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EDUCATION, HEALTH, FOOD INFLATION AND ECONOMIC GROWTH IN PAKISTAN

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Abstract. Educated and healthy workforce always remains an invaluable asset for a country economic growth, whereas food inflation becomes the cause of food insecurity and, hence, hinders economic growth. The high prices of food in Pakistan may obstruct the attainment of the Millennium Development Goals and significantly threaten the food security and socio-economic well-being of the poorest of Pakistan. This empirical work examines the cointegration and the causality among education, health, food inflation and economic growth in Pakistan by utilizing data from 1971-72 to 2010-11. The ARDL approach to cointegration and causality technique given by Toda Yamamoto (1995) were used for econometric analysis. This study reveals that the food inflation has negative, while the education has direct impact on economic growth both in the short-run and long-run. Two-way causality between each of 'economic growth and education', 'education and food inflation' and 'food inflation and economic growth' is also found. Macroeconomic policy makers including government must reduce food inflation that, in turn, leads to high economic growth and more opportunity for education. Threshold level of food inflation may first be estimated and food inflation in Pakistan must be kept below its threshold level.

Keywords: Education, Food inflation, Economic growth, ARDL, Causality

JEL classification: H75, L66, O4, P36

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I. INTRODUCTION

Educational institutions particularly higher educational institutions like colleges and universities educate the citizens and enable them to actively participate in economic activities. Universities explain, disseminate, advance, create and distribute knowledge through variety of activities including research. Educational institutions provide their services to community, expertise to assist societies in social, cultural, political, human and economic development process. Universities and other educational institutions contribute in the improvement and development of education at all levels and of all kinds.

Skill development through education is the main source of productivity enhancement of the workforces. Economic growth (EG) not only depends upon education, but also influences by the factors like labour and capital stock, availability and efficient utilization of natural resources and energy etc. Education exerts the positive effect on human productivity. It produces new knowledge, skilled labour force, decreases inequalities and is the source of better employment (Hussain, 2008).

Investment in human capital was not given due weightage before 20th century. In second half of the 20th century, a huge investment in human capital and research and development (R&D) was made, and as a result rapid changes in production methods took place. Education played a vital role in improving the productivity and efficiency of the workforce. It is the first step in the way of growth and development process. Better-educated workforce is a key to diffusion and adoption of new technology and new production methods. Investing in education also helps in lowering the crime rate, terrorism and child labour through reducing the poverty, while poverty and inflation are also thought to be the basic root cause of the terrorism and child labour (Kruger and Malečková, 2003; Veron and Fabre, 2004).

Educating the children is very much linked with food inflation. Poor households spend major portion of their earnings on food items. According to United Nations report (2008), the poorest households of Pakistan need to spend at least 70 percent of their income on food and other items like education and health. High food inflation prevents heads of households to send their children to schools. The reason behind this is that, if a family has not enough resources to fulfill the basic necessities of life then, how they can send their children to schools. Instead of sending children to schools, they send their children to the labour market to earn something. So, high food inflation and poverty also seem to be one of the major causes of child labour in developing countries like Pakistan. The economic and social impact of

food inflation is a serious and complex issue for Pakistan. The high prices of food in Pakistan may obstruct the attainment of the Millennium Development Goals and significantly threaten the food security and socio-economic well-being of the poorest of Pakistan.

Afzal *et al.* (2010), Afzal *et al.* (2011) and Morote (2000) argued that the linkage between education and growth were not always direct. There are many other variables that affect the linkages between education and EG. Better health and better health facilities have a direct and positive impact on both acquiring education and enhancing EG (Beherman, 1996; Selowsky, 1981). Better health and nutrition have a positive effect on labour productivity, especially on poor segment of the society. Empirical studies have shown that health and nutrition programs have helped to increase the life time earnings of individuals (Wolgemuth, Lathman, Hall and Crompton, 1982).

Education in private as well as public sector faces a lot of problems in Pakistan. Almost every government has neglected education sector in the shape of lower investment in it. Education expenditure remained less than 2% of GNP throughout Pakistan's history. Food inflation, poverty, income skewness, gender and regional inequalities, poor performance of public sector and high fee in private sector educational institutions, poor educational policies and various systems of education are the big hurdles in the way of educational and human development process of Pakistan.

In Pakistan, EG is less due to low level of quality education, low level of capital formation, high unemployment, rising food and other basic items prices, deteriorating health conditions, low level of savings and investment, bad governance and extremism and last but not the least, the political turmoil and instability. High inflation is considered one of the main reasons of low growth and low development in Pakistan. High inflation may lead to the insecurity of future profitability of projects of investment. This is more vulnerable when high inflation is consistent with unpredictability increase in prices.

The problem of low EG and less education in Pakistan can only be well addressed if a researcher studies together the relationship among EG, education and food inflation. It is also very important to study the relationship among education, food inflation and EG in Pakistan with the inclusion of other relevant variables like labour force, physical capital and health. The main objective of this empirical work is to examine the short-run (SR) and long-run (LR) relationships and causal nexus among education, food inflation and EG by including other variables like labour force, health

and physical capital. Labour force and physical capital were included in the study because they are considered as very basic ingredients of EG. Health variable was included in this study so that this study may test the comprehensive effect of human capital on EG of Pakistan.

Statement of Problem

Education is considered very important for EG but the linkage between education and EG is not always direct. There are some other variables that may affect the relationship between education and EG. Among other variables, food inflation has become very crucial factor that may affect the linkage between education and EG. So, the present research work is designed to check the SR and LR relationships among education, food inflation, and EG by including other variables like labour force, health and physical capital in case of Pakistan.

Objectives of the Study

The objectives of the present work are (*i*) to analyze the SR and LR relationship among education, food inflation and EG, and (*ii*) to check the causality among education, food inflation and EG.

Significance of the Study

Education is the most important factor that plays a leading task in the process of EG and development of nations. More accumulation of the human capital generates more skilled labour that, in turns, leads to more EG and development. Education creates opportunity for the individuals by enhancing their productivities. The present empirical work is a significant addition in body of literature that covers the comprehensive relationship among education, health, food inflation, labour force, physical capital and EG. This study provides information to all, especially for the policy makers in Pakistan to control food inflation and to speed up each of the EG and education.

The rest of the paper is organized as follow: Section II presents a brief literature review of previous studies. Section III presents the data sources, model specification, variables rationality and the estimation techniques. Section IV consists of empirical results and their analysis. Conclusion and policy recommendations are presented in section V of the paper.

II. REVIEW OF LITERATURE

High education level and sustainable EG have proved to be the important source of improvement in the socio-economic status of a country, while high episode of inflation has proved itself a big hurdle in the way of improving

education as well as EG. One percent rise in inflation above its threshold level leads many people to fall into poverty. Inflation affects the poor harder than that of the other classes of the society. Specifically, the poor are badly affecting by price hike in food items. Households struggle their best to meet the minimum standards of living but they may have no choice except to cut down expenditures on their family health and their children's education. Hanif (2012) found that food inflation hurts poor more than rich in Pakistan as the poor spend higher proportion of their income on food items as compared to the rich. According to Hanif, higher global food and crude oil prices in 2008 resulted in higher food inflation in Pakistan. A comparison of food inflation with wage increases for labour, the poor in labour class was found to be at disadvantage.

Many a studies are available at national and international level regarding the linkages between education and EG, between education and food inflation, and between food inflation and EG. However, a very few studies are available in literature that have established the linkage among education, food inflation and EG. The present empirical study is planned to explore the linkages among education, food inflation and EG in Pakistan. The review of relevant previous studies is given below:

Permaani (2008) considered education as an input of EG in East Asian countries by using panel data from 1965 to 2000. The author has used schooling years as a proxy to measure the human capital. The author estimated 'Labour Augmented Solow Model' and concluded that the Asian countries showed a momentous contribution of human capital to EG.

Francis and Iyare (2006) checked the causality between education and economic development in the Caribbean. They applied cointegration and Vector Error Correction Models (VECM) on time series data from 1964-1998. Their findings showed that there was bidirectional causality between education and income in the SR in Jamaica, but no causality between education and income was found in the SR and LR in Barbados, Trinidad and Tobago. The authors recommended that higher income of a country must be spent on education.

Using data for the span of 1980 to 2008, Danacica, Belascu and Llie (2010) explored the causal nexus between EG and higher education for Romania. Their study results confirmed LR linkage between higher education and EG and one way causality that ran from EG to higher education. However, this study faces series drawbacks. The study used Johansen and Juselius (1990, 1995) cointegration technique on just 28 observations and the optimal lag length is four. The estimation technique

may mislead the result and data may face the loss of degree of freedom due to short data span.

Afzal *et al.* (2010) analyzed the linkages between EG and school education in Pakistan. The ARDL cointegration approach results confirmed two-way inverse relationships between school education and EG in the SR, while two-way direct linkage between school education and EG has been found in the LR. Inflation retards school education and EG only in the LR according to this study. This study recommends reduction in inflation and poverty, so that school education and EG can be speeded up.

Chaudhary *et al.* (2009) investigated the causality between EG and higher education in Pakistan. They used Johansen cointegration approaches in a VAR framework and TY (1995) causality techniques for the data 1972 to 2005. The results of cointegration approach confirmed LR relationship among education, labour force, capital and *RGDP*. Casualty results confirmed the unidirectional causality running from *RGDP* to higher education. This study applied university enrollment as the improper proxy for higher education. Higher education in Pakistan consists of college education and university education. If proper proxy of higher education was used, than it may possible that higher education may cause to EG in Pakistan.

By utilizing ten different indicators of education and applying ARDL approach to cointegration and Toda-Yamamoto (TY) technique to test causality, Afzal *et al.* (2011) examined the cointegration and causality in education and EG of Pakistan for the period of 1971-72 to 2008-09. The results of their study confirmed the LR relationship among education, labour force, physical capital and EG in case of Pakistan. The results of the TY causality confirmed the two way linkage between education and EG. Further, they recommend that more investment in university education led to more EG.

Stengos and Aurangzeb (2008) analyzed the effect of education on EG in Pakistan for the time period 1973-2001. They have applied the Levine Renelt methodology to check the causal impact of education on growth. The results of their study confirm that education has a robust effect on growth. Human capital can be developed through the saving and investing in health and education sectors. Moav and Neeman (2008) found that human capital and poverty are inversely related. The people who concern about their status save more and consume less. Whereas, less educated people does not concern about their status and thus they remain in the poverty trap.

Wadud *et al.* (2007) confirmed the evidence of bidirectional causality between education and EG for Bangladesh. Liu (2005) investigated the linkage between education and EG. He used cointegration and Granger causality approaches in his analysis. The results showed that EG caused primary education. On the other hand, higher education caused EG. Cointegration does not exist between education and EG in this study.

Katircioglo (2009) tested LR relationship and checked causality between higher education and EG in North Cyprus. The author applied cointegration and Granger causality tests in his analysis. The results of this study showed that there existed LR relationship between education and EG. Unidirectional causality also found that ran from higher education to EG. Higher education led growth hypothesis is recommended for the Turkish Cypriot economy.

Keeping in view the above discussion and previous studies, the main objective of this study was to explore the linkages among education, food inflation and EG by including other variables like labour force, physical capital, and health. The present study is different from all of the above studies in the respect that this study applies more suitable econometric technique to check the robustness of the results. There is hardly any study in literature that covers the combine effects of education, health, food inflation, labour force, physical capital and EG for Pakistan.

III. DATA SOURCES AND METHODOLOGY

The reliability of empirical results always depends upon data frequency, data span, data sources and last but not the least, the methodology used in the analysis. This section includes data sources and methodology that have been used in this study.

Data Sources

The present research work uses annual time series data on real GDP, education, health, labour force, Sensitive Price Index (SPI) as a measure of inflation and physical capital for the span of 1971-1972 to 2010-2011 in case of Pakistan. Data were collected from various issues of *Annual Reports State Bank of Pakistan*, *Pakistan Economic Survey* and various publications of *Pakistan Bureau of Statistics*.

Methodology

A variety of functional forms were tested to check the relationship among EG, education, health, food inflation, labour force, and physical capital. The most suitable functional form which was free from econometric problems *i.e.,* log-lin form of the interested variables was specified as:

$$\ln RY = \gamma_0 + \gamma_1 \ln PK + \gamma_2 \ln L + \gamma_3 \ln Ed + \gamma_4 \ln H + \gamma_5 \ln Finf + \varepsilon_1 \quad (1)$$

Where:

ln = Natural logarithm

RY = Real GDP, a proxy that is used to measure EG. This proxy was used by Katircioglu (2009), Chaudhary *et al.* (2009), Jin (2008), Abbas and Peck (2007) and Wadud *et al.* (2007); Afzal *et al.* (2010), Afzal *et al.* (2011) and Afzal *et al.* (2012).

PK = Real physical capital is measured through real fixed capital formation. This proxy for real physical capital was used by Chaudhary *et al.* (2009); Khorasgani (2008); Abbas and Peck (2007); Afzal *et al.* (2010), Afzal *et al.* (2011) and Afzal *et al.* (2012).

L = Total labour force is a proxy for measuring the stock of labour. It was already utilized by Wadud *et al.* (2007) and Chaudhary et al. (2009); Afzal *et al.* (2010) and Afzal *et al.* (2011).

Ed = Education index. In literature, education is measured by enrollment rates or by expenditures on education, but this research work utilizes a more comprehensive measure of education *i.e.,* Education Index. This proxy for education was also used by Afzal *et al.* (2011), Afzal *et al.* (2012) and Afzal *et al.* (2012). Education index was developed by using 2000 UNDP methodology as:

$$\text{Education Index} = \frac{2}{3} * ALI + \frac{1}{3} * GEI$$

$$\text{Adult Literacy Index } (ALI) = \frac{ALR - \min}{\max - \min} = \frac{ALR - 0}{100 - 0}$$

$$\text{Gross Enrollment Index } (GEI) = \frac{GER - \min}{\max - \min} = \frac{GER - 0}{100 - 0}$$

H = Health. Many studies have used expenditures on health as a proxy to measure health which is not free from shortcomings.

This study uses a more comprehensive measure of health *i.e.,* life expectancy index (LEI). Life expectancy index was constructed by using 2000 UNDP methodology as:

$$\text{Life Expectancy Index } (LEI) = \frac{LE - \min}{\max - \min} = \frac{LE - 25}{85 - 25}$$

Life expectancy means the expected (in the statically sense) number of years of life remaining at given age.

Finf= Food inflation. Food inflation is measured by Sensitive Price Index (SPI) in this empirical work.

Auto-Regressive Distributed Lag (ARDL) Approach to Cointegration

Engle-Granger (1987) residual based test, Johansen (1988, 1991), Johansen and Juselius (1990) Maximum Likelihood based test and Gregory and Hansen (1996) are commonly used tests that exists in literature for conducting cointegration. However, these techniques face many problems like low power and stationarity problems. These tests also do not capture the effect of small data set. To overcome the above said problem, the present study applied the ARDL cointegration approach proposed by Pesaran (1997) and Pesaran and Shin (1995, 1999). Pesaran *et al.* (2001) further extended the ARDL approach. ARDL have superiority over other cointegration techniques. Firstly, it can be applied when the variables are I(0) or I(1) or mutually integrated, but still it is pre-requisite that none of the variable is of I(2). Secondly, it takes care of the problem of endogeneity. Thirdly, ARDL approach is helpful in data generating process through taking sufficient number of lags general-to-specific modeling framework. Fourthly, comparison to other VAR models, ARDL approach can be accommodating greater number of variables. Finally, ARDL approach performs better and gives more robust results in case of small data set, *i.e.* 30-70, observations. Banerjee *et al.* (1993) state that Dynamic Error Correction Model (DECM) can be obtained from ARDL through a simple linear transformation. DECM gives the SR coefficient without losing the LR information.

Unit Root (UR) Tests

It is still prerequisite to make sure that not a single one variable used in the study is of order 2 or higher order while applying the ARDL technique to cointegration, because the calculated F-statistic doesn't remain valid in the

presence of order 2 or higher orders (Ouattara, 2004; Sezgin and Yildirm, 2002). So, testing UR is very crucial before estimating the ARDL model. For this purpose, the present study used various tests of UR to check the robustness of the results. Augmented Dickey-Fuller UR test (ADF), DF-GLS, Phillips-Perron (PP) and Ng-Perron UR tests have been applied in this study.

Like cointegration, different causality techniques are also available in literature. The present research utilizes a relatively more robust and problem freee causality approach known as 'TY Augmented Causality Approach (1995)'. A brief introduction of this causality technique is given below.

Toda Yamamoto (TY) Approach to Causality

Various tests are available to check the causality among variables, *i.e.* Granger (1969), Engle and Granger (1987) and Johansen and Juselius (1990). These tests are not free from errors, like they require pre-testing of stationarity, selection of maximum lag length and they are very sensitive to modal specification. So, in these test, it is necessary to pre-testing the UR and cointegration. To overcome these problems, the present study applied a more robust causality approach given by TY (1995) and it was further explained by Rambaldi and Doran (1996) and Zapata and Rambaldi (1997). The 'Augented Granger Causality' given by 'TY (1995)' is very simple to apply and it also follows asymptotic Chi-square distribution. The major advantage of above said approach is that, in this technique, it is not necessary to check the pre testing the order of integration or cointegration properties among variables (Toda Yamamoto, 1995; Dolado and Luthepoha, 1996; Giles and Mirza, 1999). Rambaldi and Doran (1996) have modified Wald test that is considered more efficient when Seemingly Unrelated Regression (SUR) Model is used in the estimation. One of the attractiveness of using SUR model is that it takes care of possible simultaneity bias in system of equations.

IV. EMPIRICAL RESULTS AND INTERPRETATION

To examine the relationship among EG, stock of labour, physical capital, education, health and food inflation, different tests have been applied. In this part of the study, the results of different 'UR tests', 'ARDL Cointegration' 'and 'TY Causality' techniques are being presented:

UR Results

Table 1 presents a summary of the results of various UR tests regarding the order of integration.

TABLE 1

Integration

Variable	ADF		PP		DF-GLS		Ng-Perron	
	Intercept	Intercept & trend	Intercept	Intercept & trend	Intercept	Interpret & trend	Intercept	Intercept & trend
ln *RY*	Order 1		Order 1		Order 1		Order Zero	
ln *PK*	Order 1		Order 1		Order 1			Order Zero
ln *L*	Order 1		Order 1		Order 1		Order 1	
ln *Ed*		Order Zero		Order Zero		Order Zero		Order Zero
ln *H*	Order 1		Order 1		Order 1		Order 1	
ln *Finf*	Order 1		Order 1		Order 1		Order 1	

In Table 1 each of ln *RY*, ln *L*, ln *PK*, ln *H* and ln *Finf* are of order 1{I(1)} with constant, according to ADF, PP, DF-GLS UR criteria. Not a single one variable of this study is of order 2 {I(2)} according to all UR criteria. Hence, ARDL approach to cointegration is the suitable one and is being applied.

