0$ expresses the unconditional volatility. Here a significant change in $\alpha_0$ indicates structural change in the unconditional volatility of the underlying stocks due to resumption of SSFs. The remainder of the study examines the differences in findings for SSFs written on underlying stocks listed in different industries.

3. **Data and Methodology**

Two approaches have been used in the literature to study the impact of futures on dynamics of the underlying stock market. First approach, introduced by Harris (1989), compares the pre to post dynamics of the underlying stock. Second approach, used by Faff, Mckenzie and Brailsford (2002), compares the cross-sectional analysis of the dynamics between SSFs and relatively matched non-SSFs. Both the approaches have their own built-in advantages. Robustness and difference in cross-sectional determinants are the highlights of the aforementioned approach. The second approach is given significant importance in the recent literature.

Trading in one month SSF contracts was introduced in Pakistan in July 2001 with ten stocks meeting the stringent criteria for listing on the KSE. With the passage of time, the number of SSFs grew to a total of 46 by February 2008. In reaction to market turmoil arising in the global economic crisis, trading in SSFs was discontinued. However, on July 27, 2009 with an improved risk management mechanism, trading in 18$^2$ stocks resumed. The contract specifications are presented in annexure-I. The features of newer SSFs depict that more cash margin will be required now than before, which will make trading in derivatives more interesting. Contrary to the old future contracts introduced in July’ 2001, the newer ones have few differences. Previously, bank/ cash guarantee was 50 percent cash. Now, with newer SSFs,

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2 The SSFs stocks are Adamjee Insurance (Insurance Companies), Azgard Nine (Textile Composite), Bank Al-Falah (Commercial Banks), DG Khan Cement (Cement), Engro Chemical (Fertilizer), Fauji Fertilizer (BQ) (Fertilizer), Fauji Fertilizer Co (Fertilizer) HUBCO (Power Generation and Distribution), Lucky Cement (Cement), MCB (Commercial Bank), NBP (Commercial Banks), Nishat Mills (Textile Composite), OGDC (Oil & Gas), PPL (Oil & Gas), PSO (Oil & Gas), PTCL (Technology & Communication), POL (Oil & Gas), and UBL (Commercial Banks).
the cash/bank margin is 100 percent. Second, instead of distributing mark to market profit, the exchange will retain all the profit. Third, concentration margin takes will be applied instead of special margin. To be listed each had to meet the stringent criterion set by the Securities and Exchange Commission of Pakistan (SECP) and the KSE to govern the selection of the stocks. The sample period used for this study then spans the re-launching date of the SSFs. Six months’ daily closing prices of the stocks on each side of the event date are used to analyze the possible movement of positive feedback traders from spot to futures markets. The data is obtained from the online database of Business Recorder, the premier financial newspaper in Pakistan.

Factors other than the resumption of SSFs may also have affected the underlying dynamics of the spot market. For example, market or industry wide changes around the time of resumption of SSFs may have had a significant impact on the market as well. To ensure that such market or industry wide changes that alter the dynamics of the market may not erroneously be attributed to the resumption of futures trading, it is important to implement a control system to take care of these possible sources of biasness. Thus, in this study, the empirical models are also estimated for a sample of stocks on which SSFs were not written. A relatively matched non-SSFs sample is thus selected for cross-sectional comparison between contracts with and without SSFs written on them. The parameters used for the selection of non-SSFs sample are market capitalization and trading volume in respective sectors as used by Khan Shah and Abbas (2011).

4. Empirical Results

To answer the major research question related to the impact of trading in SSFs on the dynamics of the underlying stock markets, Equations 5 and 6 are estimated for the pre and post future market periods in the sample for the 18 SSFs and 16 non-SSFs.

Summary statistics for SSFs and non-SSFS is presented in Table 1 and 2. These tables depict the mean (μ), standard deviation (σ), Skewness (S), Kurtosis (K), Jarque Berra test of normality (JB), unit root test for stationarity (U), and ARCH test for 10 lags. Mixed trend regarding departures from

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3 The non-SSFs stocks are ABL (Commercial Banks), ACBL (Commercial Banks), APL (Oil & Gas), ARL (Oil & Gas), BAHL (Commercial Banks), DHC (Fertilizer), EFU (Insurance), FCCL (Cement), HBL (Commercial Banks), KAPC (Power Generation and Distribution), KTM (Textile Composite), MGCL (Oil & Gas), MLCF (Cement), NCL (Textile Composite), NRL (Oil & Gas), and TELE (Technology & Communication).
normality and an ARCH effect is evident from both pre and post datasets of SSFs and non-SSFs. Further analysis is required to find out the interrelationship between the autocorrelation and volatility.

Maximum likelihood estimates for both pre and post periods of SSFs and non-SSFs are computed through empirical version of the feedback trading model and are presented in the Tables 3 and 4. The model allows for asymmetric response of volatility to news. The results are summarized for 8 key coefficients \((\alpha, \mu, \varphi_0, \varphi_1, \alpha_0, \alpha_1, \beta, \text{and } \delta)\) in the feedback trading model which constitute Equation 5 and 6.

For pre futures periods of SSFs, the feedback trading coefficient \(\varphi_1\) is negative (Positive feedback trading) for AJI, AN, DGKC, FFC, MCB. For the other 13 stocks, \(\varphi_1\) is positive (negative feedback trading). It means that 28% of the portfolio stocks show signs of positive feedback trading while the remaining 72% depict signs of negative feedback trading before the resumption of SSFs. For the post futures period of SSFs 50% of the stocks (9 stocks) show positive feedback trading and 50% depict negative feedback trading. Similarly, for pre future period of non-SSFs, APL, DHC, EFU, KAPC and TELE show signs of positive feedback trading. APL is significant at 1% and EFU at 5%, rest are insignificant. ABL, ACBL, ARL, BAHL, FCCL, HBL, KTM, MGCL, MLCF, NCL and NRL possess positive \(\varphi_1\), among which only MLCF is significant at 1%. For post-future period of non-SSFs, stocks ABL, ACBL, APL, BAHL, EFU, FCCL, HBL, KAPC, NCL, and TELE depict signs of positive feedback trading. Only FCCL is significant at 1% level of significance. Negative feedback trading is depicted by ARL, DHC, KTM, MGCL, MLCF and NRL. ARL and MGCL are significant at 1%. Evidently, 31% of the non-SSFs portfolio of stocks used in this study showed signs of positive feedback trading and 69% depict negative feedback trading in the pre future period. For the post future period, the proportions reversed with the percentage of positive and negative feedback trading now 63% to 37%.