Cointegration Results

To estimate the SR and LR relationship among EG, education, health, labour force, physical capital and food inflation, the present research used the Error-Correction version of ARDL model of equation (1) as:

$$\begin{aligned}\Delta \ln RY = {} & a_{0RY} + \sum_{i=1}^{n} b_{iRY} \ \Delta \ln RY_{t-i} + \sum_{i=1}^{n} c_{iRY} \ \Delta \ln PK_{t-i} + \sum_{i=1}^{n} d_{iRY} \ \Delta \ln L_{t-i} \\ & + \sum_{i=1}^{n} e_{iRY} \ \Delta \ln Ed_{t-i} + \sum_{i=1}^{n} f_{iRY} \ \Delta \ln H_{t-i} + \sum_{i=1}^{n} g_{iRY} \ \Delta \ln Finf_{t-i} \\ & + \delta_{1RY} \ln RY_{t-1} + \delta_{2RY} PK_{t-1} + \delta_{3RY} L_{t-1} + \delta_{4RY} Ed_{t-1} + \delta_{5RY} H_{t-1} \\ & + \delta_{6RY} Finf_{t-1} \end{aligned} \quad \text{(A)}$$

The first step in ARDL approach is to examine the LR relationship among the interested variables by carrying out familiar F-statistic on the differenced variables components of 'Unrestricted Error Correction Model' (UECM) for the joint significance of the coefficients of lagged level of the variables. The equation estimated for the regressand *RY* was defined in the first step as:

$$\Delta \ln RY = a_{0\mathrm{RY}} + \sum_{i=1}^{n} b_{iRY} \Delta \ln RY_{t-i} + \sum_{i=0}^{n} c_{iRY} \Delta \ln PK_{t-i} + \sum_{i=0}^{n} d_{iRY} \Delta \ln L_{t-i} + \sum_{i=0}^{n} e_{iRY} \Delta \ln Ed_{t-i} + \sum_{i=0}^{n} f_{iRY} \Delta \ln Finf_{t-i} + \sum_{i=0}^{n} g_{iRY} \Delta \ln H_{t-i} \quad \text{(B)}$$

To construct 'Error Correction Mechanism (ECM)', the first lag of the level of each variable is added into the equation (B) and a "Variable Addition Test" is performed by estimating F-test on the joint significance of all the added lagged level variables as.

$$\Delta \ln RY = a_{0\mathrm{RY}} + \sum_{i=1}^{n} b_{iRY} \Delta \ln RY_{t-i} + \sum_{i=0}^{n} c_{iRY} \Delta \ln PK_{t-i} + \sum_{i=0}^{n} d_{iRY} \Delta \ln L_{t-i} + \sum_{i=0}^{n} e_{iRY} \Delta \ln ED_{t-i} + \sum_{i=0}^{n} f_{iRY} \Delta \ln Finf_{t-i} + \sum_{i=0}^{n} g_{iRY} \Delta \ln H_{t-i} + \delta_{1\mathrm{RY}} \ln RY_{t-1} + \delta_{2\mathrm{RY}} \ln PK_{t-1} + \delta_{3\mathrm{RY}} \ln L_{t-1} + \delta_{4\mathrm{RY}} \ln ED_{t-1} + \delta_{5\mathrm{RY}} \ln Finf_{t-1} + \delta_{6\mathrm{RY}} \ln H_{t-1} \quad \text{(C)}$$

The ARDL approach has been applied to study the SR and LR linkages among the said variables. The results of ARDL approach to cointegration are presented in Table 2.

TABLE 2

Cointegration

Regressand	Lag length				Output
When ln *RY* is regressand	1	2	3	4	
Δ ln *RY* [*F* ln *RY* (ln *RY* / ln *PK*, ln *L*, ln *Ed*, ln *Finf*, ln *H*)]	2.602 [0.049]	10.991 [0.000]	6.827 [0.000]	5.248 [0.002]	Cointegration

Lower and upper critical values for bounds testing ARDL for 1%, 5% and 10% significance levels are 3.65-4.66, 2.79-3.67 and 2.37-3.20, respectively.

The results in Table 2 indicate that there establishes cointegrating relationship among ln *RY*, ln *PK*, ln *L*, ln *H*, ln *Finf* and ln *Ed*, when ln *RY* is the regressand, as at least one F-value is higher than that of the value of upper critical bounds.

TABLE 3

Dynamic ARDL (3, 3, 3, 1, 2, 3) Model

(Regressand = *RY*)

Regressor	Coefficient	T-value (p-value)
ln *RY*(–1)	0.5705	2.6243 (0.020)
ln *RY*(–2)	–0.2596	–1.2808 (0.221)
ln *RY*(–3)	0.1989	1.4403 (0.172)
ln *PK*	0.1237	2.2716 (0.039)
ln *PK*(–1)	–0.0789	–0.9280 (0.369)
ln *PK*(–2)	0.0945	1.1552 (0.267)
ln *PK*(–3)	0.0702	1.1172 (0.283)
ln *L*	0.4398	2.0634 (0.058)
ln *L*(–1)	0.3600	1.3755 (0.191)
ln *L*(–2)	–0.4045	–1.3897 (0.186)
ln *L*(–3)	0.6465	2.3690 (0.033)
ln *Ed*	0.1200	1.7059 (0.110)
ln *Ed*(–1)	0.1139	1.6038 (0.131)
ln *Finf*	–0.0555	–1.9523 (0.071)
ln *Finf*(–1)	0.0360	1.0429 (0.315)
ln *Finf*(–2)	–0.0599	–1.8215 (0.090)
ln *H*	0.0835	.84836 (0.411)
ln *H*(–1)	0.2099	1.7389 (0.104)
ln *H*(–2)	–0.2966	–2.7258 (0.016)
ln *H*(–3)	0.1813	1.9569 (0.071)
Constant	0.3852	0.60297 (0.556)
Diagnostic Tests: R^2 = 0.99 DW-value = 2.11 F-statistic = 1420.1 (0.000)	Auto Correlation (LM) = 0.8181 (0.336) Functional Form (LM) = 0.6260 (0.980) Heteroscedasticity (LM) = 2.3720 (0.124) Normality (LM) = 1.6915 (0.429)	

The results of dynamic ARDL (3, 3, 3, 1, 2, 3) model based on R-BAR criterion are presented in Table 3. The results in Table 3 tell that the ln *PK*, ln *L* and ln *Ed* seems to have the positive and significant impact on ln *RY*, while the ln *Finf* seems to have the negative and significant impact on ln *RY*. The model also qualified entire diagnostic tests.

After estimating the dynamic model, the results of LR estimated coefficients are set in Table 4.

TABLE 4

Estimated Long-Run Coefficients of ARDL (3, 3, 3, 1, 2, 3) Model

(Regressand = *RY*)

Regressor	Coefficient	T-value (p-value)
ln *PK*	0.4349	6.0640 (0.000)
ln *L*	2.1256	9.1578 (0.000)
ln *Ed*	0.4773	3.5703 (0.003)
ln *Finf*	–0.1621	–2.0593 (0.059)
ln *H*	0.3636	1.7773 (0.097)
Constant	0.7859	0.6134 (0.549)

The results in Table 4 reveal that the ln *PK*, ln *L*, ln *Ed* and ln *H* have the positive and significant LR relationship with ln *RY*. In LR, an increase in each of ln *PK*, ln *L*, ln *Ed* and ln *H* leads to an increase in ln *RY*. On the other side, ln *Finf* has the negative and significant LR relation with ln *RY*.

After explaining LR coefficients, the estimated SR coefficients of ARDL (3, 3, 3, 1, 2, 3) are shown in Table 5. The results in Table 5 reveal that the ln *PK*, ln *L*, ln *Ed* and ln *H* have the positive and significant SR relationship with ln *RY*. The food inflation has negative and significant impact on ln *RY* in the SR. Error Correction Term is highly significant with negative sign, indicating the establishment of cointegration and LR causality among ln *RY*, ln *Ed*, ln *H*, ln *L*, ln *PK* and ln *Finf*, when ln *RY* serves as a regressand.

TABLE 5

Short-Run Results of ARDL (3, 3, 3, 1, 2, 3) Model

(Regressand = *RY*)

Regressor	Coefficient	T-value (p-value)
d ln *RY*(1)	0.0607	0.31485(0.756)
d ln *RY*(2)	–0.1989	–1.4403(0.166)
d ln *Pk*	0.1274	2.2716(0.035)
d ln *Pk*(1)	–0.1648	–2.3485(0.030)
d ln *Pk* (2)	–0.0703	–1.1172(0.278)
d ln *L*	0.4400	2.0634(0.053)
d ln *L*(1)	–0.2420	–0.96926(0.345)
d ln *L*(2)	–0.6465	–2.3690(0.029)
d ln *Ed*	0.1200	1.7059(0.104)
d ln *Finf*	–0.0556	–1.9523(0.066)
d ln *Finf*(1)	0.0600	1.8215(0.084)
d ln *H*	0.0836	0.84836(0.407)
d ln *H*(1)	0.1153	1.0557(0.304)
d ln *H*(2)	–0.1814	–1.9569(0.065)
Constant	0.3853	0.60297(0.554)
ecm(–1)	–0.4902	-4.5027(0.000)
ecm = ln *RGDP* – 0.4349 ln *PK* – 2.1256 ln *L* – 0.4773 ln *Ed* + 0.1621 ln *Finf* – 0.3636 ln *H* – 0.78591 constant		
Diagnostic Test Statistics: R^2 = 0 .79770, F-value = 3.6803(0.004), DW-statistic = 2.1173		

Stability Tests

The stability of model 1 was checked by applying CUSUM and CUSUMSQ tests (CCST) in Figures 1 and 2. The CCST confirms that the results are stable as the calculated lines lie inside the critical bounds at 95 percent level of confidence. The results in Figures 1 and 2 depict that the lines are within the critical bounds. This implies that the model is statistically stable. It can easily be concluded that there is no structural break in the model. The model can also safely be used for prediction purposes.

FIGURE 1

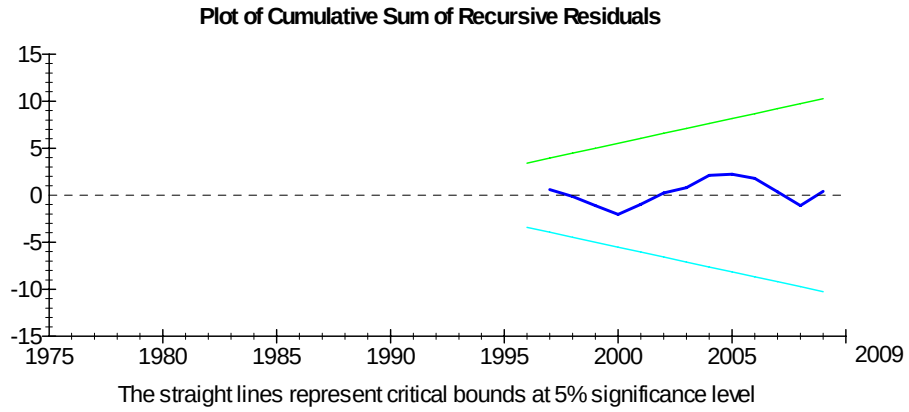
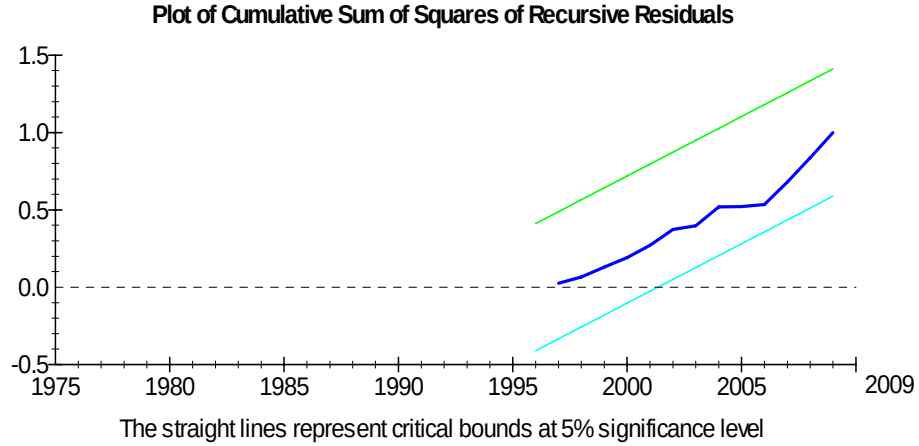


FIGURE 2



Toda-Yamamoto Augmented Granger Causality Tests (TYAGCT)

To check the causality among ln *RY*, ln *PK*, ln *L*, ln *Ed*, ln *Finf* and ln *H*, this study utilized the TYAGCT. The following models were being estimated to apply the TYAGCT:

$$\ln RY_t = \alpha_1 + \sum_{i=1}^{3} \beta_{1i} \ln RY_{t-i} + \sum_{i=1}^{3} \gamma_{1i} \ln Ed_{t-i} + u_{1t} \quad (1)$$

$$\ln Ed_t = \alpha_2 + \sum_{i=1}^{3} \beta_{2i} \ln Ed_{t-i} + \sum_{i=1}^{3} \gamma_{2i} \ln RY_{t-i} + u_{2t} \quad (2)$$

$$\ln RY_t = \alpha_3 + \sum_{i=1}^{3} \beta_{3i} \ln RY_{t-i} + \sum_{i=1}^{3} \gamma_{3i} \ln F\inf_{t-i} + u_{3t} \tag{3}$$

$$\ln F\inf_t = \alpha_4 + \sum_{i=1}^{3} \beta_{4i} \ln F\inf_{t-i} + \sum_{i=1}^{3} \gamma_{4i} \ln RY_{t-i} + u_{4t} \tag{4}$$

$$\ln Ed_t = \alpha_5 + \sum_{i=1}^{3} \beta_{5i} \ln Ed_{t-i} + \sum_{i=1}^{3} \gamma_{5i} \ln F\inf_{t-i} + u_{5t} \tag{5}$$

$$\ln F\inf_t = \alpha_6 + \sum_{i=1}^{3} \beta_{6i} \ln F\inf_{t-i} + \sum_{i=1}^{3} \gamma_{6i} \ln Ed_{t-i} + u_{6t} \tag{6}$$

$$\ln RY_t = \alpha_7 + \sum_{i=1}^{3} \beta_{7i} \ln RY_{t-i} + \sum_{i=1}^{3} \gamma_{7i} \ln Ed_{t-i} + \sum_{i=1}^{3} \delta_{7i} \ln F\inf_{t-i} + u_{7t} \tag{7}$$

$$\ln Ed_t = \alpha_8 + \sum_{i=1}^{3} \beta_{8i} \ln Ed_{t-i} + \sum_{i=1}^{3} \gamma_{8i} \ln RY_{t-i} + \sum_{i=1}^{3} \delta_{8i} \ln F\inf_{t-i} + u_{8t} \tag{8}$$

$$\ln F\inf_t = \alpha_9 + \sum_{i=1}^{3} \beta_{9i} \ln F\inf_{t-i} + \sum_{i=1}^{3} \gamma_{9i} \ln Ed_{t-i} + \sum_{i=1}^{3} \delta_{9i} \ln RY_{t-i} + u_{9t} \tag{9}$$

TABLE 6

TYAGCT

Model	Null Hypothesis (H_0)	Test Statistic: Wald test (χ^2-statistic)		
		Value	df	Prob.
BIVARIATE CAUSALITY				
ln RY and ln Ed				
Model 1	ln *Ed* causes not ln *RY*	2.811 [0.094]	1	Reject*
Model 2	ln *RY* causes not ln *Ed*	30.26 [0.000]	1	Reject*
ln RY and ln Finf				
Model 3	ln *RY* causes not ln *Finf*	17.74 [0.000]	1	Reject*
Model 4	ln *Finf* causes not ln *RY*	23.23 [0.000]	1	Reject*
ln Ed and ln Finf				
Model 5	ln *Ed* causes not ln *Finf*	23.11 [0.000]	1	Reject*
Model 6	ln *Finf* causes not ln *Ed*	3.669 [0.055]	1	Reject*

Model	Null Hypothesis (H_0)	Test Statistic: Wald test (χ^2-statistic)		
		Value	df	Prob.
TRIVARIATE CAUSALITY				
ln RY, ln Ed and ln Finf				
Model 7	ln *Finf* causes not ln *RY*	22.37 [0.000]	1	Reject*
Model 7	ln *Ed* causes not ln *RY*	3.410 [0.065]	1	Reject*
Model 8	ln *RY* causes not ln *Ed*	34.15 [0.000]	1	Reject*
Model 8	ln *Finf* causes not ln *Ed*	2.300 [0.129]	1	Cannot Reject*
Model 9	ln *Ed* causes not ln *Finf*	4.398 [0.036]	1	Reject*
Model 9	ln *RY* causes not ln *Finf*	0.489 [0.484]	1	Cannot Reject*

*Reject H_0

The models 1 and 2, are estimated by SUR method.

The **bivariate** and **trivariate** causality results are given in Table 6. The results in Table 6 show that there exists bivariate causality in all bivariate cases, *i.e.* ln *Ed* to ln *Finf*, ln *RY* to ln *Finf*. The results of trivariate causality tell that there is feedback causality in Ed and RY, one- way causality that is running from ln *Finf* to ln *RY* and ln *Ed* to *ln Finf is* also found.

$$\ln RY_t = \alpha_{10} + \sum_{i=1}^{3} \beta_{10i} \ln RY_{t-i} + \sum_{i=1}^{3} \gamma_{10i} \ln PK_{t-i} + \sum_{i=1}^{3} \delta_{10i} \ln Ed_{t-i} + \sum_{i=1}^{3} \gamma_{10i} \ln F\inf_{t-i} + u_{10t} \quad (10)$$

$$\ln Ed_t = \alpha_{11} + \sum_{i=1}^{3} \beta_{11i} \ln Ed_{t-i} + \sum_{i=1}^{3} \gamma_{11i} \ln PK_{t-i} + \sum_{i=1}^{3} \delta_{11i} \ln RY_{t-i} + \sum_{i=1}^{3} \gamma_{11i} \ln F\inf_{t-i} + u_{11t} \quad (11)$$

$$\ln F\inf_t = \alpha_{12} + \sum_{i=1}^{3} \beta_{12i} \ln F\inf_{t-i} + \sum_{i=1}^{3} \gamma_{12i} \ln PK_{t-i} + \sum_{i=1}^{3} \delta_{12i} \ln Ed_{t-i} + \sum_{i=1}^{3} \gamma_{12i} \ln RY_{t-i} + u_{12t} \quad (12)$$

$$\ln RY_t = \alpha_{13} + \sum_{i=1}^{3} \beta_{13i} \ln RY_{t-i} + \sum_{i=1}^{3} \gamma_{13i} \ln L_{t-i} + \sum_{i=1}^{3} \delta_{13i} \ln Ed_{t-i} + \sum_{i=1}^{3} \gamma_{13i} \ln F\inf_{t-i} + u_{13t} \tag{13}$$

$$\ln Ed_t = \alpha_{14} + \sum_{i=1}^{3} \beta_{14i} \ln Ed_{t-i} + \sum_{i=1}^{3} \gamma_{14i} \ln L_{t-i} + \sum_{i=1}^{3} \delta_{14i} \ln RY_{t-i} + \sum_{i=1}^{3} \gamma_{14i} \ln F\inf_{t-i} + u_{14t} \tag{14}$$

$$\ln F\inf_t = \alpha_{15} + \sum_{i=1}^{3} \beta_{15} \ln F\inf_{t-i} + \sum_{i=1}^{3} \gamma_{15i} \ln L_{t-i} + \sum_{i=1}^{3} \delta_{15i} \ln Ed_{t-i} + \sum_{i=1}^{3} \gamma_{15i} \ln RY_{t-i} + u_{15t} \tag{15}$$

$$\ln RY_t = \alpha_{16} + \sum_{i=1}^{3} \beta_{16i} \ln RY_{t-i} + \sum_{i=1}^{3} \gamma_{16i} \ln H_{t-i} + \sum_{i=1}^{3} \delta_{16i} \ln Ed_{t-i} + \sum_{i=1}^{3} \gamma_{16i} \ln F\inf_{t-i} + u_{16t} \tag{16}$$

$$\ln Ed_t = \alpha_{17} + \sum_{i=1}^{3} \beta_{17i} \ln Ed_{t-i} + \sum_{i=1}^{3} \gamma_{17i} \ln H_{t-i} + \sum_{i=1}^{3} \delta_{17i} \ln RY_{t-i} + \sum_{i=1}^{3} \gamma_{17i} \ln F\inf_{t-i} + u_{17t} \tag{17}$$

$$\ln F\inf_t = \alpha_{18} + \sum_{i=1}^{3} \beta_{18i} \ln F\inf_{t-i} + \sum_{i=1}^{3} \gamma_{18i} \ln H_{t-i} + \sum_{i=1}^{3} \delta_{18i} \ln Ed_{t-i} + \sum_{i=1}^{3} \gamma_{18i} \ln RY_{t-i} + u_{18t} \tag{18}$$

Table 7 presents the results of ***tetra-variate*** causality. There are three cases of tetra-variate causality the first one is 'ln *Ed*, ln *RY*, ln *Finf*, ln *PK*', the second one is 'ln *RY*, ln *Ed*, ln *Finf*, ln *L*' and the last one is 'ln *RY*, ln *Ed*, ln *Finf*, ln *H*'.