For the whole sample, Tables 5 and 6 report the non-parametric Kruskal-Wallis test investigating whether the coefficients in pre futures period are significantly different from post future period. As Table 5 indicates, of all the 8 coefficients \((\alpha, \mu, \varphi_0, \varphi_1, \alpha_0, \alpha_1, \beta, \text{and } \delta)\) in the AR (1)-GJR-GARCH only the coefficient for unconditional variance \(\alpha_0\) is statistically significantly different in the post future period at the 1% level of significance for SSFs. All other coefficients show insignificant difference. This gives prima facie
evidence that SSFs trading may not have influenced underlying spot market dynamics. If there is an increase in informational efficiency and decrease in feedback trading due to resumption of derivative trading, then we may expect an increase in $\alpha_1$, decrease in $\beta$ and $\delta$, and increase (decrease) in the value of $\phi_1$ when $\phi_1$ is negative (positive). In SSFs, the stock with increasing $\alpha_1$ and simultaneous decreasing $\beta$ are in pre to post scenario are: AN, BAF, EC, HUBCO, NBP, NML, and POL. The SSFs with decreasing $\alpha_1$ and increasing $\beta$ are: FFBQ, FFC, MCB, OGDC, PSO and PTCL. The SSFs with simultaneously decreasing $\alpha_1$ and $\beta$ are: LUCK, PPL, and UBL. And, SSFs with simultaneously increasing $\alpha_1$ and $\beta$ are: AJI and DGKC. In NonSSFs, the stock with increasing $\alpha_1$ and simultaneous decreasing $\beta$ are in pre to post scenario are: DHC, MGCL, MLCF, and TELE. The NonSSFs with decreasing $\alpha_1$ and increasing $\beta$ are: ABL, ACBL and APL. The SSFs with simultaneously decreasing $\alpha_1$ and $\beta$ are: ARL, BAHL, FCCL, HBL, KAPC, KTM, NCL, and NRL. And, SSFs with simultaneously increasing $\alpha_1$ and $\beta$ is: EFU. Since the results are not consistent with this pattern, we cannot say that resumption of feedback trading has impacted (promotion of positive feedback traders) the underlying spot market. The influence of SSFs on stock market volatility can be analyzed by comparing the $\alpha_0$ coefficient pre and post future period for both SSFs and non-SSFs. For non-SSFs the coefficients for unconditional volatility $\alpha_0$ and asymmetric response $\delta$ to news are significantly different from pre to post future periods. However, it is to be noted that a similar trend is evident in the non-SSFs portfolio.

5. Conclusion

This study examines the influence of the resumption of futures trading on the dynamics of the underlying spot markets. The study uses a model that incorporates volatility as well as allowing for changes in the degree to which the future trading inhibits or promotes feedback trading. By investigating the behavior of the underlying stock on which SSFs are traded, it is possible to gain insight that was previously not possible. For example, because the SSFs include a number of stocks from different sectors with different characteristics, it is possible to isolate sector specific effects. This sector variability allows the analysis to address the concern over role of SSFs in relation to less liquid sectors. More basically, we would expect that if futures markets do affect their underlying spot markets, such effects would be more evident in the behavior of tradable individual stocks, rather than in the dynamics of a market index that cannot be traded directly. Finally, in addition
to the specific nature of SSFs, endogeneity can also be addressed meaningfully by developing a control sample of non-SSFs.

The results provide meaningful and more reliable insight into the effect of futures trading on the underlying spot market. The findings suggest that the presence of positive feedback trading in both the pre and post period for SSFs and non-SSFs is statistically insignificant. Furthermore, unconditional volatility has changed significantly but for both SSFs and non-SSFs, while the asymmetry coefficient is statistically insignificant for SSFs but significant for non-SSFs.

It follows that resumption of SSFs trading has not negatively impacted the dynamics (arrival of positive feedback traders) of the underlying stock market. Given that KSE index futures exist alongside SSFs, it would be expected that their underlying stocks would be even less affected by the resumption of SSFs trading. The effect of the resumption of SSFs trading on the dynamics of the underlying market, particularly feedback trading and volatility was found to be statistically insignificant. In the period following the resumption of futures trading, there is no evidence to support the hypothesis that futures trading has either inhibited or promoted positive feedback trading. The results are consistent with the view that the reestablishment of a future market is not the cause of destabilization in the underlying stock market.
References


Table 1: Summary Statistics of Portfolio Returns for SSFs

<table>
<thead>
<tr>
<th>Scrip</th>
<th>Mean</th>
<th>Std. Dev.</th>
<th>Skewness</th>
<th>Kurtosis</th>
<th>Normality test</th>
<th>Unit root test</th>
<th>ARCH test</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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<td></td>
<td></td>
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<td>Prob.</td>
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SSFs Trading and its Impact on Feedback Trading and Volatility: A Case Study of Pakistan

Table 1: continued

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*, **, *** represents significance at 10%, 5% and 1% respectively
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*, **, *** represents significance at 10%, 5% and 1% respectively
## Table 3: Maximum Likelihood Estimates of AR(1)-GJR-GARCH for SSFs

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SSFs Trading and its Impact on Feedback Trading and Volatility: A Case Study of Pakistan

Table 3: continued

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B stands for Before
A stands for After
* a b represents significance at 10%, 5% and 1% respectively.
Table 4: Maximum Likelihood Estimates of AR(1)-GJR-GARCH for Non-SSFs

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### Table 4: continued

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<th>Prob.</th>
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<th>Prob.</th>
<th>( \alpha_1 )</th>
<th>Prob.</th>
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<td>0.34</td>
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</tr>
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</table>

\( \alpha \) stands for **Before**

\( \text{A stands for After} \)

\(*, a, b \) represents significance at 10%, 5% and 1% respectively
Table 5: Test Statistics\textsuperscript{a,b}

<table>
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<tr>
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<th>Alpha(S)</th>
<th>Meau(S)</th>
<th>Phiknot(S)</th>
<th>Phione(S)</th>
<th>Alphaknot(S)</th>
<th>Alphao(ne)(S)</th>
<th>Beta(S)</th>
<th>Saii(S)</th>
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<tbody>
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<td>0.626</td>
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<td>18.156</td>
<td>0.016</td>
<td>0.144</td>
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<tr>
<td>Df</td>
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<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Asymp. Sig.</td>
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<td>0.527</td>
<td>0.429</td>
<td>0.681</td>
<td>0</td>
<td>0.899</td>
<td>0.704</td>
<td>0.174</td>
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</table>

\textsuperscript{a. Kruskal Wallis Test}

\textsuperscript{b. Grouping Variable: Pretopost\(S\)}

Table 6: Test Statistics\textsuperscript{a,b}

<table>
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<tr>
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<th>Phiknot(N)</th>
<th>Phione(N)</th>
<th>Alphaknot(N)</th>
<th>Alphao(ne)(N)</th>
<th>Beta(N)</th>
<th>Saii(N)</th>
</tr>
</thead>
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<td>Chi-Square</td>
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<td>0.091</td>
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<tr>
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<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Asymp. Sig.</td>
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<td>0.163</td>
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</table>

\textsuperscript{a. Kruskal Wallis Test}

\textsuperscript{b. Grouping Variable: Pretopost\(N\)}
### Annexure I: Contract Specifications of Deliverable Future Contracts

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<th>Specification</th>
<th>Details</th>
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<td><strong>Position Limits</strong></td>
<td>As prescribed under Regulations Governing Risk Management of Karachi Stock Exchange, as amended from time to time</td>
</tr>
<tr>
<td><strong>Daily Price Limits</strong></td>
<td>As provided under Regulations Governing Risk Management of the Exchange</td>
</tr>
<tr>
<td><strong>Contract Period</strong></td>
<td>1 calendar month</td>
</tr>
<tr>
<td><strong>Opening of Contract</strong></td>
<td>Monday preceding the last Friday of the month, if Monday is not a trading day, then immediate next trading day</td>
</tr>
<tr>
<td><strong>Overlapping Period</strong></td>
<td>Maximum Five Days (not less than two days).</td>
</tr>
<tr>
<td><strong>Expiration Date/Last Trading Day</strong></td>
<td>Last Friday of the calendar month, if last Friday is not a trading day, then immediate preceding trading day</td>
</tr>
<tr>
<td><strong>Settlement</strong></td>
<td>T+2 settlements falling immediate after the close of contract</td>
</tr>
<tr>
<td><strong>Depository of Underlying Security</strong></td>
<td>Central Depository Company of Pakistan Limited</td>
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Foreign Aid and Macroeconomic Performance in Pakistan: 
Exploring the Role of Local Financial Sector Development

Muhammad Luqman, Mirajul Haq and Irfan Lal¹

Abstract

It is widely recognized that foreign aid may not be used effectively in recipient countries due to a problem of absorptive capacity. This study assesses the role of such capacity in the effective use of foreign aid in Pakistan. To accomplish this, we incorporate domestic financial sector development in our model. The empirical analysis estimates growth equations using time series data of Pakistan over the period 1972-2011. We construct the index of financial sector development using principal component analysis. The ARDL bound testing approach of co-integration was used for empirical analysis. The empirical evidence substantiates the fact that foreign aid is more effective and consequently enhances both long and short run growth process only in the presence of local financial sector development. For instance, our result revealed that absorptive capacity (i.e. interactive term of local financial sector development and foreign aid) is positive and statistically significant. The findings support the claim that ‘local financial sector development plays an important role in the effectiveness of foreign aid’. In addition, the results indicate that foreign aid makes a positive and statistically significant impact on economic growth after allowing nonlinearity between the variables; this, in turn, indicates diminishing return to foreign aid in case of the Pakistan. Our control variables i.e., physical capital and human capital bear their expected positive signs and are also statistically significant. This indicates that physical capital and human capital also play an important role in the log-run economic growth process of Pakistan.

Keywords: Foreign Aid, Effectiveness, Economic Growth, Human Capital, Co-integration

JEL Classification: O11, F35, G2, C13, C22

¹The authors are Lecturer, Assistant Professor at the Kashmir Institute of Economics, University of Azad Jammu & Kashmir, Muzaffarabad and Research Fellow at the Institute of Business Management, Karachi, respectively.

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1. Introduction

As world economies are growing more and more interdependent, mutual assistance among them, and its response to economic performance is one of the appealing areas in economic literature. Cooperation in economic sphere to promote economic growth and hence alleviate poverty originates from the aid program known as the Marshall Plan. The main rationale behind the Marshall Program was the reconstruction and restructuring of war-torn economies of Europe after Second World War. After the advent of Marshall Plan, growing body of economic literature sustain that foreign assistance (foreign aid) play s a pivotal role in the growth process and hence poverty alleviation in developing countries. In this connection, Chenery and Strout (1966) put forward the rationale for foreign aid in terms of saving and foreign exchange gaps and argued that it decelerates the growth process in developing countries. They indicated that developing economies could overcome the downbeat impact of dual gaps through external finance. These aid-growth strategies pursued in the developing and underdeveloped economies during the decade of 1960s become the victim of bitter criticism by economists and policy makers on the grounds of income distribution, political motives of aid and its effectiveness. Chenery and Strout (1966) work opened a new avenue for discussion among economists and policy makers. They are not agreeing on the optimistic view that foreign aid is always beneficial for long run economic growth. The major anxiety about foreign aid was its effectiveness and hence repercussions in long run economic growth. Two views prevail among economists about the effectiveness of foreign aid and hence its response to economic growth. But if foreign aid is used in a policy framework aimed at steady long run economic growth then it can fly over the domestic gap and would be economically desirable. On the other hand, if foreign aid is used to maintain the existing status quo, non-development current expenditure (i.e. defense expenditures) and debt servicing then it could be economically inadvisable. To meet these end international donor agencies i.e. International Monetary Fund (IMF) and World Bank (WB) attached different conditions on the provisions of aid. The underlying principle behind aid conditionality is the incentives provided to the recipient countries to adopt those policies, which enhance the productivity as well as probability of obtaining the desired objectives and outcomes.2

2Aid conditionality has been normal practice of bilateral as well as multilateral donors for achieving specific objectives. Since early 1980, when International Monetary Fund and World Bank started to provide loan under Structural Adjustment Program (SAP), conditionality of foreign aid became
The literature on macroeconomic analysis of foreign aid cannot state conclusively that either foreign aid has been beneficial or detrimental to the long run economic growth process of recipient countries. Most of the empirical literature on foreign aid is based on cross-country evidence which often creates more confusion about the net effectiveness of foreign aid. Thus, the question of aid effectiveness remains an issue for analysis of specific countries and specific time periods. In this state of confusion and contradiction, the present study undertakes an in depth empirical analyses of foreign aid and long run economic growth for Pakistan.