The results of models 10, 11 and 12 in Table 7 show that *Ed*, *Finf* and *PK* cause *RY*. On the other side, ln *RY*, ln *Finf* and ln *PK* cause ln *Ed*. The null hypothesis that ln *RY*, ln *PK* causes not ln *Finf* is rejected, while ln *Ed* causes not ln *Finf* is rejected. So, in first case bidirectional causality exists between ln *Ed* and ln *RY*, between ln *Finf* and ln *RY* and unidirectional causality is running from ln *Finf* to ln *Ed*.

TABLE 7

TYAGCT

Model	Null Hypothesis (H_0)	Test Statistic: Wald test (χ^2-statistic)		
		Value	df	Prob.
TETRAVARIATE CAUSALITY				
ln RY, ln Ed, ln Finf and ln PK				
Model 10	ln *Ed* causes not ln *RY*	2.6605 [0.103]	1	Reject*
Model 10	ln *Finf* causes not ln *RY*	21.575 [0.000]	1	Reject*
Model 10	ln *PK* causes not ln *RY*	4.7369 [0.030]	1	Reject*
Model 11	ln *RY* causes not ln *Ed*	27.917 [0.000]	1	Reject*
Model 11	ln *Finf* causes not ln *Ed*	6.0960 [0.014]	1	Reject*
Model 11	ln *PK* causes not ln *Ed*	6.0792 [0.014]	1	Reject*
Model 12	ln *RY* causes not ln *Finf*	3.2366 [0.072]	1	Reject*
Model 12	ln *Ed* causes not ln *Finf*	0.0839 [0.772]	1	Cannot Reject*
Model 12	ln *PK* causes not ln *Finf*	6.6423 [0.010]	1	Reject*
ln RY, ln Ed, ln Finf and ln L				
Model 13	ln *Ed* causes not ln *RY*	4.6007 [0.032]	1	Reject*
Model 13	ln *Finf* causes not ln *RY*	1.8742 [0.171]	1	Cannot Reject*
Model 13	ln *L* causes not ln *RY*	44.230 [0.000]	1	Reject*
Model 14	ln *RY* causes not ln *Ed*	5.4496 [0.020]	1	Reject*
Model 14	ln *Finf* causes not ln *Ed*	4.0174 [0.045]	1	Reject*
Model 14	ln *L* causes not ln *Ed*	1.9077 [0.167]	1	Cannot Reject*
Model 15	ln *RY* causes not ln *Finf*	4.1913 [0.041]	1	Reject*
Model 15	ln *Ed* causes not ln *Finf*	2.1544 [0.142]	1	Cannot Reject*
Model 15	ln *L* causes not ln *Finf*	9.0653 [0.003]	1	Reject*
ln RY, ln Ed, ln Finf and ln H				
Model 16	ln *Ed* causes not ln *RY*	0.4865 [0.485]	1	Cannot Reject*
Model 16	ln *Finf* causes not ln *RY*	15.597 [0.000]	1	Reject*
Model 16	ln *H* causes not ln *RY*	0.9018 [0.342]	1	Cannot Reject*
Model 17	ln *RY* causes not ln *Ed*	3.2599 [0.071]	1	Reject*
Model 17	ln *Finf* causes not ln *Ed*	10.044 [0.002]	1	Reject*
Model 17	ln *H* causes not ln *Ed*	8.9394 [0.003]	1	Reject*
Model 18	ln *RY* causes not ln *Finf*	4.1913 [0.041]	1	Reject*
Model 18	ln *Ed* causes not ln *Finf*	2.1544 [0.142]	1	Cannot Reject*
Model 18	ln *H* causes not ln *Finf*	9.0653 [0.003]	1	Reject*

*Reject H_0

The results of models 13, 14 and15 in Table 7 show that ln *Ed*, and ln *L* cause ln *RY*, while *Finf* causes not ln *RY*. The ln *RY* and ln *Finf* cause ln *Ed* but ln *L* causes not ln *Ed*. The null hypothesis of ln *RY* and ln *L* cause not ln *Finf* is rejected, while ln *Ed* causes not ln *Finf* is not rejected. In this case, bidirectional causality also exists between ln *Ed* and ln *RY* and one way causality that is running from ln *RY* to ln *Finf* and ln *Finf* to ln *Ed* is also found.

The results of models 16, 17 and 18 in Table 7 show that ln *Finf* causes ln *RY* but ln *H* and ln *Ed* causes not ln *RY*. On the other side, ln *RY*, ln *Finf* and ln *H* cause ln *Ed*. The null hypothesis that ln *RY* and ln *H* cause not ln *Finf* is rejected. While, ln *Ed* causes ln *Finf* does not rejected. Therefore, unidirectional causality is running from ln *RY* to ln *Ed*, ln *Finf* to ln *Ed* and bidirectional causality exists between ln *Finf* and ln *RY*.

$$\ln RY_t = \alpha_{19} + \sum_{i=1}^{3}\beta_{19i}\ln RY_{t-i} + \sum_{i=1}^{3}\gamma_{19i}\ln PK_{t-i} + \sum_{i=1}^{3}\delta_{19i}\ln Ed_{t-i} + \sum_{i=1}^{3}\gamma_{19i}\ln F\inf_{t-i} + \sum_{i=1}^{3}\gamma_{19i}\ln L_{t-i} + u_{19t} \tag{19}$$

$$\ln Ed_t = \alpha_{20} + \sum_{i=1}^{3}\beta_{20i}\ln Ed_{t-i} + \sum_{i=1}^{3}\gamma_{20i}\ln PK_{t-i} + \sum_{i=1}^{3}\delta_{20i}\ln RY_{t-i} + \sum_{i=1}^{3}\gamma_{20i}\ln F\inf_{t-i} + \sum_{i=1}^{3}\gamma_{20i}\ln L_{t-i} + u_{20t} \tag{20}$$

$$\ln F\inf_t = \alpha_{21} + \sum_{i=1}^{3}\beta_{21i}\ln F\inf_{t-i} + \sum_{i=1}^{3}\gamma_{21i}\ln PK_{t-i} + \sum_{i=1}^{3}\delta_{21i}\ln Ed_{t-i} + \sum_{i=1}^{3}\gamma_{21i}\ln RY_{t-i} + \sum_{i=1}^{3}\gamma_{21i}\ln L_{t-i} + u_{21t} \tag{21}$$

$$\ln RY_t = \alpha_{22} + \sum_{i=1}^{3}\beta_{22i}\ln RY_{t-i} + \sum_{i=1}^{3}\gamma_{22i}\ln PK_{t-i} + \sum_{i=1}^{3}\delta_{22i}\ln Ed_{t-i} + \sum_{i=1}^{3}\gamma_{22i}\ln F\inf_{t-i} + \sum_{i=1}^{3}\gamma_{22i}\ln H_{t-i} + u_{22t} \tag{22}$$

$$\ln Ed_t = \alpha_{23} + \sum_{i=1}^{3}\beta_{23i}\ln Ed_{t-i} + \sum_{i=1}^{3}\gamma_{23i}\ln PK_{t-i} + \sum_{i=1}^{3}\delta_{23i}\ln RY_{t-i} + \sum_{i=1}^{3}\gamma_{23i}\ln F\inf_{t-i} + \sum_{i=1}^{3}\gamma_{23i}\ln H_{t-i} + u_{23t} \tag{23}$$

$$\ln F\inf_t = \alpha_{24} + \sum_{i=1}^{3}\beta_{24i}\ln F\inf_{t-i} + \sum_{i=1}^{3}\gamma_{24i}\ln PK_{t-i} + \sum_{i=1}^{3}\delta_{24i}\ln Ed_{t-i} + \sum_{i=1}^{3}\gamma_{24i}\ln RY_{t-i} + \sum_{i=1}^{3}\gamma_{24i}\ln H_{t-i} + u_{24t} \quad (24)$$

$$\ln RY_t = \alpha_{25} + \sum_{i=1}^{3}\beta_{25i}\ln RY_{t-i} + \sum_{i=1}^{3}\gamma_{25i}\ln H_{t-i} + \sum_{i=1}^{3}\delta_{25i}\ln Ed_{t-i} + \sum_{i=1}^{3}\gamma_{25i}\ln F\inf_{t-i} + \sum_{i=1}^{3}\gamma_{25i}\ln L_{t-i} + u_{25t} \quad (25)$$

$$\ln Ed_t = \alpha_{26} + \sum_{i=1}^{3}\beta_{26i}\ln Ed_{t-i} + \sum_{i=1}^{3}\gamma_{26i}\ln H_{t-i} + \sum_{i=1}^{3}\delta_{26i}\ln RY_{t-i} + \sum_{i=1}^{3}\gamma_{26i}\ln F\inf_{t-i} + \sum_{i=1}^{3}\gamma_{26i}\ln L_{t-i} + u_{26t} \quad (26)$$

$$\ln F\inf_t = \alpha_{27} + \sum_{i=1}^{3}\beta_{27i}\ln F\inf_{t-i} + \sum_{i=1}^{3}\gamma_{27i}\ln H_{t-i} + \sum_{i=1}^{3}\delta_{27i}\ln Ed_{t-i} + \sum_{i=1}^{3}\gamma_{27i}\ln RY_{t-i} + \sum_{i=1}^{3}\gamma_{27i}\ln L_{t-i} + u_{27t} \quad (27)$$

In Table 8, the results of ***pentavariate*** causality are being presented. There are three cases of pentavariate causality, the first one is ln *Ed*, ln *RY*, ln *Finf*, ln *PK*, ln *L*, the second one is ln *RY*, ln *Ed*, ln *Finf*, ln *PK*, ln *H* and the last one is ln *RY*, ln *Ed*, ln *Finf*, ln *L*, ln *H*.

The results of models 19, 20 and 21 in Table 8 show that ln *Ed* and ln *Finf* causes not ln *RY*, while ln *RY* and ln *Finf* causes ln *Ed*, and ln *RY* and ln *Ed* causes ln *Finf*. So, in first case bidirectional causality exists between *Finf* and *Ed*, and unidirectional causality running from *RY* to *Ed* and *RY* to *Finf*.

The results of models 22, 23 and 24 in Table 8 show that ln *Ed* causes not ln *RY* but ln *Finf* causes ln *RY*. On the other side, ln *RY* and *Finf* cause ln *Ed* and ln *RY* and ln *Ed* cause ln *Finf*. In this case, bidirectional causality exists among *RY* and *Finf*, *Ed* and *Finf*, while unidirectional causality running from *RY* to *Ed*.

The results of models 25, 26 and 27 in Table 8 show that ln *Ed* causes ln *RY* but ln *Finf* causes not ln *RY*. On the other side, ln *RY* and ln *Finf* cause ln *Ed*. The null hypothesis that ln *RY* causes not ln *Finf* is not rejected and

ln *Ed* causes not ln *Finf* is rejected. In last case, bidirectional causality exists among *RY* and *Ed*, *Ed* and *Finf*.

TABLE 8

TYAGCT

Model	Null Hypothesis (H_0)	Test Statistic: Wald test (χ^2-statistic)		
		Value	df	Prob.
PENTAVARIATE CAUSALITY				
ln *RY*, ln *Ed*, ln *Finf*, ln *PK* and ln *L*				
Model 19	ln *Ed* causes not ln *RY*	1.821 [0.177]	1	Cannot Reject*
Model 19	ln *Finf* causes not ln *RY*	1.315 [0.251]	1	Cannot Reject*
Model 20	ln *RY* causes not ln *Ed*	11.65 [0.001]	1	Reject*
Model 20	ln *Finf* causes not ln *Ed*	2.760 [0.097]	1	Reject*
Model 21	ln *RY* causes not ln *Finf*	5.009 [0.025]	1	Reject*
Model 21	ln *Ed* causes not ln *Finf*	2.997 [0.083]	1	Reject*
ln RY, ln Ed, ln Finf, ln PK and ln H				
Model 22	ln *Ed* causes not ln *RY*	1.349 [0.245]	1	Cannot Reject*
Model 22	ln *Finf* causes not ln *RY*	10.46 [0.001]	1	Reject*
Model 23	ln *RY* causes not ln *Ed*	17.468 [0.00]	1	Reject*
Model 23	ln *Finf* causes not ln *Ed*	4.844 [0.028]	1	Reject*
Model 24	ln *RY* causes not ln *Finf*	5.453 [0.020]	1	Reject*
Model 24	ln *Ed* causes not ln *Finf*	6.874 [0.009]	1	Reject*
ln RY, ln Ed, ln Finf, ln L and ln H				
Model 25	ln *Ed* causes not ln *RY*	4.545 [0.033]	1	Reject*
Model 25	ln *Finf* causes not ln *RY*	1.672 [0.196]	1	Cannot Reject*
Model 26	ln *RY* causes not ln *Ed*	5.817 [0.016]	1	Reject*
Model 26	ln *Finf* causes not ln *Ed*	6.386 [0.012]	1	Reject*
Model 27	ln *RY* causes not ln *Finf*	2.472 [0.116]	1	Cannot Reject*
Model 27	ln *Ed* causes not ln *Finf*	2.711 [0.100]	1	Reject*

*Reject H_0

$$\ln RY_t = \alpha_{28} + \sum_{i=1}^{3} \beta_{28i} \ln RY_{t-i} + \sum_{i=1}^{3} \gamma_{28i} \ln PK_{t-i} + \sum_{i=1}^{3} \lambda_{28i} \ln L_{t-i} + \sum_{i=1}^{3} \delta_{28i} \ln Ed_{t-i} + \sum_{i=1}^{3} \gamma_{28i} \ln F\inf_{t-i} + \sum_{i=1}^{3} \gamma_{28i} \ln H_{t-i} + u_{28t} \quad (28)$$

$$\ln Ed_t = \alpha_{29} + \sum_{i=1}^{3} \beta_{29i} \ln Ed_{t-i} + \sum_{i=1}^{3} \gamma_{29} \ln PK_{t-i} + \sum_{i=1}^{3} \lambda_{29i} \ln L_{t-i} + \sum_{i=1}^{3} \delta_{29i} \ln F\inf_{t-i} + \sum_{i=1}^{3} \gamma_{29i} \ln RY_{t-i} + \sum_{i=1}^{3} \gamma_{29i} \ln H_{t-i} + u_{29t} \quad (29)$$

$$\ln F\inf_t = \alpha_{30} + \sum_{i=1}^{3} \beta_{30i} \ln F\inf_{t-i} + \sum_{i=1}^{3} \gamma_{30i} \ln PK_{t-i} + \sum_{i=1}^{3} \lambda_{30i} \ln L_{t-i} + \sum_{i=1}^{3} \delta_{30i} \ln Ed_{t-i} + \sum_{i=1}^{3} \gamma_{30i} \ln RY_{t-i} + \sum_{i=1}^{3} \gamma_{30i} \ln H_{t-i} + u_{30t} \quad (30)$$

TABLE 9

TYAGCT

Model	Null Hypothesis (H_0)	Test Statistic: Wald test (χ^2-statistic)		
		Value	df	Prob.
HEXAVARIATE CAUSALITY				
ln RY, ln PK, ln L, ln Ed, ln Finf and ln H				
Model 28	ln *PK* causes not ln *RY*	5.6022 [0.018]	1	Reject*
Model 28	ln *L* causes not ln *RY*	12.116 [0.001]	1	Reject*
Model 28	ln *Ed* causes not ln *RY*	1.8115 [0.178]	1	Cannot Reject*
Model 28	ln *H* causes not ln *RY*	1.4416 [0.230]	1	Cannot Reject*
Model 28	ln *Finf* causes not ln *RY*	1.5268 [0.217]	1	Cannot Reject*
Model 29	ln *PK* causes not ln *Ed*	4.6355 [0.031]	1	Reject*
Model 29	ln *L* causes not ln *Ed*	0.3889 [0.533]	1	Cannot Reject*
Model 29	ln *Finf* causes not ln *Ed*	6.0502 [0.014]	1	Reject*
Model 29	ln *RY* causes not ln *Ed*	4.6748 [0.031]	1	Reject*
Model 29	ln *H* causes not ln *Ed*	0.8857 [0.347]	1	Cannot Reject*
Model 30	ln *PK* causes not ln *Finf*	9.7869 [0.002]	1	Reject*

Model	Null Hypothesis (H_0)	Test Statistic: Wald test (χ^2-statistic)		
		Value	df	Prob.
Model 30	ln *L* causes not ln *Finf*	6.7448 [0.009]	1	Reject*
Model 30	ln *Ed* causes not ln *Finf*	7.2222 [0.007]	1	Reject*
Model 30	ln *RY* causes not ln *Finf*	2.5466 [0.111]	1	Cannot Reject*
Model 30	ln *H* causes not ln *Finf*	11.051 [0.001]	1	Reject*

*Reject H_0

The results of Table 9 present that *PK* and *L* causes *RY*, while other variables like *Ed*, *H* and *Finf* cause not *RY*. On the other side, *PK*, *L* and *RY* cause *Ed* but *L* and *H* cause not *Ed*. The null hypothesis that *PK*, *L*, *Ed* and *H* cause not *Finf* is rejected. On the other side, the null hypothesis that *RY* causes not *Finf* is not rejected. In conclusion, there exists bidirectional causality between *Ed* and *Finf*.

A summary of the causal nexus among education, labour force, physical capital, health, food inflation and economic growth is presented in Table 10.

TABLE 10

Causal Nexus among Education, Labour Force, Physical Capital, Health, Food Inflation and EG

Hypothesis	TYAGCT Procedure								
	Bi-variate	Tri-variate	Tetravariate			Pentavariate			Hexa-variate
		RY, *Ed*, *Finf*	*RY*, *Ed*, *Finf*, *PK*	*RY*, *Ed*, *Finf*, *L*	*RY*, *Ed*, *Finf*, *H*	*RY*, *Ed*, *Finf*, *PK*, *L*	*RY*, *Ed*, *Finf*, *PK*, *H*	*RY*, *Ed*, *Finf*, *L*, *H*	*RY*, *Ed*, *Finf*, *PK*, *L*, *H*
Ed causes *RY*	Yes	Yes	Yes	Yes	No	No	No	Yes	No
RY causes *Ed*	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Finf causes *RY*	Yes	Yes	Yes	No	Yes	No	Yes	No	No
RY causes *Finf*	Yes	No	Yes	Yes	Yes	Yes	Yes	No	No
Finf causes *Ed*	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Ed causes *Finf*	Yes	Yes	No	No	No	Yes	Yes	Yes	Yes

V. CONCLUSION AND RECOMMENDATIONS

Education in each and every sense is a key to economic progress and prosperity. Education helps improving the socio-economic status of a country. The present empirical work was planned to examine the cointegration through ARDL and causality through Toda Yamamoto Approach among education, health, food inflation and EG in Pakistan by utilizing annual time series data for the period of 1971-1972 to 2010-2011.

The results validate the positive and statistical significant LR relationship among EG (economic growth), labour force, physical capital, health and education. Food inflation appeared to exert the significant negative effect on EG. In the SR, labour force, physical capital, health and education have significant direct and positive relationship with EG, while food inflation is found to have significant negative relationship with EG.

Bidirectional causality is found between education and EG only for bivariate, trivariate and tetravariate cases. Two-way causality also exists between food inflation and education in bivariate, pentavariate and hexavariate cases. Causality exists in EG and food inflation but its direction is kept on changing with different specifications.

Recommendations

The following recommendations are being made on the basis of findings of the study:

- The government and other policy makers must reduce and control food inflation and provide targeted subsidies on food and edibles to the poors, so that the education and EG of the country may further be enhanced.
- Since the EG causes positively to education in all causal cases, so special focus must be given to accelerate and sustain EG of the country.
- More expenditure by government should be made to education sector along with others sectors of the economy.
- Threshold level of food inflation may first be estimated in order to keep food inflation below its threshold level, so that the poor segment of the society may contribute to raise both the education level and EG of Pakistan.
- Causal nexus among education, food inflation and EG in the presence of other factors other than physical capital, health and labour force may further be examined and generalized.

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DEMOGRAPHIC AND WELFARE RELATED COVARIATES OF MACROECONOMIC PERFORMANCE IN A DIGITAL AGE IN ASIA

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Abstract. Conventional growth models usually overlook the importance of demographic factors as a determinant of growth and their complementarities with other factors. This study develops a model to elucidate the role of demographics and human welfare in Asian countries in explaining the income determination by considering their complementarities with ICT. Sample of Asian countries have been used to analyze this model called as Demo-Tech Income Model. Considerable support is found for this hypothesis using data of selected Asian countries. Referring to Solow's Paradox, a possible explanation is found that emphasizes the importance of favourable demographic features and higher levels of welfare in explaining the 'fuzzy' ICT-income nexus. Demo-Tech income model is suitable for Asian countries that have favourable demographic features, such as higher concentration in urban areas and upright population pyramids. This model can have similar implications for other developing regions with similar demographic patterns and initial stage of ICT diffusion.

Keywords: Demography, Welfare, Macroeconomic performance, Asia

JEL classification: E60, I31, J11

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I. INTRODUCTION

From pre-historic times man has undertaken to store, recollect, and process information as a source of value. Starting from image carving in stone walls to today's digital technology, the information is handled in a number of ways.[1] During the last half of 20th century, the 'information revolution' was made possible through the digital Information and Communication Technology (ICT) (Drucker, 1998).[2] ICT has affected agriculture, industry and services sectors of economies world over like no other technology in past (Allen and Morton, 1995). Terms like information economy, digital economy, e-economy, weightless economy, paperless economy have been floated over the last 3 decades to term this readily evolving kind of economy. For instance, one of the pioneering works in this regard was a report by Porat (1977). Later, during mid-1990s term 'New Economy' was introduced to represent the marvelous growth in software industry in US. Besides technological, Moore's law has deep social and economic implications that goes a long way in affecting society and economy through improved ICT.[3] [4] Besides this law, a predictive hypothesis by George Gilder (1997) asserts the dynamic nature of ICT. According to him, bandwidth of network would triple each year for the span of 25 years. Increased processing ability (Moore's prediction) and extensive networking (Gilder's prediction) of electronic devices in economic and social fields of life.[5] As ADB (2001) list a few instances of ICT for development of UDCs in the fields of poverty reduction, governance, public health, education and management of environmental and natural resources.

Despite such promising potential of ICT, Nobel Prize winner Robert M. Solow's phrase, "You can see the computer age everywhere but in the

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[1]For more see, The Economic Implications of Moore's Law by G. D. Hutcheson Chapter 2 in *Into the Nano Era* by Howard Huff (2009).

[2]The ICT revolution is crucial insofar as it involves technologies geared to the production and dissemination of knowledge and information. These new technologies, that first emerged in the 1950s and then really took off with the advent of the Internet, have breathtaking potential.

[3]Moore's law purports an exponentially increasing 'information processing' capability in the field of microelectronics.

[4]The projections of growth rate of information processing might not be exact, but technological upgradation has always been unbridled.

[5]e-banking, e-billing, e-commerce, e-development, e-education, e-government, e-health, e-inclusion, e-participation, e-procurement, e-services, e-ticketing and e-transactions etc.

productivity statistics" has steered controversy in 1987.[6] This study tries to provide a plausible explanation for this paradox considering the case of Asian countries that have favourable demographic features.[7]

II. ICT IN ASIAN REGION

Asia as one of the densely populated regions of the world has shown high demand for ICT products after the falling prices of ICT equipment during the last quarter of 20th century. Policy reforms of deregulation and privatization in Asian countries like India, Pakistan, China and Indonesia have enabled the spread of ICT.[8]

TABLE 1

Descriptive Statistics of ICT Indicators

S. No.	Name	N	Mean	Maximum	Minimum	Standard Deviation
1.	FBBS	264	4.69	8.12	0.90	1.61
2.	FIS	264	5.68	8.37	1.84	1.30
3.	FTL	264	6.38	8.57	4.37	0.98
4.	ICTMI*	264	6.39	8.45	4.04	0.96
5.	INTU	264	16.38	81.60	0.05	20.68
6.	MBLC	264	6.81	8.94	3.06	1.06

*Components of ICT are diverse in nature and are evolving at the same time and are divided into basic components and advanced components. Basic components are of common use for a longer period of time while advanced components are more sophisticated and dynamic in nature. Data of basic components is used to estimate ICTMI due to data availability and common use at macro level and equal weights are used.

A dataset of 24 countries is included in empirical analysis for the time span 2000-2010 depending on the availability of data. The chosen indicators are fixed broadband internet subscribers (FBBS), fixed internet subscribers per 100 inhabitants (FIS), internet users per 100 inhabitants (INTU), fixed

[6]Written in review of a book 'Manufacturing Matters' by Stephen Cohen and John Zysman.

[7]ICT-Income nexus can be referred to as the causality between ICT and Economic Growth. Potential outcomes can be either: 1) no causality; 2) Uni-directional causality or 3) Bi-causality.

[8]For more on regulatory reforms and ICT infrastructure in Asia, see Samarjiva and Zainudeen (2008).

telephone lines per 100 inhabitants (FTL), information and communication technology maturation index (ICTMI), internet users per 100 inhabitants (INTU) and mobile cellular telephone subscriptions per 100 inhabitants (MBLC).[9]

III. DISCUSSION

At regional level, the ICT indicators show a mixed picture. For instance, the average FBBS in sample countries is 4.689 per 100 inhabitants which is quite low as compared to world average (17.0) and much lower as compared to that of DCs (49.3).[10] The average FIS, FTL, INTU and MBLC in sample countries is 5.678, 6.379, 18.383 and 6.812 per 100 inhabitants, respectively. Low average values for FIS, FTL and MBLC can be attributed to high concentration of the UDCs in this sample of Asian countries. Fixed broadband, fixed Internet and fixed telephone lines are being replaced by wireless technology (mobile and wireless broadband) due to the 'universal access' of the latter.[11] This clarifies the low average of FIS and FTL in sample countries while the low average of MBLC is due to later arrival of the mobile technology in sample countries.

It is evident that all other components of ICT show lower average level except for INTU. Internet users per 100 inhabitants give a promising picture and are likely to spearhead the overall scenario of ICT in sample countries. Its high average is due to its rapid adoption and since INTU includes approximately both kinds of internet users (fixed line and wireless). The maximum value of INTU is for Korea, which is one of the few countries out of the sample that have 'local IT players'. Local IT players allow the indigenous production of ICT (software and hardware). Arguably the biggest reason for UDCs being laggards in the field of ICT is not having indigenous development of ICT. This study hinges upon the data of fixed ICT components, since the wireless ICT is relatively new and therefore data is scarce for most countries while non-existent in a few cases.

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[9]ICTMI (Information and Communication Technology Maturation Index) is inspired from Information and Communication Development Index (IDI) in Teltscher *et al.* (2010) 'Measuring Information Society' published by International Telecommunication Union (ITU).

[10]Statistics for world average and DC average are estimated by author using ITU database for same number of years.

[11]Universal access implies the ability to have access (to a digital media) virtually everywhere, independent of wired network.

Further heedful observation of data over time reveals that China, INTU has seen a major spur and has become the flagship component of ICT in China. Indonesia, India, Iran and Pakistan show similar trends of rapid increase in INTU starting from an initial level of low diffusion. While Israel, Japan, Korea and Malaysia are the 'early adaptors' of INTU and are continuing their higher diffusion of INTU. Such all reveals a region wide trend in adopting Internet services. This is tabulated in Table 2.

TABLE 2

Dynamics of ICT Indicators in Overall Sample Countries

YEAR	FBBS	FIS	FTL	INTU	MBLC	ICTMI
2000	3.39	5.01	5.67	18.97	6.25	5.74
2001	3.57	6.85	7.73	7.50	7.88	7.50
2002	3.91	6.71	7.16	10.32	7.33	7.04
2003	4.22	6.15	6.47	35.84	7.01	6.53
2004	4.49	5.05	6.21	17.51	6.30	6.02
2005	4.73	5.50	5.96	36.94	6.77	6.27
2006	5.05	4.78	5.45	15.26	6.05	5.53
2007	5.32	5.57	6.06	28.45	6.50	6.05
2008	5.53	6.39	6.90	7.72	7.56	7.05
2009	5.63	6.24	6.85	18.02	7.38	6.86
2010	5.73	4.21	5.70	5.68	5.90	5.65
						

Sparklines show that FBBS is the monotonously increasing component of ICT in sample countries. While FIS, FTL, INTU and MBLC are components of ICT that are rather erratic. Consequently the ICTMI (aggregate of ICT components) is also erratic as evident by sparklines.

The sparklines reveal no major trend except for that in the number of fixed broadband subscribers. Limited time span of approximately one decade can be one of the reasons for this. Nevertheless, the indicators have been stable on the whole and have a non-decreasing trend.

An innovative model is developed in this research that incorporates demographic factors along with ICT in a model that determines the national income in Asian economies. Such is justified since Asian economies are mostly labour surplus economies and have favourable demographic features.

IV. EXISTING LITERATURE

Solow's paradox was basically raised for macroeconomy and not otherwise (Lee, Gholami and Tong, 2005). Yet considerable amount of research is done for developed countries both at micro and macro level, including country case-studies, cross-country studies, industry level and firm level studies.[12] Most of research on productivity paradox has been furnished on developed countries, more specifically on OECD countries due to availability of suitable and ample data (see Howard and Mazaheri, 2009).

The 1970s and 1980s saw many economies making extensive use of existing technology to spur their economic growth seemingly following Robert Solow's model of economic growth which posits that the determinants of economic growth can be separated out into increases in inputs (labour and capital) and technical progress. Under this model, Solow calculated that about four-fifth of the growth in US output per worker was attributable to technical progress. Since this work, many advanced models of economic growth have been proposed, leading to varying conclusions about the causes of economic growth. During 1980s, however, there was growing belief that not only existing technology can spur growth rather technological change can also take place and contribute to growth (Romar, 1986). Later during 1990s, some researchers found evidence of ICT growth relationship. For a review of Solow's Paradox, see Schwartz (2010). During the last decade, empirical and theoretical literature has pointed out the possible contribution of factors that complement the ICT-Income relationship. Some of these factors are said to be political, economic and social.[13]

For micro level studies, Brynjolfsson and Hitt (2000) highlight the short-sightedness of looking at ICT capital only, since these investments enable other positive externalities which are complementary and usually overlooked in previous researches. Gargallo-Castel and Galve-Górriz (2007) conduct a micro level study to explore the ICT-productivity relationship in Spanish firms. Their innovation was to introduce a set of organizational variables (workers' qualifications, management attitude and process innovation) which would support the ICT to have its impact on organizational productivity. This is one example of exploring ICT paradox at micro-level along with

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[12]A micro-to-macro methodology based on a large-scale and cross-country firm level database on ICT and productivity has been conducted in Europe's Digital Competitiveness Report, Volume I.

[13]Gretton and Parham (2003) and Gargallo-Castel and Galve-Gorriz (2007). Also see Heeks and Kenny (2002).

complementary factors. Their findings affirm the role of (organizational) complementary factors in strengthening the ICT-productivity relationship.

A handful of studies conducted for Asian region disclosed the need for e-skills, e-readiness and e-competence of human resource. Traits like attitude towards and believes about ICT are also researched. These studies have tried to explain the ICT-growth nexus using this human capital related framework (Awang, 2004; Ahmed, 2006). But for Asian region, the complementary factors have not been incorporated in the empirical analysis.

In effort of spiraling down to main debate, this study suggests a newer set of complementary factors including demographic factors and welfare related factors. In this study, complementary factors are divided into two major categories and are explained below:

V. DEMOGRAPHIC FEATURES

From demographic point of view, a few factors are listed and explained in the light of existing empirical literature.

ECONOMICALLY PRODUCTIVE YOUTH

Youth, here, refers to age group that is capable of contributing to production in an economy. The salient trait of Asian region (especially the developing countries) is the young population which implies potential human resource as revealed by population pyramids and their forecasts. Asian Miracle is considered an outcome of the young population in East Asian countries (Bloom and Williamson, 1998; Bloom and Finlay, 2009). Such population combined with ICT can increase income via improved productivity. Younger people adopt the Internet more as compared to older people (Goldfarb and Prince, 2008). Abdelfattah *et al.* (2010) also found similar results for youth.

In relatively advanced countries like those in Europe young population that uses the advanced ICT for recreational and economically productive purposes is termed as 'digital natives' (European Commission, 2010). Age and gender are previous related with ICT by Ono and Zavodny (2007). Authors examine the patterns of IT in five countries, considering the deviations in IT usage across gender, education, age and income groups.[14]

[14]Some studies relate dependence of ICT usage and its consequences (digital divide) with level of education, income, household type, race, age, gender, experience with digital technologies, individual capabilities and language are Primo Braga *et al.* (2000); Nurmela and Viherä (2000); van Dijk and Hacker (2003); Stanley (2003); Welling and Kubicek (2000).

This study hypothesizes a certain age cohort to be relatively more productive that is termed as 'digitally productive' group of population.

URBAN POPULATION

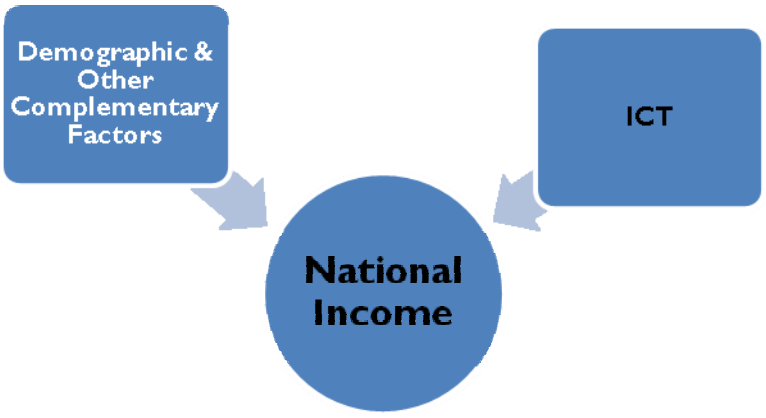
Furuholt and Kristiansen (2007) inquire the difference between access to ICT in rural and urban areas of Tanzania and find no significant difference. This opens the debate for inquiring the impact of urban-rural population in a country in relation with ICT adoption. Under the theory of agglomeration economies, greater urban area and population is considered to be an advantage to a country. Therefore, the population/labour in urban areas is relatively more productive than population in non-urban areas. Increased usage of ICT by such 'more productive' population can become a cause of increased income.

WELFARE RELATED FACTOR: HUMAN DEVELOPMENT INDEX

A population with higher HDI (higher education, better health and good standard of living) is hypothesized to be more productive user of ICT. Empirical literature in this direction is very limited. Ngwenyama *et al.* (2006) find similar results for West African countries. While Abdelfattah *et al.* (2010) in their exploratory study find that countries with low HDI rank have citizens who are less connected.

FIGURE 1

Converging Radial Diagram for Demo-Tech Income Model
ICT and Complementary Factors (Demographic
and Welfare) Affect National Income



Source: Authors' own formulation.

VI. HYPOTHESIS

For inquiring ICT-income nexus with complementary factors (henceforth Demo-Tech Income Model), the following hypothesis is developed:

H_A: ICT will contribute more to national income when coalesced with complementary factors (favourable demographic features and greater human development).

SAMPLE ISSUES AND DATA SOURCES

A dataset of mixed sample of countries of Asian region (few DCs and mostly UDCs) is gleaned depending on availability of data for relevant variables. A maximum of 24 countries are selected while the number of years is 11. T = 11 and N = 24, since t > n, there is a panel data set.[15] Collection of data is done from World Development Indicators (WDI) and International Telecommunication Union (ITU) for selected Asian countries.

VII. DEVELOPMENT OF DEMO-TECH INCOME HYPOTHESIS

The model developed in this study is named as **Demo-Tech Income Model**. Based on the factors included in it, *i.e.* demographic features and information and communication technology, the term Demo-Tech Model is devised. Emphasis is kept on demographic factors and ICT, since they are likely to have strong complementarities. Among other variable is human development index. Human Development Index is expected to have a significant influence on the ability of the ICT users to be more productive and capable of contributing to national income.

ESTIMABLE MODEL

Demo-Tech model is estimated for assessing the role of ICT, along with complementary factors, in explaining national income:

$$YCD_{i,t} = \omega\,(ICTMI_{i,t}, ICTSERT_{i,t}, p1564_{i,t}, URBNP_{i,t}, TRD_{i,t}, ELTKW_{i,t}) \quad (1)$$

$$YCD_{i,t} = \alpha_{i,t} + \alpha^{1}_{i,t}\,(YCD_{i,t-1}) + \beta_{i,t}\,(ICTMI_{i,t}) + \gamma_{i,t}\,(ICTSERT_{i,t}) + \delta_{i,t}\,(p1564_{i,t}) + \kappa_{i,t}\,(URBNP_{i,t}) + \lambda_{i,t}\,(TRD_{i,t}) + \zeta_{i,t}\,(ELTKWi,t) + \eta i + \varepsilon i,t \quad (1\text{-e})$$

[15]Bangladesh, Bru Nei Darul Islam, China, Indonesia, India, Iran, Israel, Jordan, Japan, Kazakstan, Kryzgystan, Cambodia, Korea, Kowait, Lao PDR, Malaysia, Oman, Pakistan, Philippines, Russia, Saudi Arabia, Thailand, Tajikstan, Yemen.

Where, *YCD* is *GDI* in constant dollars. All reappearing notations stand for variables as above.[16] *ELTKW* is the technology related complementarity by using the variable 'electric power consumption in kWh' and *TRD* shows the trade openness as a percentage of GDP. η_i are the country specific effects and $\varepsilon_{i,t}$ is the error term. *i* shows countries and *t* years.

A COUPLE OF TESTS FOR ENDOGENEITY

Test for endogeneity are estimated:

TABLE 3

Tests for Endogeneity in Instrumental Variables (IVs) – Durbin-Wu-Hausman

Null Hypothesis (H_0): Regressor is Exogenous			
Test	Notation	Statistic	p-value
Wu-Hausman F test	F (1, 207)	30.571	0.0000
Durbin-Wu-Hausman χ^2 test	χ^2 (1)	31.853	0.0000

Source: Author's calculations using Stata (Special Edition) 12.0 user defined command ivendog.

DECISION ON USING IV REGRESSION OR GMM – IV-HETEROSKEDASTICITY TESTS

As per Baum *et al.* (2003), GMM gives more efficient estimates as compared to simple Instrumental Variables regression when heteroskedasticity exists. In presence of heteroskedasticity, GMM estimator is a better estimator. The results of these tests are given in Table 4.

Results of the two tests are in favour of presence of heteroskedasticity. Breusch-Pagan/Godfrey/Cook-Weisberg and White/Koenker $n^{R_c^2}$ test statistics are statistically significant at 1% level of significance. Pagan-Hall General test and Pagan-Hall Test w/assumed Normality statistics show reveal homoskedasticity. Since half of tests reveal the presence of heteroskedasticity, it is safer to assume heteroskedasticity and GMM should be preferred.

[16]ICTM is used as an 'external instrument' as suggested in Roodman (2009).

TABLE 4

Testing Heteroskedasticity in Presence of Instrumental Variables (Levels of IVs)

Null Hypothesis (H_0): Disturbance is Homoskedastic		
Test	χ^2 (6)	p-values
Pagan-Hall General Test Statistic	1.184	0.9913
Pagan-Hall Test w/assumed Normality	1.424	0.9848
White/Koenker $n^{R_c^2}$ Test Statistic	57.319	0.0000
Breusch-Pagan/Godfrey/Cook-Weisberg	73.369	0.0000

Source: Author's calculations using Stata (Special Edition) 12.0 user defined command ivhettest, all.

GMM ESTIMATION RESULTS

System GMM is considered for estimation of the panel dataset for Demo-Tech model, justification of which is given in Table 5.