Pakistan is one of the largest aid-receiving countries in the world. Because of low level of domestic savings and foreign exchange constraints, Pakistan depends heavily on foreign capital especially foreign aid. Pakistan initiated trade liberalization reforms in mid 1980s and has fully liberalized since mid-1990s and, therefore, opened up new opportunities for trade promotion, economic growth, and poverty alleviation. However, it cannot properly harvest these opportunities as, among other things, its trade balance has deteriorated over time. The one key reason for this is an underdeveloped physical and commercial infrastructure. A large segment of the empirical literature stresses the importance of absorptive capacity (i.e. physical and commercial infrastructure) in gaining from globalization and liberalization. With this in mind, some policy makers justify economic aid for Pakistan. In Pakistan total foreign debt increased from $ 46.16 billion in 2008 to $ 64.04 billion in 2011. In the past forty years (1960-2002) Pakistan has received around US $ 73.14 billion in the form of foreign aid but this aid could not benefit the whole society and has failed to improve the economic conditions in Pakistan (Anwar and Michaelowa, 2006). Social indicators such as education, health, and employment are not encouraging. The overall situation of the economy casts doubt about the effectiveness of foreign aid as a tool for economic growth. Despite the growing concern over effectiveness of foreign aid in Pakistan and its status as one of the largest foreign aid-receiving countries, only few studies have investigated the impact of foreign aid on

criticized on several grounds. In 1998, World Bank published a policy research report entitled Assessing Aid. The empirical part of the report investigated the role of macroeconomic impact of foreign aid on the effectiveness of foreign aid and found that foreign aid helps to spur economic growth but only in countries with good economic policy. Instead of Aid Conditionality, the Assessing Aid Report focuses on selectivity. This report proposes the use of measure of good economic policies and strong institutional environment to select eligible for aid.

3 Foreign debt shows increasing trend and it grows by 12.7 percent on average during 2007 to 2010.
economic performance of Pakistan.\textsuperscript{4} However, there is no study that investigates the role of financial markets in aid-growth relationship in case of Pakistan. The extent to which a country can benefit from foreign aid is believed to be sensitive to the country’s financial markets development. This study is an attempt to assess and analyze the role of financial market development in the aid-growth relationship in Pakistan.

2. Review of Literature

Generally, the recent economic literature on foreign aid effectiveness falls into three groups. First, are studies, which are based on strong assumption and argue that foreign aid could assist growth only in conducive policy environment (e.g. Burnsid and Dollar, 2000). Second, some studies suggest that there is nonlinear effect in the aid growth relationship due to diminishing return to aid (Dalgaard and Hansen, 2001; Hansen and Trap (2000a, 2000b); Lensink and White, 2001). Third, some studies on aid effectiveness strongly contradict the first two by suggesting that not only foreign aid has no positive effect on growth but it also hurts economic growth. It expands the public sector, substitute the domestic resource mobilization. It is argued that foreign aid is used to encourage corrupt and inefficient government in developing countries, distort the income distribution in favor of corrupt, and rent seeking segment of country (Griffin and Enos, 1970; Boon, 1996; Weisskoff, 1972; Easterly, 2001; Mosely and Hudson, 1995).

Most recently, different studies investigated the role of structural characteristics such as local financial sector development, political regimes, macroeconomic policy, and political instability of the aid-receiving country in enhancing the positive impact of foreign aid on economic growth. Most of these studies have argued that among structural characteristics local financial sector development plays an imperative role in the effectiveness of foreign aid. The impact of financial sector development on economic growth has been excessively scrutinized both theoretically and empirically. Many of these studies have found positive impact of financial development on economic growth\textsuperscript{5}. The main argument supporting the hypothesis is that sound intermediaries in a proper regulatory framework ends up boosting saving and capital accumulation. Capital formation is the one important determinant of

\textsuperscript{4} Studies found positive impact of foreign aid on economic growth (Shabir and Mahmood, 1992; Mohey-ud-din, 2006), while others argued that foreign aid inversely impacted Pakistan economic growth (Khan and Ahmed, 2007; Ali, 1993; and Khan and Rahim, 1993; Javed and Quayyum, 2011).

\textsuperscript{5} McKinnon (1973) and Shaw (1973), King and Levine (1993), Beck et al., 2000a, Abu-Bader and Abu-Qarn (2008); among others
investment and hence of economic growth. Further financial sector development also improves the efficiency of capital allocation and technological development within the economy\(^6\). In this association, Nkusu and Sayek (2004) investigated the role of financial sector on aid effectiveness in an integrated framework. Their study found that local financial sector development enhances the positive effect of foreign aid on economic growth and helps poor countries to achieve their development goals. Ang (2009) has assessed the role of financial deregulation and liberalization on aid effectiveness in India and found that foreign aid exerted the negative impact on economic growth in India. However, financial liberalization mitigates these negative effects by increasing the efficiency and absorptive capacity of the economy. Elbadawi et al (2008) found that local financial sector development mitigates the negative impact of foreign aid by protecting the traded goods sector, and it also increases the absorptive capacity of economy. Mundaca (2009) developed a theoretical model of workers’ remittances, financial intermediation, and economic growth. He tested his model empirically using data from Latin America and Caribbean countries. He argued that local financial sector development enhances the positive impact of foreign remittances on economic growth.

Macroeconomic impact of foreign aid is also controversial in case of Pakistan. A few studies found positive impact of foreign aid on economic growth in case of Pakistan (Shabir and Mahmood, 1992; Mohey-ud-din, 2006). Some studies found that foreign aid inversely affected the economic growth (Ali, 1993; Khan and Rahim, 1993; Ishfaq and Ahmed, 2005; Khan and Ahmed, 2007). Javed and Qayyum (2011) have investigated the role of macroeconomic policy in aid effectiveness in case of Pakistan. They constructed the policy index using inflation, budget deficit and trade openness as important indicators of macroeconomic policy. Their study found that foreign aid could work but only in a favorable policy environment. Shirazi et al. (2009) have investigated the impact of foreign aid on the Human Development Index in case of Pakistan. They found that proper management of foreign aid would contribute to human development in Pakistan. However, there is no study that investigates the role of financial markets in aid-growth relationship in the case of Pakistan.

\(^6\) After the recent financial crises, there is growing consensus among the policy makers, researchers, and economists that financial capitalism without regulatory framework, can crowd out the private investment and thus economic growth.
3. Model Specification, Methodology and Data

Following Mankiw et al. (1992), this study builds on the model of growth that includes human capital as well as physical capital in the spirit of the Solow model. The model assumes Cobb-Douglas production function. This makes the model tractable and lead easily to quantities analysis. A further advantage of Cobb-Douglas assumption is that it appears to be reasonable approximation of actual production function. Hence incorporating human capital in production function takes the following form:

\[ Y = (AL)^{\alpha} K^{\beta} H^{\gamma} \]  

(1)

Apart from conventional factors of production, we also want to analyze the impact of foreign aid in the process of economic growth. Therefore, the human capital augmented production function is extended further by incorporating foreign aid as foreign capital.\(^7\) By incorporating foreign aid (foreign capital) the production function, extend as follows:

\[ Y = (AL)^{\alpha} K^{\beta} H^{\gamma} F^{\theta} \quad \text{Where } F \text{ is foreign capital (foreign aid)} \]  

(2)

Foreign Aid inflows can put upward pressure on the real exchange rate and reduce the competitiveness of the traded goods sector, particularly exports. To mitigate these adverse effects, when monetary and exchange rate policies are carried out in shallow domestic financial markets then level and volatility of interest rate increases, which automatically crowds out private investment and hence retards economic growth.