TABLE 5

SYSTEM GMM Estimates (Augmented ICT-Income Nexus)

Dependent Variable: Gross National Income ($YCD_{i,t}$)

	Coefficients	Standard Errors	t-statistics	p-values
$YCD_{i,t-1}$	0.9552	0.0614	15.55	0.000
$ICTMI_{i,t}$	0.0224	0.0081	2.77	0.006
$ICTSERT_{i,t}$	0.0035	0.0016	2.23	0.027
$P1564_{i,t}$	0.2878	0.1668	1.73	0.086
$URBNP_{i,t}$	0.0162	0.0069	2.36	0.019
$TRD_{i,}t$	–0.0324	0.0371	–0.87	0.383
$ELTKW_{i,t}$	1.0082	0.1732	5.82	0.000
C	–0.6707	0.2896	–2.32	0.022

	Coefficients	Standard Errors	t-statistics	p-values
Time Dummies				
yrtd_02	–0.0298	0.0151	–1.97	0.050
yrtd_03	–0.0208	0.0104	–1.99	0.047
yrtd_04	–0.0140	0.0089	–1.57	0.118
yrtd_05	–0.0070	0.0119	–0.59	0.556
yrtd_06	–0.0109	0.0056	–1.94	0.054
yrtd_07	–0.0070	0.0055	–1.29	0.200
yrtd_08	–0.0053	0.0043	–1.24	0.217
yrtd_09	–0.0026	0.0022	–1.16	0.247
Other Tests and Parameters				
Observations = 135	Countries = 15	Instruments = 135	F (15, 23) = 7162 [p = 0.000]	
p-value: Hansen J-Test = 0.222		M1: p = 0.198 & M2: p = 0.304		
Difference in Hansen tests / C-tests: [p = 0.730, p = 0.644, p = 0.626 and p = 0.794]				

Source: Author's calculations using Stata (Special Edition) 12.0 user defined command xtabond2.

NOTE: Following Roodman (2006) and Mileva (2007), SGMM is applied on model with arguments **small, twostep** and **robust**.

VIII. INTERPRETATION

The growth model estimations reveal the existence of relationship between ICT and national income based upon demographic complementary factors. Lagged value of national income is found to be positively related with its previous values, showing the dynamic behaviour of the variable yielding a dynamic panel model. It is statistically significant at all levels. The pivotal variable ICTMI comes with a positive sign showing favourable effect of ICT on national income. Similar to demo-tech productivity models, ICTSERT is also used in the regression capturing the interaction effect of ICT and school

enrollment rate at tertiary level. This coefficient is both positive and significant (at 10% level of significance). This entails that highly educated ICT users contribute to national income.

ICT using young (physically and mentally capable) population is also found to contribute to national income. Statistically significance is both at 5% and 10%. Substantial portion of this segment of population is expected to be ICT-savvy and proficient user.

Urban population is hypothesized to be more economically productive than rural population. Population in urban areas gets better education and job opportunities due to urbanization economies. Impact of ICT on national income becomes richer if urban population is included in the regression. Its coefficient is statistical significant. Such positive contribution can be attributed to urbanization economies.

ICT's role in national income is favourably complemented by higher levels of trade openness as represented by coefficient of TRD. Empirical evidence on trade-income relationship is inconclusive and can vary from sample to sample. In this growth regression, however, trade openness has a negative impact on national income.

Electricity consumption in this regression justifies its inclusion via positive sign of its coefficient and significance at 1% (5% and 10% as well). In terms of magnitude the coefficient is the highest, because the role of electricity consumption is not limited only to complementing the ICT. Rather electricity consumption complements other non-ICT sectors, *e.g.* industry, as well and contributes to national income via other channels. Consequently, it is safely stated that electricity consumption has strong complementarity with ICT.

Time dummies have been included and they improve the statistical diagnostics of the model as per Sarafidis *et al.* (2006). The overall significance of the model is satisfactory (at 1%, 5% and 10% levels of significance) as per F-test of joint significance. Condition that number of observations > number of instruments also holds in this case, *i.e.* (240 > 30). Hansen test of correct specification and over-identifying restrictions has a p-value of greater than 0.05, *i.e.* (p-value = 0.222 > 0.05) implying that all over-identified instruments are exogenous. The Arellano and Bond test for first order 'M_1' and second order 'M_2' correlation, *i.e.* AR(1) and AR(2) show p-value of greater than 0.000,. *i.e.* $(M_1)_{\text{p-value}} = 0.198 > 0.05$ and $(M_2)_{\text{p-value}} = 0.304 > 0.05$. Hence, there is no second order serial correlation in residuals.

C-test (Baum, 2006; Roodman, 2006) for the validity of subsets of instruments for level and difference equations are also satisfactory. These tests are four in number and have same criteria, i.e. the p-value should be greater than 0.05:

$(\text{C-test})_{\text{Ho: GMM-differenced instruments are exogenous}} = 0.730 > 0.05$

$(\text{C-test})_{\text{Ho: System GMM instruments are exogenous \& they increase Hansen J-test}} = 0.644 > 0.05$

$(\text{C-test})_{\text{Ho: GMM instruments excluding IV-instruments are exogenous}} = 0.126 > 0.05$

$(\text{C-test})_{\text{Ho: Standard IV-instruments are exogenous \& they increase Hansen J-test}} = 0.794 > 0.05$

There is not enough evidence to reject the null hypotheses set in these four tests of difference-in-Hansen/C-tests.

IX. CONCLUSION AND RECOMMENDATIONS

Empirical results confirm the existence of complementarities between demographic and welfare related factors and the ICT. These factors include population in large urban areas that is found to reinforce the ICT-income relationship. Urban population in likely to be digitally literate and hence economically more productive. Similar implications are found for ICT using age cohort of population that use ICT for economically productive purposes. More specifically, it is affirmed that populations with higher level of HDI (education, health and living standards) are better able to use ICT for productive purposes contributing to national income. The strongest complementarity is convincingly with electricity consumption.

Outcome of this research related to HDI shows that merely throwing ICT at the disadvantaged populations/regions shall not bring the desired result of increased income. For that the funding agencies have to embed these ICT development programmes with awareness campaigns so as to enable the target population for the economically productive usage of ICT equipment. For instance programme of ICT4D (Information and Communication Technology for Development) faces issue of poor infrastructure, low illiteracy and poor health in implementing the ICT-based development projects in disadvantaged regions like Africa (For more details see Heeks, 2002). As highlighted in the empirical analysis of this study youth, combined with ICT diffusion, can contribute to level of productivity and hence national output. Most of sample countries have shown greater proportion of youth in total population. Need is to channelize this youth but making them digitally literate so they contribute to national income. In brief this finding of the study suggests a form of man-power planning which focuses the ICT skills to channelize the benefits of favourable demographic

features. Moreover, the supply of electricity for proper operation of ICT is inviolable for ICT to show a significant impact on national income. Policy makers should lay down plans and projects for uninterrupted electricity supply for the functioning of today's digitally advanced economies.

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DEFENSE EXPENDITURES AND EXTERNAL DEBT: EVIDENCE FROM PAKISTAN AND INDIA

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Abstract. Defense expenditures and external debt is an area that is less focused in the defense economics literature. This study has explored the defense-debt nexus for the two rival neighboring countries, *i.e.* Pakistan and India. We have used the time series data for the period of 1972 to 2010. The methodology employed for the study is Autoregressive Distributed Lag (ARDL). Dunne (2003) defense-debt model has been used to probe the impacts of defense expenditures on external debt in both the countries. The findings of the study suggest that defense spending has escalated external debt in both the countries. The study suggests that both the countries must reduce their defense expenditures as these are contributing to their external debt accumulation. So, both the countries should lessen their defense spending to get the sovereignty and self-esteem in the world.

Keywords: Defense expenditures, External debt, Pakistan and India, ARDL

JEL classification: H56, H63, P24

I. INTRODUCTION

There are many dimensions of defense expenditures. A lot of empirical and theoretical work has been carried out to explore the economic effects of defense spending since the seminal study of (Benoit, 1973). The defense-

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growth relationship has been the center of attention of the researchers or more specifically the defense economists. A few studies (*see* Brzoska, 1983; Looney, 1989; Karagol and Sezgin, 2004; Kollias *et al.*, 2004; Dunne *et al.*, 2004a; 2004b; Günlük-Senesen, 2004; Karagol, 2005; Narayan and Narayan, 2008; Narayan and Smyth, 2009; Wolde-Rufael, 2009 and Shahbaz *et al.*, 2013) have focused on defense-debt relationship. The counties like Pakistan and India, who have hostile relationship with each other, have to spend more on defense activities. Therefore, we cannot ignore the role of defense spending in external debt accumulation of these countries. The countries have to hinge on internal or external debts to finance the sizeable defense expenditures. It is a matter of great importance to investigate the impact of defense outlays on external debt because external debt has adverse economic effects.

This study has significance in the existing defense-debt literature due to two reasons. Firstly, it is the prime attempt on defense-debt relationship for Pakistan and India simultaneously. The second contribution of this study is that it uses an ARDL approach to examine the defense-debt relationship.

The study is planned as follows: In section II, we have reviewed the studies on defense expenditures and external debt. Section III contains the model specification. Section IV presents data, description of variables and methodology. ARDL Model Specification and Bounds Testing Procedure have been explained in section V and VI respectively. The empirical results have been elaborated in section VII. Finally, section VIII offers the conclusion of the study.

II. STUDIES ON DEFENSE EXPENDITURES AND EXTERNAL DEBT

The defense-debt nexus is a controversial area of defense economics. The researchers have concentrated little on this aspect of defense expenditures. Therefore, less empirical studies are available on the subject both for developing and developed countries.

The pioneer study to explore the defense-debt relationship was conducted by Brzoska (1983). The findings of the study revealed that defense spending was the main cause of external debt in developing countries. According to Brzoska, defense spending escalated the external debt 20% to 30%.

Looney and Frederiksen (1986) analyzed the impacts of defense expenditures, external debt and investment on economic growth for two set

of developing countries (thirty eight resource constrained and twenty eight resource unconstrained countries) over the period of 1970-1982. The authors used factor and discriminate analysis to classify the countries. The study considered the borrowing capacity of countries while explaining the defense-growth relationship. The empirical results indicated the positive effects of defense spending on growth in unconstrained countries while negative insignificant effects of defense spending were found for constrained countries.

Looney (1987) investigated the impact of military spending on the external public debt of third world countries. The author grouped the third world into two separate groups *i.e.* un-dynamic resource constrained countries and dynamic less constrained countries. The study found that defense expenditures contributed to external debt of constrained countries but no such evidence was found for unconstrained countries.

Dunne (2003) examined the relationship between military spending and debt in three South American countries (Argentina, Brazil and Chile) in 1980s. The findings of the study suggested that military expenditures did not contribute in Argentina and Brazil's debt evolution but some evidence was found for Chile.

Dunne *et al.* (2004) explored the impact of defense expenditures on external debt of eleven small industrializing countries (including Pakistan and India) by employing the dynamic panel data and Arellano–Bond GMM techniques over the period of 1960-2000. The empirical results of both techniques indicated the positive relationship between defense spending and economic growth.

Narayan and Smyth (2009) investigated the defense-debt nexus for six Middle Eastern countries (Bahrain, Iran, and Jordan Oman, Syria and Yemen) over the period 1988-2002.

The study found long run relationship between defense expenditures, external debt and income using Pedroni test for panel cointegration. The authors indicated that military expenditures contributed to external debt of Middle Eastern countries.

Now we turn towards the national studies. In another study, Looney (1989) investigated the defense-debt nexus for Pakistan and highlighted that defense spending of Pakistan influenced the capability of foreign borrowing. The study showed that foreign lenders reduced lending to Pakistan due to increase in military spending and Pakistan being the resource constraint country.

Karagol and Sezgin (2004) attempted to document the relationship between defense expenditures and debt rescheduling in Turkey over the period 1955–2000 using the Probit model approach. The empirical results suggested that financial variables contributed in rescheduling probabilities while political variables were not found significant in debt rescheduling.

Günlük-Senesen (2004) evaluated the role of defense spending in the evolution of external indebtedness of Turkey in 1980s. The study concluded that besides other factors defense spending increased the Turkey's current account deficit and external debt. Sezgin (2004) studied the defense and debt relationship in Turkey over the period of 1979-2000. The study used Engle–Granger methodology to analyze the impacts of defense spending, defense equipment expenditures and arms imports on Turkey's external debt. The findings suggested the negative relationship between defense spending and external debt in the long run. The arms imports showed the positive effect on external debt in the short run.

Karagol (2005) applied the multivariate model to explore the causal relationship between defense spending and foreign debt in Turkey for the period 1955-2000. The study revealed the long run relationship or cointegration between defense spending and foreign debt. Positive effects of defense spending were found for external debt accumulation. Granger causality test suggested the unidirectional causality from defense spending to debt. Another study by Karagol (2006) re-evaluated the defense-debt relationship for Turkey over the period of 1960-2002 by extending the Looney and Frederiksen's (1986) study. The study found positive relationship between defense spending and external debt by applying various econometric tools, *i.e.* cointegration, impulse response functions and variance decomposition.

Karagol and Turhan (2008) estimated the relationship between defense expenditures, external debt and political business cycles in Turkey over the period 1960-2002. The study included two effects of political business cycles namely the electoral effects and the partisan effects. The findings of the study suggested that the effects of defense spending were positive under impulse response functions. The study explored the importance of colors of political parties. The results revealed that political ideology and fiscal policy played a vital role in determining the defense expenditures.

Feridun and Sissoko (2008) discussed the impact of defense spending on external debt in Brazil for the period 1971-2002. The study concluded Granger causality test to explore the defense-debt relationship. The findings of the study suggested that defense spending mounted up the debt of Brazil. Unidirectional causality found from defense spending to external debt.

Narayan and Narayan (2008) examined the impact of defense expenditures on external debt in Fiji over the period 1970-2005. The study used cointegration and vector error correction framework. The empirical results suggested that military spending contributed a lot in the evolution of both external debt and domestic debt in the long run.

Wolde-Rufael (2009) investigated the defense-debt relationship in Ethiopia for the period 1970–2005. The study conducted Autoregressive Distributed Lag (ARDL) approach to cointegration and Granger causality tests. The findings of the study suggested positive and significant effect of defense spending on external debt. Moreover, a causal and long-run relationship was found between defense spending, external debt and income.

In the latest study by Shahbaz *et al.* (2013) for Pakistan investigated the impacts of defense spending on external debt over the period of 1973-2009. The authors applied the ARDL bounds testing approach of cointegration. The empirical results suggested the cointegration among the defense expenditures, external debt, investment and economic growth. The study indicated the positive relationship between defense expenditures and external debt. Moreover, the study suggested some policy implications to reduce the external debt in Pakistan.

After reviewing the above mentioned empirical studies, we can conclude that defense spending mount up external indebtedness.

III. MODEL SPECIFICATION

Brzoska (1983) contributed in the literature of defense economics by exploring the positive defense-debt relationship in his seminal study for developing countries. The other empirical studies also suggested the positive association between defense spending and external debt. On the basis of existing empirical studies, the positive relation between defense outlays and external debt can be explained through three channels. First, defense spending is a component of total government expenditures. So, it is part of budget and government has to finance it through different sources internally or externally. Tax is the most significant internal source of financing the government outlays. If the tax revenues are inadequate to finance the defense expenditures, government has to face a budget deficit. To finance the budget deficit, government needs foreign borrowing in case of limited domestic resources. Dunne (2003) pointed out four ways of deficit financing due to large defense spending:

1. Use of foreign exchange reserves

2. Printing of currency
3. Borrowing from abroad
4. Borrowing internally

These modes of deficit financing have their own limitations and implications. If government uses foreign exchange reserves to finance the deficit, this may create foreign exchange crises. Similarly, printing of currency generates inflation due to increase in money supply. Borrowings domestically and externally have also the side effects on the economy such as crowding out of private investment due to domestic debt and external debt crises due to external borrowing.

So, external debt accumulates with an increase in defense expenditures for the countries like Pakistan and India. Second, the countries with less foreign exchange reserves have to rely more on external debt to finance arms imports military expenditure (Dunne *et al.*, 2004; Karagol, 2005; Narayan and Narayan, 2008 and Wolde-Rufael, 2009). Third, the countries, that are producing arms in their own territory, have to import modern automated technology and intermediary equipments. Therefore, these countries by compulsion finance these products either by foreign borrowing or by lessening their foreign exchange reserves (Günlük-Senesen, 2004; Narayan and Narayan, 2008; Narayan and Smyth, 2009).

As such there is no specific theory to explain the defense-debt relationship in the literature. Narayan and Smyth (2009) noted:

> "In terms of the existing literature there are no firm guidelines on what explanatory variables to include in addition to military expenditure."

Dunne *et al.* (2004) argued:

> "In developing a model of military spending and debt, the aim is not to provide a complete explanation of the evolution of debt, but to discern the specific effects of military expenditure on debt, given the capacity of the economy to finance the domestic and foreign spending that military expenditure involves."

Thus, the core issue is that how the defense expenditures are financed when we are investigating the impacts of defense spending on external debt. If the defense spending is financed through tax revenues, there will be no need of external borrowing. But if the defense outlays were financed through external borrowing, it would then create external debt accumulation.

The existing empirical studies on defense-debt relationship reveal that two factors must be kept in mind while modeling the defense-debt phenomenon: (*i*) country's capacity to engage in external borrowing and (*ii*) alternative financing sources.

In line with the above discussion and Dunne (2003) model, we are including GDP, foreign exchange reserves and exports along with defense expenditures to analyze the defense-debt relationship for both countries. The functional form of the defense-debt model can be written for both the countries as:

$$REDP = f(RGDP, REXP, RFER, RDEP) \quad (1)$$

$$REDI = f(RGDP, REXP, RFER, RDEI) \quad (2)$$

The variable of GDP is included in the model to capture the capacity of a country for paying the foreign debt. An increase in GDP would enhance capacity of a country to pay the external debt. In the same fashion, increase in GDP can encourage the new external borrowing. So the expected sign of this variable is vague. 'Non-defense exports' is intended to include expected negative sign in the model. Export revenues create the supply of foreign exchange that leads to fall in external borrowing. High foreign exchange reserves indicate the ability of a country to manage debt. If foreign exchange reserves increase, the country can pay more of its external debt and reliance on external borrowing can decrease. So, this variable has expected negative sign. Lastly, the variable of defense spending is expected to show positive sign due to external debt as a mode of financing.

IV. DATA, DESCRIPTION OF VARIABLES AND METHODOLOGY

DATA

The data sources for Pakistan are *Handbook of Statistics on Pakistan Economy 2010*, *World Development Indicators* and *Global Development Finance*. Specifically, data on dollar exchange rate, GDP at constant 2000 US $ and GDP at current 2000 US $ have been acquired from *World Development Indicators* and *Global Development Finance* while the data on exports, external debt, defense expenditures and foreign exchange reserves have been taken from *Handbook of Statistics on Pakistan Economy*.

For India's data, *Handbook of Statistics on the Indian Economy* 2011, *World Development Indicators* and *Global Development Finance* have been used. Specifically, data on dollar exchange rate, GDP at constant 2000 US $

and GDP at current 2000 US $ have been acquired from *World Development Indicators* and *Global Development Finance* while the data on exports, external debt, defense expenditures and foreign exchange reserves of India have been taken from *Handbook of Statistics on the Indian Economy*.

For both the countries, we have converted all the variables from local currency to US $ by means of $ exchange rates and then deflated all the variables by GDP deflator to find inflation adjusted or real variables. To check the stationarity or nonstationarity of all the series of the variables, Augmented Dickey Fuller (ADF) test has been used to examine the integration properties of variables. There is an evidence of unit root (non-stationarity) found in almost all the variables specified in the above mentioned equations. We have shown the results of ADF test in Table 1.

TABLE 1

Results of Augmented Dickey Fuller Test

Unit Root Test on Level (For Pakistan)							
Variables	None	Lags	Intercept	Lags	Intercept and Trend	Lags	Con-clusion
RDEP	0.45297	0	–1.83097	0	–1.68005	0	I(1)
RGDP	2.2422	4	2.4333	1	–0.5962	1	I(1)
RED	1.4907	0	–0.9581	0	–1.8811	0	I(1)
REXP	2.9138	0	–0.1262	0	–2.3062	0	I(1)
RFER	0.5074	0	–0.4978	0	–1.9010	0	I(1)
Unit Root Test on Level (For India)							
Variables	None	Lags	Intercept	Lags	Intercept and Trend	Lags	Con-clusion
RDEI	2.0877	0	0.3518	0	–0.0287	0	I(1)
RGDP	17.5319	0	12.4944	0	5.1692	0	I(0)
RED	3.7472	0	1.3511	0	–2.6363	0	I(1)
REXP	1.9535	2	1.5477	2	0.4770	2	I(1)
RFER	2.5054	0	1.3795	0	–0.7516	0	I(1)

Source: Authors' calculations

We have applied Autoregressive Distributed Lag (ARDL) Model to estimate the equations as it requires any order of integration. We have discussed the ARDL technique in section V.