Deeper financial markets and greater financial absorptive capacity allow monetary and exchange rate management authorities to mitigate the negative impact of aid flows, thereby increasing the gain associated with donor support. Deeper financial markets can play an important role in curbing the possible crowding out effect of Foreign Aid on private investment that is exerted through high and volatile interest rate (Nkusu and Sayek, 2004).

Following Nkusu and Sayek (2004), Elbadawi et al (2008) and Ang (2009), we include financial development in the model through an interactive term.

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\(^7\) Following Khan (2007), Burke et al. (2006), Ahmed, and Hamdani (2003) we have used foreign aid as proxy for foreign capital.
3.1 Empirical Model

To analyze the contribution of financial market in the processes of economic growth through foreign aid, the following baseline model is estimated using time series data of Pakistan spanning between 1972 and 2011.

\[ \ln Y_t = \beta_0 + \beta_1 \ln X_t + \beta_2 \ln (Ay)_t + \beta_3 \ln (Ay * FD)_t + \varepsilon_t \]  \hspace{1cm} (3)

Where

- Y = Real GDP
- \((Ay*FD)\) = Interactive term of financial development and foreign aid
- Ay = Foreign aid to GDP ratio
- X = Vector of control variables that includes, gross fixed capital formation, human capital and financial development.
- \(\varepsilon\) = Error term.

3.2 Empirical Methodology

This study is based on annual time series data of Pakistan for the 1972-2011 period. As all the variables are time series, each variable could be stationary I (0) or non-stationary I (1) and I (2). If all the variables involved in the study are integrated order one I (1) then we can use Johansen maximum likelihood procedure proposed by Johansen (1988) and Johansen and Juselius (1990). If some variables are stationary at level I (0) and some are integrated of order I(1) then Auto Regressive Distributed Lag (ARDL) is a suitable estimation technique which is also known as bound testing approach and was introduced by Pesaran et. al. (2001).

If after testing, the variables are found to be non-stationary, then next step would be the investigation of long run and short run relationship between the variables. For this purpose we can used the co-integration technique. As all the variables under study are not stationary at level, the Auto Regressive Distributed Lag (ARDL) (Pesaran et. al., 2001) is a suitable estimation technique. This technique is preferred to other conventional co-integration approaches because it can be applied irrespective of order of integration and provides reliable results in case of small samples. The ARDL approach assumes all the variables to be endogenous; hence, this approach provides correct and precise estimates of long run parameter and valid inference even in the presence of endogenous explanatory variable. Thus, simultaneity or endogeneity is not an issue. Pesaran and Shin (1999) found that in case of small
sample short run ARDL based estimators are super consistent. This approach also involves the short-run dynamics in the estimation of long run parameters. Therefore, equation under the ARDL approach is as follows:

$$\Delta Y_t = \sigma + \sum_{i=1}^{p} \beta_i \Delta Y_{t-i} + \sum_{i=0}^{p} \delta_i \Delta K_{t-i} + \sum_{i=0}^{p} \gamma_i \Delta H_{t-i} + \sum_{i=0}^{p} \lambda_i \Delta F D_{t-i} + \sum_{i=0}^{p} \eta_t \Delta A y_{t-i} + \sum_{i=0}^{p} \rho_i \Delta F D \ast A y_{t-i} + \alpha_1 Y_{t-1} + \alpha_2 K y_{t-1} + \alpha_3 H_{t-1} + \alpha_4 F D_{t-1} + \alpha_5 A y_{t-1} + \alpha_6 (F D \ast A y)_{t-1} + \varepsilon_t$$

(4)

Where $p$ is the lag length and under Bound testing approach the null hypothesis of no long run relationship between $Y_t$ and its determinants is as follows:

$$H_0: \alpha_1 = \alpha_2 = \alpha_3 = \alpha_4 = \alpha_5 = \alpha_6 = 0$$

$$H_1: \alpha_i \neq 0$$

for at least one $i$, where $i = 1, 2, 3, 4, 5, 6$

The presence of co-integration can be checked testing the above null and alternative hypothesis by using the F test. If the test statistics exceeds their respective upper critical values then the null hypothesis is rejected and we can conclude that a long run relationship exist (Ang, 2010). On the other if the calculated value of F test falls below the lower bound critical value we conclude that there is no long run relationship among the variables. If co-integration is established, we can find long run elastiiities by normalizing on $\alpha_1$ as follows.

$$Y_{t-1} = \frac{\alpha_2}{\alpha_1} K_{t-1} + \frac{\alpha_3}{\alpha_1} H_{t-1} + \frac{\alpha_4}{\alpha_1} F D_{t-1} + \frac{\alpha_5}{\alpha_1} A y_{t-1} + \frac{\alpha_6}{\alpha_1} (F D \ast A y)_{t-1}$$

(5)

3.2.1 Short Run Analysis of the Models

The short run dynamics are examined using the error correction mechanism (ECM), which explains changes in the dependent variable in the explanatory variables as well as deviations from the long run relationships between the variables and its determinants. We formulate the error correction equation for our model 1 as follows.
\[ \Delta Y_t = \sigma + \sum_{i=1}^{p} \beta_i \Delta Y_{t-i} + \sum_{i=0}^{p} \delta_i \Delta K y_{t-i} + \sum_{i=0}^{p} \gamma_i \Delta H_{t-i} + \sum_{i=0}^{p} \lambda_i \Delta F D_{t-i} + \sum_{i=0}^{p} \eta_t \Delta A y_{t-i} + \sum_{i=0}^{p} \rho_i \Delta F D * A y_{t-i} + \theta E C_{t-1} + \nu_1 t \] (6)

Where \( \Delta \) is the difference operator and \( E C_{t-1} \) is an error correction term. The sign of the parameters \( \theta \) is expected to be negative.