DESCRIPTION OF VARIABLES

RDEP = Real Defense Expenditures of Pakistan

RDEI = Real Defense Expenditures of India

REDP = Real External Debt of Pakistan

REDI = Real External Debt of India

RGDP = Real Gross Domestic Product

REXP = Real Exports (merchandise or non-defense)

RFER = Real Foreign Exchange Reserves

V. ARDL MODEL SPECIFICATION

In this section, we derive the general form of the error correction model (ECM) by using the two variables X_t and Y_t with n lags for Y_t and m lags for X_t.

$$Y_t = \alpha_0 + \sum_{i=1}^{n} \alpha_i Y_{t-i} + \sum_{i=0}^{m} \beta_j X_{t-i} + u_t \tag{3}$$

β_0 exhibits the impact of X_t on Y_t in short run. Long run coefficients can be determined by setting $Y_t = Y_{t-1} = Y_{t-2} = \ldots. = X_{t-n} = Y_t^*$ and $X_t = X_{t-1} = X_{t-2} = \ldots. = X_{t-n} = X_t^*$ and plugging in (3).

$$Y_t^* = \alpha_0 + \alpha_1 Y_t^* + \alpha_2 Y_t^* + \ldots. + \alpha_n Y_t^* + \beta_0 X_t^* + \beta_1 X_t^* + \beta_2 X_t^* + \ldots. + \beta_n X_t^* + u_t$$

After rearranging the terms, we have:

$$Y_t^* = A + BX_t^* + u_t \tag{4}$$

Where

$$A = \frac{\alpha_0}{(1 - \alpha_1 - \alpha_2 - \ldots. - \alpha_n)}$$

$$B = \frac{(\beta_0 + \beta_1 + \beta_2 + \ldots. + \beta_n)}{(1 - \alpha_1 - \alpha_2 - \ldots. - \alpha_n)}$$

B is (a composite parameter) the long run multiplier. We derive Error Correction Model (ECM) from equation (3) by substituting the following expressions:

$$Y_{t-n} = Y_{t-(n-1)} - \Delta Y_{t-(n-1)}$$

$$\text{and } X_{t-n} = X_{t-(n-1)} - \Delta X_{t-(n-1)} \tag{5}$$

$$Y_t = \alpha_0 + \alpha_1 Y_{t-1} + ... + \alpha_{n-1} Y_{t-(n-2)} + (\alpha_{n-1} + \alpha_n) Y_{t-(n-1)} - \alpha_n \Delta Y_{t-(n-1)}$$
$$+ \beta_0 + \beta_1 Y_{t-1} + ... + \beta_{m-1} Y_{t-(m-2)} + (\beta_{m-1} + \beta_m) Y_{t-(m-1)} - \beta_m \Delta Y_{t-(m-1)}$$

Now substituting the following expressions:

$$Y_{t-(n-1)} = Y_{t-(n-2)} - \Delta Y_{t-(n-2)}$$

$$\text{and } X_{t-(m-1)} = X_{t-(m-2)} - \Delta X_{t-(m-2)} \tag{6}$$

After substituting, we have:

$$Y_t = \alpha_0 + \alpha_1 Y_{t-1} + ... + \alpha_{n-3} Y_{t-(n-3)} + (\alpha_{n-2} + \alpha_{n-1} + \alpha_n) Y_{t-(n-2)} -$$
$$(\alpha_{n-1} + \alpha_n) \Delta Y_{t-(n-2)} - \alpha_n \Delta Y_{t-(n-1)} + \beta_0 X_t + \beta_1 X_{t-1} +$$
$$.... + \beta_{m-3} X_{t-(m-3)} + (\beta_{m-2} + \beta_{m-1)} + \beta_m) X_{t-(m-2)} -$$
$$(\beta_{m-1} + \alpha_m) \Delta X_{t-(m-2)} - \alpha_n \Delta X_{t-(n-1)}$$

The consecutive substitution of equations (5) and (6) and similar equations would finally give us the following expression:

$$\Delta Y_t = \alpha_0 + \gamma Y_{t-1} + \theta X_{t-1} + \sum_{j=1}^{n-1} a_j \Delta Y_{t-j} + \sum_{j=0}^{m-1} b_j \Delta X_{t-j} + \varepsilon_t \tag{7}$$

The composite parameters in equation (7) are defined as:

$$a_j = -\sum_{i=j+1}^{n} a_i, \quad b_j = -\sum_{i=j+1}^{m} b_i, \quad \gamma = \sum_{i=1}^{n} a_i - 1, \quad \theta = \sum_{i=0}^{m} \beta_i$$

The Unrestricted Error Correction Models (UECMs) to explain the defense-debt relationship for Pakistan and India are given below respectively:

$$\Delta(REDP)_t = \alpha + \beta_1(REDP)_{t-1} + \beta_2(RGDP)_{t-1} + \beta_3(REXP)_{t-1} + \beta_4(RFER)_{t-1} + \beta_5(RDEP)_{t-1} + \sum_{i=1}^{p_1}\delta_1\Delta(REDP)_{t-i} + \sum_{i=0}^{p_2}\delta_2\Delta(RGDP)_{t-i} + \sum_{i=0}^{p_3}\delta_3\Delta(REXP)_{t-i} + \sum_{i=0}^{p_4}\delta_4\Delta(RFER)_{t-i} + \sum_{i=0}^{p_5}\delta_5\Delta(RDEP)_{t-i} + \varepsilon_t \quad (8)$$

$$\Delta(REDI)_t = \alpha + \beta_1(REDP)_{t-1} + \beta_2(RGDP)_{t-1} + \beta_3(REXP)_{t-1} + \beta_4(RFER)_{t-1} + \beta_5(RDEI)_{t-1} + \sum_{i=1}^{p_1}\delta_1\Delta(REDI)_{t-i} + \sum_{i=0}^{p_2}\delta_2\Delta(RGDP)_{t-i} + \sum_{i=0}^{p_3}\delta_3\Delta(REXP)_{t-i} + \sum_{i=0}^{p_4}\delta_4\Delta(RFER)_{t-i} + \sum_{i=0}^{p_5}\delta_5\Delta(RDEI)_{t-i} + \varepsilon_t \quad (9)$$

The parameters β_i are long-run multipliers and the δ_i are short-run dynamic parameters of ARDL. ε_t is white noise error and Δ shows first difference sign.

VI. BOUNDS TESTING PROCEDURE

It is essential to test the existence of long run relationship before estimating long-run parameters and error correction coefficients. For the purpose, Ordinary Least Squares (OLS) method is employed to locate the value of F or Wald Statistic for the joint significance of the parameters of lagged variables *i.e.*

$$H_0 = \beta_1 = \beta_2 = \beta_3 = \beta_4 = \beta_5 = 0 \qquad \text{(No Cointegration)}$$

$$H_1 = \beta_1 \neq \beta_2 \neq \beta_3 \neq \beta_4 \neq \beta_5 \neq 0 \qquad \text{(Cointegration)}$$

In equations (8) and (9), null hypothesis exhibits that lagged variables have no long run relationship whereas the alternative hypothesis shows the long run relationship. The null hypothesis is tested by using F-statistic as follows.

- If F statistic > the upper bound critical value, the null hypothesis is rejected.
- If F-statistic < the lower bound critical values, the null hypothesis is accepted
- If F-statistic is between the lower and upper bound critical values, the test is inconclusive.

If long-run relationship exists, the long-run coefficients can be calculated by employing the following equations for both the countries:

$$REDP_t = \alpha + \sum_{i=1}^{p_1} \eta_1 (REDP)_{t-i} + \sum_{i=0}^{p_2} \eta_2 (RGDP)_{t-i} + \sum_{i=0}^{p_3} \eta_3 (REXP)_{t-i} + \sum_{i=0}^{p_4} \eta_4 (RFER)_{t-i} + \sum_{i=0}^{p_5} \eta_5 (RDEP)_{t-i} + \varepsilon_t \quad (10)$$

$$REDI_t = \alpha + \sum_{i=1}^{p_1} \eta_1 (REDI)_{t-i} + \sum_{i=0}^{p_2} \eta_2 (RGDP)_{t-i} + \sum_{i=0}^{p_3} \eta_3 (REXP)_{t-i} + \sum_{i=0}^{p_4} \eta_4 (RFER)_{t-i} + \sum_{i=0}^{p_5} \eta_5 (RDEI)_{t-i} + \varepsilon_t \quad (11)$$

The short-run dynamics can be estimated by the following equations for Pakistan and India:

$$\Delta REDP_t = \alpha + \sum_{i=1}^{p_1} \lambda_1 \Delta (REDP)_{t-i} + \sum_{i=0}^{p_2} \lambda_2 \Delta (RGDP)_{t-i} + \sum_{i=0}^{p_3} \lambda_3 \Delta (REXP)_{t-i} + \sum_{i=0}^{p_4} \lambda_4 \Delta (RFER)_{t-i} + \sum_{i=0}^{p_5} \lambda_5 \Delta (RDEP)_{t-i} + \omega ECM_{t-1} + \varepsilon_t \quad (12)$$

$$\Delta REDI_t = \alpha + \sum_{i=1}^{p_1} \lambda_1 \Delta (REDI)_{t-i} + \sum_{i=0}^{p_2} \lambda_2 \Delta (RGDP)_{t-i} + \sum_{i=0}^{p_3} \lambda_3 \Delta (REXP)_{t-i} + \sum_{i=0}^{p_4} \lambda_4 \Delta (RFER)_{t-i} + \sum_{i=0}^{p_5} \lambda_5 \Delta (RDEI)_{t-i} + \omega ECM_{t-1} + \varepsilon_t \quad (13)$$

In the equations (12) and (13), the short run parameters are attached with summation signs and ECM (ω) coefficient shows the speed of adjustment towards the long-run equilibrium in both the equations. ECM coefficient should be negative and statistically significant for convergence.

VII. EMPIRICAL RESULTS

THE ORDER OF LAG AND BOUND TESTING

We have used the Schwarz Bayesian Criterion (SBC) to determine the maximum lag length of the variables for both the countries' models. The SBC has suggested optimal lag length 2 in both ARDL models. We have employed the OLS on (8 & 9) to find the F-statistic by applying the Wald test. The results of Wald test for both the models are reported in Table 2.

TABLE 2

F-test for Cointegration

		5% Critical Value Bounds		10% Critical Value Bounds	
Country	F-Statistic	I(0)	I(1)	I(0)	I(1)
Pakistan	6.38	2.26	3.35	2.62	3.79
India	4.67	2.26	3.35	2.62	3.79

NOTE: Critical values are obtained from Pesaran *et al.* (1996).

For Pakistan, the calculated value of F-statistic is 6.38, which is greater than the upper bound at 5% and 10%. Similarly, for India, the calculated value of F-statistic is 4.67; it is above than the upper bound at 5% and 10%. These results show that we are unable to accept the null hypothesis of no cointegration. So, long run relationship exists in both models for Pakistan and India.

LONG-RUN ESTIMATING RESULTS

Now the next step is to find out the long run coefficients of ARDL models for both the countries. The results of the estimated long run coefficients are presented in Table 3. For both the countries, we have specified four variables. The dependent variable is Real External Debt whereas Real GDP, Real Exports, Real foreign Exchange Reserves and Real defense Expenditures are explanatory variables.

First we explain the coefficient of Real GDP (RGDP) for both the countries. Real GDP in defense-debt model exhibits the capacity of a country to pay foreign liabilities. The parameter of RGDP is negative and statistically significant in both the models. This suggests that real external debt of both the countries decreases due to an increase in RGDP. Dunne (2003) also

pointed out that "an increase in GDP automatically lowers the debt burden as a share of GDP, but may also encourage new borrowing."

In fact, the coefficient of RGDP can have either sign as Narayan and Narayan (2008) argued:

> "That a rise in income will either increase or decrease external and domestic debts. A rise in income will increase debts, if the rise is due to consumption expenditure, which consists of high import content. High import content implies a higher import bill, leading to current account imbalances. Thus, a country needs to borrow to meet the imbalances. A rise in income will reduce debts if the rise comes from capital investment, which produces additional revenue for the government, allowing the government to pay off debts and meet additional expenditure obligations."

Our results are compatible with the studies (Dunne, 2003; Narayan and Narayan, 2008; Narayan and Smyth, 2009; Wolde-Rufael, 2009) that found the negative relationship between RGDP and real external debt. In contrast, there are some studies that found the positive relationship between RGDP and real external debt (*see* Dunne *et al.*, 2004; Sezgin, 2004).

TABLE 3

Estimated Long Run Coefficients using the ARDL Approach

Pakistan			India		
Dependent variable: REDP ARDL (1, 2, 1, 1, 0)			Dependent variable: REDI ARDL (1, 1, 1, 1, 1)		
Regressor	Coefficient	t-statistic	Regressor	Coefficient	t-statistic
RGDP	–0.49964	–9.3705	RGDP	–1.5640	–2.6137
REXP	–0.51012	–1.9393	REXP	–10.2176	–1.7636
RFER	–0.46493	–1.9641	RFER	–6.2889	–1.5349
RDEP	5.1701	7.1686	RDEI	49.5689	2.0711
C	–1708.3	–1.9438	C	9819.0	0.36267

The second variable is Real exports (REXP). The variable of REXP enhances the supply of foreign exchange reserves of a country that can be used to repay the debts. So, negative sign is expected on this variable. The coefficient of REXP is negative and statistically significant in both the models of Pakistan and India. Dunne (2003) argued that "Export earnings

help generate foreign currency to make debt payments, and also allow imports to be made without resorting to overseas borrowing, so this variable should have a negative sign."

Karagol and Sezgin (2004) noted about the negative relationship between external debt and exports:

> "Of two countries with equally high debt service ratios, the country having the highest exports/GNP ratio would have the most foreign exchange left over after debt service payments relative to its GNP, ceteris paribus. This is a more stable characteristic of the economy and may thus influence the attitude toward rescheduling. A high exports/GNP ratio would tend to reduce the need for painful domestic adjustments, associating a large exports sector with a low probability of rescheduling."

Our results are in line with the studies (Dunne, 2003; Karagol and Sezgin, 2004). Exports can have the positive sign as well. Dunne *et al.* (2004) claimed:

> "…… but exports are a bit more difficult to call. We might expect a negative sign, but it is also possible that increases in exports lead to increased imports of capital and so lead to the positive effect."

Foreign exchange reserves play an important role in defense-debt model. The coefficient of real foreign exchange reserves (RFER) appears with negative sign in both the models. This suggests that external debt liabilities decrease with an increase in foreign exchange reserves of both the countries. Looney (1987) argued that "The countries with high level of reserves are not compelled to accrue external debt."

But Dunne (2003) has contradictory remarks:

> "High reserves may indicate an enhanced ability to manage debt; also, new debt was sometimes used to build up reserves, as discussed, so this variable can probably be expected to have a positive sign, if it is significant."

Turning to the main focus of this study, the coefficient of real defense expenditures is positive and statistically significant in both the models. Defense spending contributes to the external debt accumulation directly or indirectly. The countries with less foreign exchange reserves have to rely more on external debt to finance arms imports military expenditure (*see* Dunne *et al.*, 2004; Karagol, 2005; Narayan and Narayan, 2008; Wolde-Rufael, 2009). Defense spending is a budget item and government has to

finance it through different sources internally or externally. Tax is the most significant internal source of financing the government outlays. If the tax revenues are inadequate to finance the defense expenditures, government has to face a budget deficit. To finance the budget deficit, government needs foreign borrowing in case of limited domestic resources. (*see* Dunne *et al.*, 2004; Narayan and Narayan, 2008; Narayan and Smyth, 2009).

ERROR CORRECTION ESTIMATING RESULTS

The short run dynamic parameters are estimated by the unrestricted error correction model (UECM). We have reported the error correction estimation results in Table 4.

In Pakistan's equation, the dependent variable is dREDP and in India's equation, the dependent variable is dREDI where d shows the first difference of the variable. The change in RGDP is negatively related to external debt of Pakistan and India. The change in REXP has negative effects on external debt liabilities of both the countries. The change in foreign exchange reserves has negative relation with external debt. The change of defense expenditures is positively related to external debt.

TABLE 4

Error Correction Representation for the Selected ARDL Model

Pakistan			India		
Dependent variable: dREDP ARDL (1, 2, 1, 1, 0)			Dependent variable: dREDI ARDL (1, 1, 1, 1, 1)		
Regressor	Coefficient	t-statistic	Regressor	Coefficient	t-statistic
dRGDP	–0.60264	–2.9267	dRGDP	–0.40999	–4.7153
dRGDP1	1.4015	5.8837	dREXP	–1.8119	–7.3497
dREXP	–0.24314	–0.90817	dRFER	–0.59266	–5.7423
dRFER	–0.11041	–0.66596	dRDEI	3.5307	2.3722
dRDEP	3.4491	7.2073	dC	–1225.6	–0.39619
dC	–1139.7	–1.9294	ecm(-1)	–0.59046	–9.6111
Ecm(–1)	–0.66712	–7.2136			

The error correction term exhibits the speed of adjustment to restore the equilibrium in the dynamic model. The coefficient of error correction term (ECM) indicates how quickly or slowly the variables move towards

equilibrium. The term should be statistically significant with negative sign. The parameter of ECM for Pakistan and India is equal to –0.66712 and –0.59046 respectively. It suggests that the deviation from the long term equilibrium following a short run shock is corrected by more than half within one year. The findings indicate that the speed of adjustment is fairly high and it would return to its equilibrium level quickly.

VIII. CONCLUSION

In this study, we have investigated the defense-debt relationship for both the countries of sub-continent using the data for the time period 1972-2010. An Autoregressive Distributed Lag (ARDL) technique has been employed to explore defense-debt nexus. This is the first study that examines the defense-debt relationship simultaneously for Pakistan and India using ARDL approach.

The seminal and pioneer study was conducted by Brzoska (1983) to explore the positive defense-debt relationship for developing countries. We have used the Dunne (2003) defense-debt model to investigate the impacts of defense expenditures on external debt in both the countries. The dependent variable was real external debt and explanatory variables were RGDP, Real exports, Real foreign exchange reserves and real defense spending. The signs of all the variables were found negative except defense spending in both the countries. The empirical results of this study verified the Brzoska (1983) and Dunne (2003) defense-debt model by finding the positive association between defense spending and external debt in both the countries.

The implications of study suggest that both the countries must reduce their defense expenditures as these are contributing to their external debt accumulation. Dunne (2003) argued:

> "This does suggest that military burden may be important in determining debt in countries, but it is only of significance when it is not swamped by other macroeconomic and international factors."

Therefore, from this study, we can conclude that both the countries should lessen their defense spending to reduce the foreign reliance.

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DOES AGRICULTURE CREDIT AFFECT PRODUCTION EFFICIENCY? Frontier Production Function Approach

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Abstract. In the present study, the economic efficiency of credit and non-credit users in agriculture farms was estimated through frontier production function approach. In total, 152 farmers were selected through simple random sampling from District Sargodha of Punjab Province. The results of the study revealed that mean technical efficiency in the region was 0.90 and 0.79 percent of the credit and non-credit users, respectively. The high technical efficiency of credit users was safely attributed to credit availability through which they have a timely access to farm inputs. But still farmers were mis-allocating their resources means inputs at farm level. In this regard farmers need extension services along with credit use to make them economically efficient.