Whereas EC term is formulated as

\[ E C = Y_t - \left( \frac{\alpha_2}{\alpha_1} K_{t-1} + \frac{\alpha_3}{\alpha_1} H_{t-1} + \frac{\alpha_4}{\alpha_1} F D_{t-1} + \frac{\alpha_5}{\alpha_1} A y_{t-1} + \frac{\alpha_6}{\alpha_1} F D * A y_{t-1} \right) \] (7)

### 3.3 Construction of Variables and Data Sources

Important variables used in this study include real GDP, Gross Fixed Capital Formation, Secondary School Enrolment, Foreign Assistances, and Financial Development. Data on these variables are collected from the Handbook of Statistics on the Pakistan Economy 2005 and updated with annual reports of State Bank of Pakistan and Government of Pakistan (GOP), Pakistan Economic Survey. The key variable of study is financial development, therefore in order to analyze the impact of financial development on economic growth we developed an index which is briefly discuss as follows.

#### 3.3.1 Financial Development Index

Financial Development is usually defined as a process that marks improvement in quantity, quality and efficiency of financial intermediary services (Abu-Badarand Abu-Qarn, 2009). Financial Development involves many institutions and activities and cannot be measured by a single indicator. Many studies on Pakistan financial sector Ma and Jalil, (2008), Khan et al. (2005) have used different indicators as a proxy for financial development. However, problem arises with this approach is that different indicator have different results. In this study we employ three commonly measure of financial development and construct a composite index using Principal Component analysis to find out the weight of these indicators.

Our first measure of Financial Development is ratio of M2 to nominal GDP. Many studies used M2/GDP as a standard measure of financial development (King and Levin, 1993). The increase in M2/GDP ratio implies...
that increases in financial intermediation and financial deepening. It also indicates the increase in private financial savings.

Our second measure of financial development is the ratio of bank credit to private sector to nominal GDP. It is quite possible that increases in private savings due to increase in M2/GDP could not increases the credit facilities to private firms which are eventually responsible for quality and quantity of investment. If the public sector contribution to total credit is larger than private sector it can hurts economic growth by crowding out of private investment. The market friendly approach suggests that role of government is to just minimize the distortions in the markets. Thus, the ratio of private credit to nominal GDP is related to the quality and quantity of private investment and hence economic growth. The ratio of private credit to nominal GDP has been extensively used in literature (King and Levin, 1993; Abu-Bader and Abu-Qarn, 2008; Carranza, et. al, 2010; Khan et. al., 2005; Ma and Jalil, 2008 among the others).

Our third measure of financial development is the ratio of Stock Market Capitalization to nominal GDP. In Pakistan, all studies on the relationship between Financial Sector and economic growth used bank based measures of financial development. But stocks markets are able to offer different kinds of financial services than the banking system and may therefore provide different kinds of imputes to investment and growth than development of the banking sector (Arestis and Demetriades, 1997). Increases in the ratio of stocks market capitalization to nominal GDP improve an economy’s ability to mobilize capital and diversify risk.

Thus, we have used the three series namely ratio of M2 to GDP, ratio of private sector credit to GDP and ratio stock market capitalization to GDP for composite index of financial sector development. We have constructed the index by using the Principal Component Analysis. The methodology of Principal Component analysis finds combinations of set of variables that explains most of the variance/covariance of the original variable (Carranza et. al., 2010). This approach is useful to tackle the problems of over-parameterization and multicollinearity. Results of Principal Component Analysis are reported in Table 1
The results indicate that first principal component explain about the 72.8 percent of variance, the second principal component explain about the 19.8 percent of the variance and third principal component explains about the 7.4 percent of variance. Following Ang (2010), we have used the percentage of variance as the weight to compute the index.

4. Empirical Findings

The empirical analysis is completed in three steps. In the first step, we have checked the time series properties of each variable included in the study. Based on these results we used ARDL bounds test for long run relationship. For short run analyses, we used an Error Correction mechanism.

4.1 Testing Unit Roots

We begin our empirical analyses by checking the time series properties of data. Although the ARDL methodology does not require, pretesting the stationarity of variables included in the study. However, this methodology is applicable if underlying variables are integrated order one or stationary at level. But if any variable is integrated of order two i.e. I(2) than results based on ARDL are spurious. Therefore pretesting of unit roots to determine the order of integration is important. Two standard unit root tests namely the Augmented Dickey Fuller (ADF) and Phillips-Perron (PP) tests used for assessing the order of integration of underlying variables. A summary of these results are reported in Table 2.
Table 2: ADF, and PP Unit Root Tests Results

<table>
<thead>
<tr>
<th>Series</th>
<th>ADF</th>
<th>PP</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Levels</td>
<td>First Difference</td>
</tr>
<tr>
<td>Ln RGDP</td>
<td>1.207</td>
<td>4.246</td>
</tr>
<tr>
<td></td>
<td>(0.83)</td>
<td></td>
</tr>
<tr>
<td>KY</td>
<td>4.855</td>
<td>------</td>
</tr>
<tr>
<td></td>
<td>(0.000)</td>
<td></td>
</tr>
<tr>
<td>Ln H</td>
<td>1.477</td>
<td>4.865</td>
</tr>
<tr>
<td></td>
<td>(0.822)</td>
<td></td>
</tr>
<tr>
<td>FD</td>
<td>2.803</td>
<td>4.274</td>
</tr>
<tr>
<td></td>
<td>(0.06)</td>
<td></td>
</tr>
<tr>
<td>Ay</td>
<td>0.637</td>
<td>8.596</td>
</tr>
<tr>
<td></td>
<td>(0.84)</td>
<td></td>
</tr>
<tr>
<td>Ay^2</td>
<td>1.460</td>
<td>7.901</td>
</tr>
<tr>
<td></td>
<td>(0.455)</td>
<td></td>
</tr>
<tr>
<td>(FD*Ay)</td>
<td>0.038</td>
<td>2.914</td>
</tr>
<tr>
<td></td>
<td>(0.956)</td>
<td></td>
</tr>
</tbody>
</table>

p values in parenthesis

The results reported in Table 6.1 indicate that all the variables are of integrated order one or I(1) except the gross fixed capital formation as ratio to nominal GDP which is stationary at level or I(0). These findings allow us to use the ARDL bound testing approach as this technique require the variables to be less than I(2). Moreover if there is mixed order of integration of time series of variable of interest the most appropriate technique for estimation is the ARDL. Results from both Augmented Dicky Fuller and Phillip Pearron test yield the same conclusion. The PP test considers the presence of structural break in the time series.

4.2 Auto Regressive Distributed Lag (ARDL): The Bound Testing Approach

As a first step in ARDL bound testing approach, we have to decide optimal lag length because in this approach the F test is sensitive to the lag length. We have selected two lag on the basis of Akaike information criterion, and Hannan-Quinn information criterion. These results are shown in the Table 3.
In ARDL bound testing approach, after the lag selection, next step is to estimate the unrestricted Error Correction Model which was already specified in the Equation 4. We have estimated the Equation 4 by ordinary least square method. Following the general to specific methodology, we have deleted the insignificant first difference terms from the model. The most parsimonious model is selected by using the general to specific methodology. We have performed the number of diagnostic test such as Langrange Multiplier (LM) test for the autocorrelation, White Heteroscedasticity test for heteroscedasticity, Jarque-Bera for normality and CUSUM and QUSUMQ for structural stability and Ramsey Reset Test for misspecification of the model. The results are reported in the Table 4.

It can be seen from the Table 4 that results obtained from the model passes through the battery of diagnostic tests. Furthermore, the CUSUM and QUSUMQ tests rule out the possibility of structural instability of the estimated models. Figures of CUSUM and QUSUMQ are available in the Appendix-A.

To find co-integration in the Bounds Testing approach we used the Wald-test to compute the F-statistics. In Bounds Testing approach the higher F-statistics is not an appropriate criteria for long run relationship instead we compare F value with lower and upper bound critical value calculated by Pesaran et al. (2001). If the value of F test falls above the upper-bound critical value than it proved that variables are co integrated (see Table 4).
Table 4: Results of Unrestricted Error Correction Model of ARDL

<table>
<thead>
<tr>
<th>Variables</th>
<th>Coefficients</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>-0.6969 (0.070)</td>
</tr>
<tr>
<td>Δln(RGDP)(_{t-1})</td>
<td>0.3028 (0.048)</td>
</tr>
<tr>
<td>Δln(H)(_{t-1})</td>
<td>0.1742 (0.010)</td>
</tr>
<tr>
<td>Δ(FD)(_{t})</td>
<td>0.3225 (0.012)</td>
</tr>
<tr>
<td>Δ(FD)(_{t-1})</td>
<td>-0.3422 (0.008)</td>
</tr>
<tr>
<td>Δln(Ay)(_{t})</td>
<td>-0.8290 (0.005)</td>
</tr>
<tr>
<td>Δln(Ay)(_{t-1})</td>
<td>-0.4151 (0.000)</td>
</tr>
<tr>
<td>Δln(FD*Ay)(_{t-1})</td>
<td>0.0750 (0.000)</td>
</tr>
<tr>
<td>ln(RGDP)(_{t-1})</td>
<td>0.0750 (0.031)</td>
</tr>
<tr>
<td>ln(Ky)(_{t-1})</td>
<td>-0.4029 (0.006)</td>
</tr>
<tr>
<td>ln(H)(_{t-1})</td>
<td>-0.0869 (0.001)</td>
</tr>
<tr>
<td>(FD)(_{t-1})</td>
<td>0.0909 (0.002)</td>
</tr>
<tr>
<td>ln(Ay)(_{t-1})</td>
<td>0.0505 (0.1818)</td>
</tr>
<tr>
<td>ln(A^2y)(_{t-1})</td>
<td>-0.0190 (0.0912)</td>
</tr>
<tr>
<td>ln(FD*Ay)(_{t-1})</td>
<td>-0.0514 (0.0651)</td>
</tr>
<tr>
<td>R-Square</td>
<td>0.796</td>
</tr>
<tr>
<td>Adjusted R-Square</td>
<td>0.651</td>
</tr>
<tr>
<td>DW-Test</td>
<td>2.0237</td>
</tr>
<tr>
<td>Serial Correlation LM test</td>
<td>3.71 (0.1565)</td>
</tr>
<tr>
<td>Jarque–Bera Test</td>
<td>1.9235 (0.3822)</td>
</tr>
<tr>
<td>White Heteroskedasticity</td>
<td>28.915 (0.522)</td>
</tr>
<tr>
<td>Ramsey Reset Test</td>
<td>0.6841 (0.4179)</td>
</tr>
<tr>
<td>F-Statistic</td>
<td>5.482 (0.0002)</td>
</tr>
</tbody>
</table>

Note: P values in parenthesis
Table 5: Bounds Testing Approach of Co-Integration

<table>
<thead>
<tr>
<th>Model</th>
<th>Specification</th>
<th>Lower Bound</th>
<th>Upper Bound</th>
<th>F-statistic</th>
<th>Decision</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>(RGDP/Ky,H,FD,Ay,A'y,Ay*FD)</td>
<td>2.27</td>
<td>3.28</td>
<td>6.46</td>
<td>Co integration</td>
</tr>
</tbody>
</table>

Above table shows that for both specifications the Bounds test reject the null hypothesis of No co integration because the computed F-statistic through Wald test is higher than upper bounds critical value. After finding the evidence of long run relationship between the variables specified in equations, we have estimated the long run and short run elasticity by using Autoregressive Distributed Lag (ARDL) approach.

4.3 Long-Run Parameters of Model

After finding the evidence of long-run relationship between the real GDP and its determinants, we normalized the coefficient of lag level variables by dividing with the coefficient of RGDP and assuming all other first difference variables are equal to zero. The expected sign of the gross fixed capital formation to GDP ratio is positive. Gross enrollment, which is proxy for the human capital, is also expected to exert a positive impact on the economic growth. The priori sign of financial development, foreign aid and interactive term of financial development and foreign aid is ambiguous. The long run estimates of the parameters are reported in the following equation.

$$lnRGDP_t = 5.36K_y + 1.15lnH_t - 1.2FD_t - 0.67Ay_t + 0.25Ay^2_t + 0.68(Ay \times FD)_t$$

(8)

Above results indicate that most of the variables are significant showing that the variables included in the model have significant long run impact on economic growth in case of Pakistan. The ratio of gross fixed capital formation to nominal GDP included in the long run equation is significant at one percent level of significance with the expected positive sign. This finding is consistent with existing literature on economic growth which emphasizes capital deepening. Secondary school Enrolment, which is proxy of human capital, is also positively and significantly affected the economic growth in case of Pakistan.