Keywords: Agricultural credit, Economic efficiency, Marginal value product, Frontier production function

JEL classification: O13, O16

I. INTRODUCTION

There are many studies which are supporting the hypothesis the access to credit increased the productivity and profit of the farm households (Diagne

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and Zeller, 2001; Adesina and Djato, 1996; Hazarika and Alwang; 2003; Foltz, 2004). Formal credit has a positive impact on household welfare outcomes. It was also found that formal credit increased rural income and productivity and that overall benefits exceeded the costs of the formal credit system by about 13 percent in India (Binswanger and Khandker, 1995; Khandker and Faruqee, 2003). In examining sources of efficiency differentials among basmati rice producers in the Punjab province of Pakistan, Ali and Flinn (1989) found significant effects of farmers' access to credit. Significant difference in productivities of credit-constrained and unconstrained households was observed in China (Feder *et al.*, 1989; 1990). In Bangladesh, Pitt and Khandker (1996) examined the impact of credit from the Grameen Bank and other two targeted credit programmes and found significant effects on household welfare, including education, labour supply and asset holding. Freeman *et al.* (1998) found that the marginal contribution of credit to milk productivity was different among credit-constrained and non-constrained farmers in East Africa.

Guirkinger and Boucher (2005; 2007) found that productivity of credit-constrained households depended on their endowments of productive assets and the credit they obtained from informal lenders. Similarly, Holden and Bekele[1] (2004) observed that households with access to credit compensated for increasing risk of drought by reallocating their production in such a way that crop sales were lower in good years to reduce the need to buy the crops in bad years, and they argued that the households would be less able to do so without access to credit.

Agriculture credit supply is complex in nature in Pakistan. It is mainly comprised of formal and informal sector. If a household was constrained in the formal market, then, credit being fungible, it must be constrained overall. Therefore, the present study focused on the market of institutional credit (Malik, 1999).

This study only analyses the farmers who have the access to credit from the formal sources which is mainly Zarai Taraqiati Bank Limited (ZTBL). Agriculture credit supply soared high due to the regulations by the central bank. In total all banks are supplying Rs. 300 billion credit to farmers (GoP, 2012). The institutional agriculture credit has a positive impact on the agriculture farm productivity in Pakistan (Iqbal *et al.*, 2003; Okurut *et al.*, 2005; Olagunju, 2007).

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[1]Cited by Komicha and Öhlmer (2008), Influence of credit constraints on production efficiency: The case of farm households in Southeastern Ethiopia.

In addition to this, lack of access to institutional credit is considered a main constraint to agriculture production. This constraint becomes more severe due the seasonality of agriculture. For the welfare of the small farmers it is important that they utilize all the available resource (fertilizers, plant protection measures and other inputs in a judicious manner. Small farmers are having less than 12.5 acres of land holding, thus it is important to develop the agriculture sector to bring prosperity and welfare in the agricultural community, and especially small farmers (Khan, 2000).

The difference in the production capacity of credit borrowers and non-borrowers is due to use of credit and pre-existing inherent characteristics of small-scale farmers. The mean difference was 40 percent of which 2 percent is due to credit. The credit can increase the output up to 21 percent. The major constraint to the farmers is to access an affordable credit which can affect the output capacity and level. There is positive linkage between the technical efficiency of farm businesses and their financial structure. The farmers with greater financial control put forth more industrious efforts to meet their debt obligations, although lenders also may be certifying greater credit value associated with more efficient production (Spio, 2002).

In the context of the above discussion, it is comprehensible that, farmers farm productivity is different with and without credit. Present study attempt to answer the following questions:

1. How does credit affect the farm production efficiency of small farmers?
2. How do farmers efficiently allocate their resources during the availability of credit?

II. ANALYTICAL FRAMEWORK

This paper will provide an analytical framework for efficiency measurement along with empirical analysis of credit users and non-credit users. Basically, the economic efficiency can be estimated by measuring technical and allocative efficiency. Technical efficiency (TE) is the ability of a firm to obtain maximum output from a given set of inputs, and allocative efficiency (AE), which reflects the ability of a firm to use the inputs in optimal proportions, given their respective prices. The concept of technical, allocative and economic efficiency can be illustrated by using input/input space (input-oriented measures) or output/output space (output-oriented measures) (Coelli, 1996) or input-output space (Ali and Chaudhry, 1990). These concepts were explained by employing input-oriented measures.

Farmers are generally believed to maximize their profit. However, it should be noted, efficiency (allocative and technical) and profit maximization are two sides of the same coin in that at the level of individual production unit you cannot have one without the other (Ellis, 1993).

There are two approaches; stochastic frontier (parametric approach) and data envelop analysis (DEA), also named as non-parametric approach mostly used to measure technical, allocative and economic efficiency. The present study employed a stochastic production frontier approach introduced by Aigner *et al.* (1977) and Meeusen and van den Broeck (1977). The weaknesses and advantages have been discussed by Coelli (1996) and Coelli and Perelman (1999). The maximum likelihood estimates provided consistent estimators for coefficients, technical inefficiency measures and variance for details (see Jondrow *et al.* (1982; Bravo-Ureta and Rieger, 1991).

III. MODEL SPECIFICATION

The Cobb-Douglas form is linear in logarithms and can be conveniently analyzed with standard linear regression. The function form fitted to the data is as follows:

$$Y = aW^{b_1} NP^{b_2} C^{b_3} L^{b_4}$$

$$\ln Y = \ln a + b_1 \ln W + b_2 \ln NP + b_3 \ln C + b_4 \ln L + e \qquad (1)$$

Where:

ln = Logarithm;

Y = Gross value of the crop products (Rupees);

W = Irrigation water in acre inches;

NP = Nutrient kg/acre;

C = Cash inputs (Rs.)/acre;

L = Labour input in man days/acre; and

e = error term.

DERIVATION OF MARGINAL VALUE PRODUCTS AND OPPORTUNITY COSTS

Where Y represents farm revenue, X_i represents the level of input of the i^{th} resource, and b_i is the regression coefficient of the i^{th} input in a Cobb-Douglas model, it can be shown that (Heady and Dillon, 1969): Marginal value product (MVP) of $X_i = dY/dX_i = b_i (\hat{Y}/X_i)$.

Following customary practice, one can obtain a point estimate of MVP by evaluating above equation at the mean value of each input, in this case irrigation water: The example for derivation of MVP and its associated statistics is given below: In this paper, individual farm budget of representative categories, *i.e.* credit users and non-credit users were developed for production function analysis.

SAMPLE AND DATA

The study was undertaken in the mixed cropping zone district Sargodha. This comprised of five tehsils: Sargodha, Bhalwal, Sahiwal, Shahpur and Sillanwali. Out of which two tahsils were purposively selected as the concentration of borrowers was high in two tahsils. From each tehsil two villages were again purposively selected. In total 80 farmers were randomly selected who owned the land less than 12.5 acres. Non-borrowers were also randomly selected from the same villages, a list was made with the help of Chowkedar of the villages. Of the total sample, 77 respondents were non-credit users and 75 were credit users for final analysis.

A structured questionnaire was used to collect information on farmer-household socioeconomic characteristics, farm management practices and income patterns. The characteristics include amongst others the following: size of arable land in acres; farmers' age in years; number of years of formal education; gender, marital status; membership of farmers' associations; farming experience in years; inputs used in production process like irrigation water in acre inches; Nutrients kg per acre; Cash inputs (land preparation cost (tillage, ploughing, planking, pesticide and hoeing cost, seed cost (Rs. per acre); L: Labour input in man days per acre.

IV. RESULTS AND DISCUSSION

The following section presents the results and discusses them in detail.

TECHNICAL EFFICIENCY OF CREDIT/NON-USERS

The maximum-likelihood estimates of Cobb-Douglas stochastic production frontier and parameters explaining inefficiency of credit users were obtained in Table 1 for the study area. The estimated coefficients of the input variables of frontier production function have a positive sign and consistent with economic theory. All coefficients were highly significant ($p = 0.01$) except labour input. In the Cobb-Douglas production function, the parameters were the respective elasticities of input which provides the important direction in production decision. The elasticity for some inputs was smaller as their sum was equal to one showing a constant return to scale.

The mean technical efficiency of credit users was 90 and that of non-credit users were 79 percent, respectively (Table 2). The results were consistent with Desai and Mellor (1993). The efficiency of credit users was higher than their counterparts.

TABLE 1

Maximum Likelihood Estimates of the Cobb Douglas Stochastic Frontier Function of Credit Users

Variables	Coefficients	t-statistics
Constant	1.945***	3.045
Irrigation Water	0.233***	2.502
Fertilizer cost	0.405***	3.543
Cash Inputs	0.346***	2.795
Labour Cost	0.058	0.736
Technical Inefficiency Model		
Constant	0.021	0.031
Farm Size	–0.006	0.287
Experience	0.001	0.133
Education	–0.008	–0.396
sigma-squared	0.043*	1.625
Gamma	0.557*	1.673
Mean Efficiency	0.90	

* indicate that the coefficient is significantly different from zero 0.10 percent probability level; ** indicate that the coefficient is significantly different from zero 0.05 percent probability level; and *** indicate that the coefficient is significantly different from zero 0.01 percent probability level.

The high technical efficiency of credit users was their more motivation towards credit. They utilize all available information regarding credit. In order to test this hypothesis preferably we would have incorporated the new technology (which is not available) in the inefficiency model to study the impact of new technology on technical inefficiency. However, scale variables farm size and education played a major role in lowering the inefficiency. The low level of technical efficiency of non-credit users as compared to credit users implied that the potential for improvement exists.

The inefficiency parameters, *i.e.* farm size, experience and education could play a major role in improving the efficiency of non-credit users.

TABLE 2

Maximum Likelihood Estimates of the Cobb Douglas Stochastic Frontier Function of Non-Credit

Variables	Coefficients	t-statistics
Constant	3.781***	15.7
Irrigation Water	0.668***	7.259
Fertilizer cost	0.044	0.977
Cash Inputs	0.003	0.068
Labour Cost	0.003	0.055
Technical Inefficiency Model		
Constant	0.400***	5.915
Farm Size	–0.017	0.842
Experience	–0.0008	–0.724
Education	–0.013*	–1.857
sigma-squared	0.017***	4.901
Gamma	0.999	0.269
Mean Efficiency	0.79	

* indicate that the coefficient is significantly different from zero 0.10 percent probability level; ** indicate that the coefficient is significantly different from zero 0.05 percent probability level; *** indicate that the coefficient is significantly different from zero 0.01 percent probability level.

The value of γ-estimate for credit users was significantly ($p = 0.10$) different from one, indicates that random error was dominant and playing a significant role to explain the variation in the dependent variable and this was normal especially in the case of agriculture where risk was assumed to be a main source of variation (Table 3 and 4). Similar was the case for the non-credit users where the value of γ-estimate was significantly ($p = 0.01$) from zero. The results were consistent with Olomola (1997). The credit was contributing significantly in reducing risk and access to all the resources on which farmer is dependent in the production process.

TABLE 3

Marginal Value Product of Selected Inputs
for Credit Users, Sargodha, Punjab

Variables	Unit	Mean	Production Elasticity	MVP (Rs.)	OC (Rs.)	MVP/ OC
Irrigation Water	Acres Inches	333	0.318	500	300	1.66
Fertilizer	N/Kgs	3070	0.342	57.73	20	2.88
Labour	M/Days	178	0.057	175.59	150	1.17
Cash Inputs	Rupees	122598	0.376	1.57	1	1.57
Gross Revenue	Rupees	521306	–	–	–	–

OC: opportunity cost

ALLOCATIVE EFFICIENCY OF CREDIT USERS AND NON-CREDIT USERS

The intent here was to show estimates of the marginal value product of inputs. Farm survey data were used to estimate the economic value of selected input and to measure the allocative efficiency of these inputs, the Cobb-Douglas (C-D) form provided the best fit to the survey data (as measured by the coefficient of determination (R^2) and t-tests on the regression coefficients). The C-D function is probably the most widely used forms for fitting agricultural production data, because of its parsimony in parameters, ease of interpretation, and computational simplicity.

TABLE 4

Marginal Value Product of Selected Inputs for
Non-Credit Users, Sargodha, Punjab

Variables	Unit	Mean	Production Elasticity	MVP (Rs)	OC (Rs.)	MVP/ OC
Irrigation Water	Acres inches	130	0.775	906	300	3.02
Fertilizer	N/Kgs	1025	0.074	10.763	20	0.5
Labour	M/Days	164	0.004	3.828	150	0.02
Cash Inputs	Rupees	27467	0.056	0.321	1	0.32
Gross Revenue	Rupees	157702	–	–	–	–

OC: Opportunity cost

The results (Table 3 and Table 4) revealed that credit users and non credit users were allocatively inefficient; especially in water use (custom hiring rates of tube well water were used as an opportunity cost). The ratio of MVP/OC was greater than one showing scarcity of the most of the inputs. However, the ratio of fertilizer, cash inputs and labour were low but the coefficients of these inputs were not significant and magnitudes of the parameters were also small. The results were consistent with Olagunju (2007) and Udayanganie *et al.* (2006). The resource-use efficiency of fertilizer and capital were higher than the non-credit users.

V. CONCLUSION AND SUGGESTIONS

The farm enterprises were predominantly small and constitute the majority of the farming community in Sargodha Division. The Division represents the mixed cropping zone where most of the crops are grown. Mostly the farmers were resource poor and often facing constraints in obtaining agricultural credit from the institutional sources. The agricultural credit schemes introduced time to time by the government did not yield desired results. There was a dearth of empirical literature to support or refute the argument for or against the agricultural credit programmes. In this paper the economic efficiency of the credit users and non-credit users was estimated through the frontier production function.

The mean technical efficiency in the region was 0.90 and 0.79 percent, for credit and non-credit users respectively. The high technical efficiency of credit users was safely attributed to credit availability through which they have an access to inputs. The results of the allocative efficiency showed that farmers were inefficient (MVP/OC) >1) in their input use at the farm level. Thus, both categories of farm were found economically inefficient.

In the light of this study's results, the following suggestions are proposed for the improvement of the production efficiency of the farmers:

- The farmers should be provided technical know how, how to utilize the credit for the enhancement of farm productivity judicious use of inputs.
- The motivation required at institutional level to target the most vulnerable group especially small farmers.

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DETERMINANTS OF UNEMPLOYMENT
Empirical Evidences from Pakistan

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Abstract. This study analyzes the determinants of unemployment in Pakistan over a period of 1976-2012 by examining the empirical relationship among the unemployment, population, foreign direct investment, gross domestic product, inflation, and external debt. It is hypothesized that these factors exert a strong impact on unemployment rate in the economy of Pakistan. Autoregressive Distributed Lag (ARDL) approach has been applied to test determinants of unemployment. Empirical results reveal that gross domestic product, population, inflation, and foreign direct investment are significant determinants of unemployment in Pakistan in short-run as well as long-run. The CUSUM and CUSUMSQ are showing that the model is structurally stable within the 5% of critical bounds. The Phillips curve exists in Pakistan both in short- and long-run.

Keywords: Unemployment, ARDL, Population, Gross domestic product, Foreign direct investment

JEL classification: C12, E01, E24, E31

I. INTRODUCTION

In general, the word 'employment' means working of different individuals in order to earn some wages which are used to meet their daily needs. On the

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other hand, before employment, unemployment is a stage during which individuals actively work in search of jobs and mentally prepare themselves to work at any level of wage which already exists in the competitive market. Based on the need and importance of the subject matter, it has various issues. Firstly, the international conference of labour statisticians (1954) provides a very restrictive standard definition about unemployment that was not applicable in developing countries since it has some controversial issues regarding the nature of unemployment. Secondly, with the relaxing the "*conventional means of criterion of seeking work*" and more coverage of unemployment has become possible. Based on that, it is argued that in the absence of any standard definition of unemployment, which would remove measurement problems, the statistical records of unemployment in various developing countries are still related to only visible unemployment which are allied to formal sector of higher opportunities and urban areas.

Like many other developing countries, due to lack of absorption capacity, unemployment has been one of the major problems. The high unemployment rate in South Asian countries is one of the most important issues that distinguish them from those of the developed countries. The excessive rate of unemployment negatively impacts on economy which causes unstable economic conditions. This is troublesome because when workers are unemployed, there is an under-utilization of resources. So the total production of a country is less than its potential level of output because resources are not fully utilized in these countries.

The focus of every government must be to create employment opportunities through various productive activities by using all available factors of production. High population is associated with alarming issue in developing countries including Pakistan. A rapid increase in population raises many socio-economic problems in the economy. It not only increases unemployment, but also accumulates the backlog of unemployment. If people cannot find jobs in their home country, they may be tempted to relocate to another country for getting jobs. This can be dangerous for the future of a nation, particularly if other nations are attracting its brain drain. Therefore, if this problem continuously persists in any economy, it could be a major factor in deteriorating the economic growth. Additionally, persistent unemployment not only affects the status of a nation in comparison to other nations, but it also leads to cruel home country problems. Long-term unemployment always results in creating financial hardships, poverty, homelessness, crime, frustration and many other problems like breakdown and family tension, social isolation, loss of confidence and self-esteem. All these lead to the erosion of a healthy society.

The unemployment rate in Pakistan was 5.7 percent in 1990s on the average which increased to 6.80 percent in 2000s on the average. The unemployment rate remained at 6 percent in last three years. The unemployment rose in the last decades of 1990s due to low economic growth as well as the result of fiscal tightening in Pakistan. Global recession, law and order situation, energy crisis and other macroeconomic variables are also responsible for high and persistent unemployment rate in 2000s. The privatization and restructuring of public sector enterprises carried out under the WB/IMF structural adjustment programmes resulted in layoffs of extra stop furniture and enhancing the situation of unemployment in period of depressed economic growth in Pakistan. The focus of this study is to explore and highlight various aspects and issues which are responsible for creation of unemployment in Pakistan.

The on determinants of unemployment shows that there are internal and external factors that determine unemployment. The internal forces are labour market fundamentals affecting labour supply and demand. These include workers and trade unions preferences, bargaining powers, firms, technology and market power. The external forces are macroeconomic policies and institutional changes related to fiscal and monetary policies and goods market. A number of the studies have been conducted so far to access the determinants of unemployment. Kalim (2003) worked on determinants of unemployment in Pakistan. She considered population and gross domestic product as determinants of unemployment She analyzed the statistical relationship between unemployment, population and GDP using dataset for 13 years from 1986-1999. It has been found that both GDP and population are major contributors to unemployment in the economy. Akhtar and Shahnaz (2005) examined the determinants of youth unemployment. They used the data from 1991-2004. The results reveal that the growth rate of GDP, growth rate of services sector and private sector investment have greater impact than the public sector investment to reduce youth unemployment. These studies have not incorporated key macroeconomic variables in model that may be responsible for change in unemployment. So it is important to identify the variables that are responsible for unemployment. This study incorporate population, gross domestic product, private investment, foreign direct investment, and external debt as determinants of unemployment and extend the time span of analysis using dataset from 1976 to 2012. The present study also examines the existence of the Phillips curve in Pakistan.

After a brief introduction in previous section, section II reviews existing literature. Section III describes empirical methodology and data description

and section IV elaborates the empirical results. Finally, conclusion and policy recommendations are presented in section V.

II. REVIEW OF LITERATURE

Since unemployment has become an important issue in Pakistan, which directly or indirectly creates economic problems. If, however, resources are properly utilized in Pakistan, this issue can be eradicated. A lot of literature is available on the subject matter, highlighting various causes and consequences regarding increasing rate of unemployment. Many studies investigated determinants of unemployment. Some studies used Microeconomic prospective and others used Macroeconomic factors of unemployment. These studies worked on developed, underdeveloped and developing countries. Different theoretical models are used for assessing the determinants of unemployment. The job search model was presented by Mortensen (1970) and Lippman and McCall (1976). According to this model, the unemployment depends on job offer and job acceptance. The job offer depends on skills of labour, education, work experience and the demand condition of local area.

Acero (1993) suggested some factors of unemployment. She stated that many elements could not be pointed out by a neoclassical perspective. Some of these factors are related to actual job search. She said that the job market keeps on changing itself as workers change job. But when these changes take a long time due to the heterogeneity of work force and the job opportunities, lack of perfect information or the cost of training, we have to face problems. When we leave people unemployed for a long time, it also creates problems. Other factors are wage rigidity, the influence of labour union and labour legislation.

Assaad *et al*. (2000) empirically examined various determinants of unemployment in Egypt. The labour market of Egypt is starving from a span of high overall unemployment, where unemployment is flourishing with constant rate. Analysis reveals that the educated female sector is being affected than that of male counterparts by the transition to a private sector economy. The female have some problem to enter in the job market, especially in private sector. They suggest that there is good policy atmosphere that is appropriate for labour-intensive techniques, experts oriented industries would help to absorb the new applicants into the labour market.