Surprisingly, the composite index of financial development is also significant with a negative sign. This result is in sharp contrast with thesis of Mcknnon (1973) and Shaw (1973) Which argued that financial deepening enhance the economic growth. This study is also in sharp contrast to the
earlier findings of Ma and Jalil (2008), Khan et al. (2005) who demonstrate that financial development positively affects economic growth in case of Pakistan. However, there are many justifications for this unexpected result. Firstly, most of the previous studies used different individual indicators of financial development instead of index. This study constructed the composite index of financial development, which might be the cause of contradictory results. Secondly, owing to the nationalization of banks in 1974, the allocation of credit to the private sector is inefficient due to political intervention. Thus, the financial sector could not create new sources of funds to assist entrepreneurs, rather it benefited the rent seeking segments of the economy, namely politicians, bureaucrats and feudals. Instead of channeling the funds to the private sector, the inefficient financial sector retarded the economic expansion. This finding is consistent with earlier literature (Khan and Khan, 2007). The ratio of foreign aid to nominal GDP is negative but insignificant. Our result does not provide any support for the argument that aid promotes economic growth. This result instead supports the hypothesis that foreign aid has been misused and misallocated and benefited the rent seeking segments of economy. This finding is consistent with the earlier studies on Pakistan (Khan and Ahmed, 2007; Javed and Qayyume, 2011). However the square of aid to nominal GDP is positive and significant which confirms the hypothesis of nonlinear relationship between aid and economic growth due to diminishing return to the aid. This finding is also consistent with earlier literature on effectiveness of foreign aid (Lensink and White, 2001; Hansen and Trap, 2001; Dalgaard and Hansen, 2001; Dalgaard et al., 2004). However, the interactive term of financial development and foreign aid is positively significant. Therefore it can be deduced that financial sector development enhance the positive impact of foreign aid on economic growth by increasing the absorptive capacity of domestic economy. This finding is consistent with earlier cross country study (Nkusu and Sayek, 2004) and country specific study of India (Ang, 2010).

4.4 Short Run Dynamics of Model

After estimating the long run relationships, we estimated error correction model to examine the short run dynamics. The error correction term (ECM) consists of residual obtained from the long run coefficients. The most parsimonious model is selected by deleting the insignificant variables. In this way, we followed the general to specific methodology. We also applied the different diagnostic test to check the validity of the model. Figures of
CUSUM and QUSUMQ are available in the Appendix-B. The short run results are reported in the Table 6

Table 6: Short Run Dynamics: An Error Correction Model

<table>
<thead>
<tr>
<th>Variables</th>
<th>Coefficients</th>
<th>T - Statistics</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>-0.140</td>
<td>-2.86</td>
<td>0.008</td>
</tr>
<tr>
<td>ΔKy</td>
<td>0.522</td>
<td>3.16</td>
<td>0.003</td>
</tr>
<tr>
<td>ΔlnHt-1</td>
<td>0.132</td>
<td>2.94</td>
<td>0.006</td>
</tr>
<tr>
<td>ΔFDt-1</td>
<td>1.764</td>
<td>-3.43</td>
<td>0.001</td>
</tr>
<tr>
<td>ΔlnAy t-1</td>
<td>-0.542</td>
<td>-3.00</td>
<td>0.005</td>
</tr>
<tr>
<td>ΔlnAy t-2</td>
<td>-0.256</td>
<td>2.38</td>
<td>0.021</td>
</tr>
<tr>
<td>Δln(A*FD) t-1</td>
<td>0.172</td>
<td>3.72</td>
<td>0.001</td>
</tr>
<tr>
<td>EC t-1</td>
<td>0.509</td>
<td>-4.46</td>
<td>0.000</td>
</tr>
<tr>
<td></td>
<td>-0.002</td>
<td>-4.03</td>
<td>0.000</td>
</tr>
</tbody>
</table>

R²: 0.75
Adjusted R²: 0.66
DW-Stat: 1.98
F-statistics: 8.89
White Heteroscedasticity Test: 16.06
Serial Correlation LM test: 3.58

Above results shows that physical capital as well as human capital are positively related to economic growth and highly significant in case of Pakistan. These results are consistent with earlier literature on economic growth which emphasizes on the importance of physical capital as well as human capital. Financial development is positive and significant at a one percent level of significance, which means financial sector is also an important determinant of economic growth in short run. This finding support the argument that money supply is positively related with output in short run. Likewise, long run foreign aid is negative and highly significant also in short run. The square of aid is negative in the first lag but positive in the second lag. Both lags variables are highly significant in short run. This finding also supports the argument that there are decreasing returns to foreign aid. The Interactive term of financial development and foreign aid is positive as well as significant in short run. This finding supports the argument that developed local financial system enhances the positive relationship between foreign aid and economic growth. The error correction term (EC t-1) is highly significant and negative which shows that there is convergence in the model in case of
shocks and it also supports the hypothesis that there is a long run relationship between the variables under investigation.

5. Conclusions and Policy Implications

The primary objective of this research exercise was to determine, whether or not foreign aid contributes to economic growth in Pakistan. To assess the role of absorption capacity, domestic financial sector development was incorporated into the model. Hence, in this model, economic growth was associated with foreign aid, financial sector development, human capital, and physical capital. The empirical analysis estimates growth equations using a time series approach for Pakistan over the period 1972-2011. The financial sector development index was constructed through Principal Component Analysis. The ARDL bound testing approach of co-integration was used for empirical analysis. The overall evidence substantiates the fact that foreign aid is more effective, and consequently enhances both long and short run growth process, only in the presence of local financial sector development. For instance, our result revealed that absorptive capacity (i.e. interactive term of local financial sector development and foreign aid) exhibits a statistically significant and positive sign. This findings support the claim that ‘local financial sector development plays an important role in the effectiveness of foreign aid’. Hence, it can be safely concluded that Pakistan can harvest the benefits of foreign aid, in the form of sustainable long run economic growth, only with the development of local financial sector. Nonlinearity between foreign aid and economic growth also bears a significant and positive sign, which indicates diminishing return to foreign aid in case of Pakistan. Our control variables i.e. physical capital and human capital bears their expected positive signs, which are both statistically significant. This indicates that both physical capital and human capital plays an important role in the log-run economic growth process of Pakistan.

There are some of the facts that can direct policy formulation. First, our empirical findings provide support to the claim that ‘local financial sector development plays an important role in the effectiveness of foreign aid’. Accordingly, Pakistan needs to develop its local financial sector in order harvest the output of foreign aid in the form of sustainable economic growth.

Second, the findings of the study support the evidence of diminishing return to foreign aid and it recommend Pakistan to minimize reliance on foreign resources. This requires public policy that contributes to the mobilization of domestic resources. Third, policy that encourages both
domestic savings and accumulation of human capital should be emphasized. Our study finds that both physical capital and human capital are the important determinants to explain economic growth in Pakistan.
References


Appendix A

Model: Role of Financial Sector Development in Long Run

CUSUM 5% Significance

CUSUM of Squares 5% Significance
Appendix B

Model: Role of Financial Sector Development in Short Run
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