Kalim (2003) worked on determinants of unemployment in Pakistan. She analyzes the statistical relationship between unemployment, population

growth and real growth rate of GDP. There is a positive relationship between unemployment and population and an inverse relationship between unemployment and GDP over a period of 1986-1999. A simple regression is used to find out the results. She concluded that population growth rate in Pakistan is extremely high as compared to other developing countries. On the employment front, it has been found that a large number of labour force remain unemployed. Both GDP and population are major contributors to unemployment in the economy.

Echebiri (2005) worked on determinants of unemployment in Umuahia and Nigeria. Umuahia has a faster population growth rate so most of labour force is not employed. The sample of 220 youths was drawn from areas with varying residential configurations and found that youth unemployment in the town shared common characteristics with that studied in many other cities in the developing world. Education and job preference have a direct relation with unemployment. It was particularly found that majority of the unemployed and first time job seekers preferred salaried employment to self-employment. The youths showed that they dislike the rural residency because there is lack of employment opportunities and poor social and physical infrastructures.

Akhtar and Shahnaz (2005) also examined the determinants of youth unemployment using data from 1991 to 2004. In 1990 there is high unemployment due to low GDP and investment. They worked on both micro and macro determinants of youth unemployment issues in Pakistan. First, unemployment of youth only begins to decrease if the annual growth rate of GDP is greater than 4.25 percent per year. Second, the growth rate of services sector GDP has greater impact on decreasing female unemployment. Third, the private sector investment has greater impact than public sector investment to reduce youth unemployment. Household micro level data showed that skill acquisition and vocational training have no impact on employment.

Schoeman *et al.* (2008) reviewed the determinants of unemployment in South Africa. They used the macro economic variables, real exchange rate and unionsation as a percentage of formal employment, crude oil prices, capital stock and banker's acceptance rate. The results showed that there is an inverse relationship between investment and unemployment and the positive relation between unemployment and unionsation, crude oil prices, appreciation of real exchange rate and strict monetary policy.

Eita and Ashipala (2010) worked on determinants of unemployment in Namibia for the period of 1971-2007. They used macro economic variables

for unemployment model. They used Engle and Granger approach to estimate the model. The results showed that there is negative relationship between inflation and unemployment, positive between wage rate and unemployment and negative between investment and unemployment. The Philips curve held in Namibia. Kingdon and Knight (2004) worked on unemployment by using probit model for South Africa. Garcia-Rubiales (2004) reviewed on causes of unemployment in Spain. Valadkhani (2003) worked on unemployment in Iran. Monastiriotis (2006) worked on unemployment by using macroeconomic variables in UK. He used Keynesian and monetarist approach of unemployment. Kyei (2011) reviewed determinants of unemployment in Limpopo Province in South Africa.

We have reviewed different studies about determinants of unemployment. These studies have not considered the important macroeconomic variables which may influence unemployment rate. Kalim (2003) considers only two variables like population and GDP as determinants of unemployment in her analysis for Pakistan economy. For comprehensive analysis, this study incorporates foreign direct investment, external debt, population, inflation and GDP as determinants, which may contribute unemployment rate in Pakistan and uses a large dataset.

III. EMPIRICAL METHODOLOGY AND DATA DESCRIPTION

There are various techniques for conducting the cointegration analysis among variables. The approaches are: the residual based approach proposed by Engle and Granger (1987) and the maximum likelihood-based approach proposed by Johansen and Juselius (1990) and Johansen (1992). When there are more than two I(1) variables in the system, the maximum likelihood approach of Johansen and Julius has the advantage over residual-based approach of Engle and Granger; both of the approaches require that the variables have the same order of integration. Autoregressive Distributed Lag (ARDL) for cointegration test has certain advantages over Johansen. This methodology does not require the classification of variables into I(0) or I(1). This study used ARDL approach to analyze cointegration among variables that was proposed by Pesaran and Shin (1998).

A simple model is used to examine the variations in unemployment rate in Pakistan. There are number of factors which influence the unemployment rate. The functional form of the model is as:

$$UN = f(GDP, POP, FDI, PINV, EXD)$$

Where

UN = Unemployment in millions

POP = Population in millions

GDP = Real Gross domestic product in US dollars (millions)

FDI = Foreign direct investment in US dollars (millions)

EXD = External debt in US dollars (millions)

PINV = Private investment in US dollars (millions)

Unemployment: The dependent variable is unemployment which is derived from labour force minus employed persons. Unemployment occurs when a person is able and willing to work but is currently without work.

Population: Population means total persons of the country. Population increase leads to increase in unemployment.

Gross Domestic Product: The total market value of all final goods and services produced annually within the boundaries of a country. The study assumes that there may be negative relationship between GDP and unemployment.

Foreign Direct Investment: Foreign direct investment (FDI) in its classic form is defined as a company from one country making a physical investment into building a factory in another country. It is the establishment of an enterprise by a foreigner. The study supposes that FDI has a negative relationship with unemployment.

External Debt: External debt is that part of the total debt in a country that is owed to foreign citizens, firms and institutions. The debt includes money owed to private commercial banks, other governments, or international financial institutions such as the IMF and World Bank. External debt leads to decrease in unemployment.

Private Investment: A private investment capital subscription, commonly referred to as PICS, is a financial tool that relies on a small pool of investors' money for real estate investments. The money managers of private investment capital subscriptions or PICS are experienced real estate investment experts, who also invest in related real estate products such as tax lien certificates, foreclosures, notes, as well as development projects on behalf of their subscribers and themselves. Private investment leads to decrease in unemployment.

The ARDL approach to cointegration involves estimating the unrestricted error correction model version of the ARDL model for unemployment and its determinants:

$$\Delta \ln UN_t = \beta_0 + \Sigma \psi_i \Delta \ln UN_{t-1} + \Sigma \beta_i \Delta \ln POP_{t-i} + \Sigma \lambda_i \Delta \ln GDP_{t-i} + \Sigma \delta_i \Delta \ln FDI_{t-i} + \Sigma \varphi_i \Delta \ln EXD_{t-i} + \Sigma \eta_i \Delta \ln CPI_{t-i} + \alpha_1 \ln UN_{t-1} + \alpha_2 \ln POP_{t-i} + \alpha_3 \ln GDP_{t-i} + \alpha_4 \ln FDI_{t-i} + \alpha_5 \ln EXD_{t-i} + \alpha_6 \ln CPI_{t-i} + \mu_t$$

The null hypothesis that there is no cointegration is defined as:

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

against its alternative,

$$H_1: \ \alpha_1 \neq 0, \ \alpha_2 \neq 0, \ \alpha_3 \neq 0, \ \alpha_4 \neq 0, \ \alpha_5 \neq 0, \ \alpha_6 \neq 0$$

by computing F-statistic.

The error correction equation is used to find the adjustment speed to the equilibrium in the third stage. The ECM equation is as follows:

$$\Delta \ln UN_t = \beta_0 + \Sigma \beta_i \Delta \ln POP_{t-i} + \Sigma \lambda_i \Delta \ln GDP_{t-i} + \Sigma \delta_i \Delta \ln FDI_{t-i} + \Sigma \varphi_i \Delta \ln EXD_{t-i} + \Sigma \eta_i \Delta \ln CPI_{t-i} + ECM_{t-1} + \mu_t$$

Inflation, external debt, foreign direct investment and GDP are likely to have inverse impact on unemployment, so the values of the coefficients λ, φ, δ and η are expected to be negative, $\lambda < 0$, $\varphi < 0$, $\delta < 0$ and $\eta < 0$. Population is expected to have a positive relation with unemployment so $\beta > 0$.

DATA SOURCES

The data sources used for the study are *International Financial Statistics* and *Government Finance Statistics Yearbook* published by International Monitory Fund (various issues and CDs), *World Development Indicators* published by World Bank and *Annual Report* published by State Bank of Pakistan. The time span to be covered in the study is 1976-2012.

IV. EMPIRICAL RESULTS

Table 1 shows the order of integration of the variables. We have applied unit root test to examine the order of integration. The ADF test has been used under the assumption of constant and trend.

Results show that the unemployment series are not stationary at level but the first differences of the series are stationary. This type of testing is useful

to avoid the chances of spurious regression as Quattara (2004) shows that the bound testing is depending on the assumption of I(0) and I(1).[1] When we have some variables that I(2) then the F-statistic explained by Pesaran *et al.* (2001) is unacceptable. AIC is used to find optimum lag length. We have taken the optimal lag length as 1.

TABLE 1

Unit Root Analysis

	ADF (at level)	ADF (at 1st difference)
ln *UN*	–1.438	–7.1660
ln *POP*	–2.969	–2.3313
ln *GDP*	–0.156	–4.4944
ln *EXD*	–5.617	–9.1713
ln *CPI*	–2.4638	–6.3824
ln *FDI*	–0.889	–3.9075
1% Critical Value	–3.6267	–3.6329
5% Critical Value	–2.9458	–2.9484
10% Critical Value	–2.6115	–2.6128

In Table 2, the calculated F-statistic = 8.45 is higher than the upper bound critical value at 5% level of significance (7.30) by unrestricted intercept and no trend for the model. We reject the null hypothesis of no long-run relationship at 5% significance level. So, there exist a cointergration among the variables. Table 3 shows the results of ARDL Model based on Akaike Information Criterion.

[1] I(1) and I(0) represent the integration process of order 1 and 0 respectively. Pesaran and Pesaran (1997) explains that the residual-based cointegration are inefficient and can lead to contradictory results, especially when there are more than two I(1) variables under consideration.

TABLE 2

Bound Testing for Cointegration

Dependent variable			F-statistic		
Unemployment			8.45*		0.0001
Critical Value	Pesaran *et al.* (2001)**		Narayan (2005)***		
	Lower Bound Value	Upper Bound Value	Lower Bound Value	Upper Bound Value	
1%	8.74	9.63	10.150	11.230	
5%	6.56	7.30	7.080	7.910	
10%	5.59	6.26	5.915	6.630	

* Significant at 5% level of significance from to Pesaran *et al.* (2001); ** Critical values are obtained from Pesaran *et al.* (2001), Table CI (V): Unrestricted Intercept and Unrestricted Trend; *** Critical values are obtained from Narayan (2005), Table CI (V): Unrestricted Intercept and Unrestricted Trend.

TABLE 3

ARDL Based on AIC

Regressors	Coefficient	S. Error	T Ratio	Prob.
ln *UN*(–1)	0.56297	0.13223	4.25	0.000
ln *POP*	2.9199	1.22	2.38	0.024
ln *GDP*	–0.73308	0.338	–2.165	0.038
ln *FDI*	–0.0692	0.03443	–2.0103	0.030
ln *EXD*	–0.2342	0.3703	–0.6325	0.532
ln *CPI*	–0.1708	0.0633	–2.69	0.011
C	-6.6533	2.2620	–2.9413	0.006
R^2	0.92	Adjusted R^2		0.9058
AIC	6.8613	SBC		1.22
F-statistic	58.74			
Prob (F-statistic)	0.000			
DW Statistic	2.13			

Table 4 shows that many econometric problems like autocorrelation, heteroscedasticity and conflict to normal distribution has not been found. In the same way, no model specification error exists with reference to functional form. Results reveal that external debt and private sector investment are not statistically significant while population, foreign direct investment and gross domestic production have significant impact on unemployment.

TABLE 4

The Diagnostic Tests

Item	Test Applied	CHSQ (χ^2)	Prob.
Serial Correlation	Lagrange Multiplier Test	.43805	0.507
Normality	Test of Skew ness and Kurtosis	7.68	0.203
Functional Form	Ramsey's reset test	1.1954	0.274
Heteroscedasticity	White Test	3.16	0.075

An analysis of Table 3 indicates that macroeconomic variables significantly explain unemployment. The value of $\overline{R}^2$ is 0.9058 that shows that 90% variation in the dependent variable is due to the independent variables. The value of F statistic is also significant at 5% level of significance, which shows the model is good fit as a whole.

TABLE 5

Estimated Long-Run Coefficients for selected ARDL Model

Regressors	Coefficient	S. Error	T Ratio	Prob.
ln *POP*	6.6812	2.4586	2.7174	0.011
ln *GDP*	–1.6774	0.8501	–1.97	0.05
ln *FDI*	–0.091	0.0399	–2.3000	0.030
ln *EXD*	–0.5359	0.8067	–0.6644	0.512
ln *CPI*	–0.345	0.1222	–2.8279	0.008
C	–15.22	4.09	–3.71	.001

Table 5 shows the results of long-run coefficients under ARDL method. Results reveal that external debt is not statistically significant while population, gross domestic product, inflation and foreign direct investment have significant and long-run effect on unemployment.

According to economic theory gross domestic product is negatively related to unemployment which is logical as rise in GDP will lead to decrease in unemployment. The relationship is significant too. FDI is significantly related to unemployment. A increase in FDI leads to decrease in unemployment. Population growth has a positive effect on unemployment that is in line with results drawn by Kalim (2003).

External debt is not reducing unemployment. The government of Pakistan got loans from World Bank and IMF since 1947. These loans were not utilized appropriately. The current external debt of Pakistan is more than $ 50 billion. The government of Pakistan allocates a huge amount for debt servicing. So there is unemployment primarily due to fewer resources for the development projects. There exists inverse and significant relationship between unemployment and inflation both in short- and long-run. A one percent rise in inflation leads to 0.34 percent decrease unemployment. This situation shows the existence of Phillips curve both in short- and long-run for Pakistan. The existence of Philips curve in Pakistan has already been proved by Hye and Siddiqui (2010), Zaman *et al.* (2011), Katria *et al.* (2012) and Gul *et al.* (2012).

TABLE 6

Error Correction Representation for the Selected ARDL Model

Regressors	Coefficient	S. Error	T Ratio	Prob.
Δ ln *POP*	2.9199	1.2244	2.3846	0.024
Δ ln *GDP*	–0.7303	0.3384	–2.1658	0.038
Δ ln *FDI*	–0.0692	0.0344	–2.0103	0.030
Δ ln *EXD*	–0.2342	0.3703	–0.6325	0.532
Δ ln *CPI*	–0.1708	0.0633	–2-69	0.011
$ECM_{(-1)}$	–0.43703	0.1322	–3.30	0.002
R^2	0.3593	Adjusted R^2		0.2312
AIC	6.86	SBC		1.2231
F-statistic	2.805			
F-significance	0.027			
DW-statistic	2.13			

Error correction representation of above long-run relationship is shown in Table 6 which captures the short-run dynamics of relationship among

macro-economic variables and unemployment. The error correction model depends upon ARDL method establishes that changes in population, foreign direct investment, inflation, gross domestic production are statistically significant, while changes in external debt have no significant short term effect.

$$ECM = \ln UN - 6.6812 * \ln POP + 1.6774 * \ln GDP + 0.0919 * \ln FDI + 0.5359 * \ln EXD + 0.34 * \ln CPI + 15.2239c$$

According to the results, the short-term elasticities of population, gross domestic product, inflation and foreign direct investment are 2.9199, –0.7330, –0.1708 and –0.069217 respectively. The short-run elasticities are smaller than the long-run elasticites. The $ECM_{(-1)}$ is the lag value of one period of error terms that find out from the long-run relationship. The value of ECM shows that the disequilibrium of short-run will be fixed long period of time. The $ECM_{(-1)}$ has a negative value and it is statistically significant. The value of ECM term shows that the process of adjustment is not quick and 43% of the last year disequilibrium in unemployment from its equilibrium path will be corrected in present year.

Figures 1 and 2 are showing the cumulative sum of recursive residuals the cumulative sum of squares of recursive residuals respectively. Both CUSUM and CUSUMSQ are within critical bounds of 5%, so it reveals that the model is structurally stable.

FIGURE 1

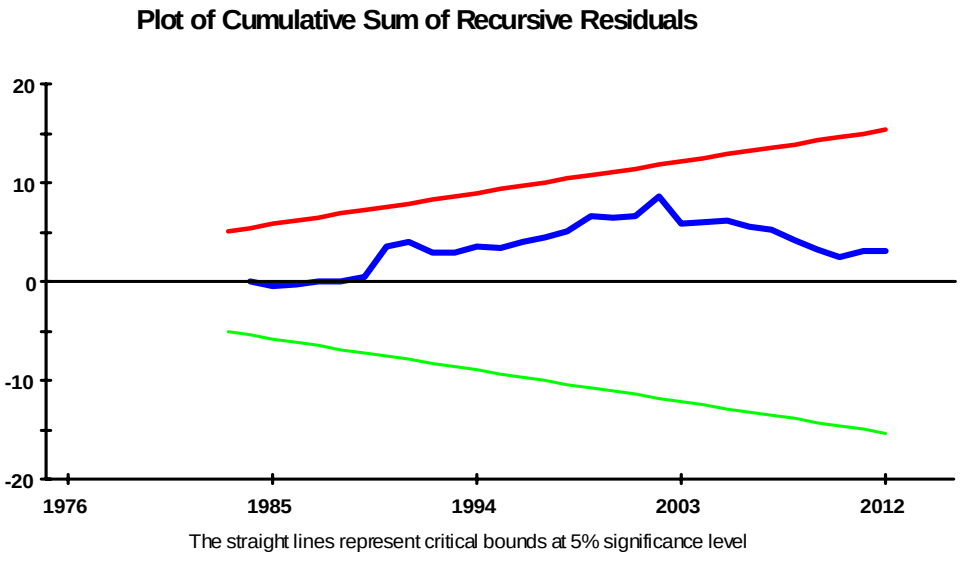
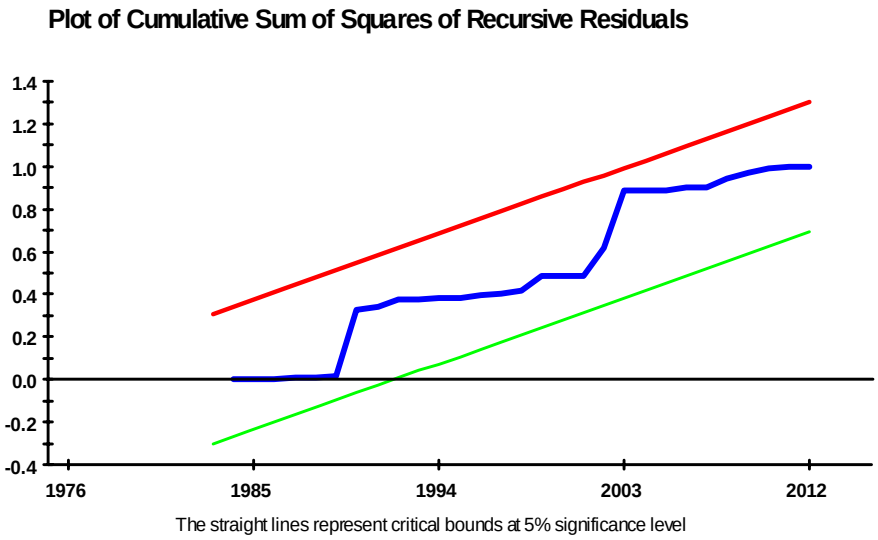


FIGURE 2



VI. CONCLUSION

The objective of this study is to explore the determinants of unemployment in Pakistan. The study examines the relationship among the population, foreign direct investment, gross domestic product, inflation, external debt and unemployment. It is hypothesized that these factors exert a strong impact on unemployment in the economy of Pakistan over a period of 1976-2012. Autoregressive Distributive lag approach has been applied as it yields consistent estimates of the long term relationship that are asymptotically normal irrespective of whether the underlying repressors are I(0) or I(1).

Results reveal that population; gross domestic product, inflation and foreign direct investment have significant long-run effect on unemployment. There exists inverse and significant relationship between unemployment and inflation both in short- and long-run. A one percent rise in inflation causes unemployment decrease by 0.34 percent. This situation shows the existence of Phillips curve both in the short and long-run for Pakistan. The $ECM_{(-1)}$ is the lag value of one period of error terms that find out from the long-run relationship. The value of ECM shows that the disequilibrium of short-run will be fixed long period of time. The $ECM_{(-1)}$ has a negative value and it is statistically significant. The value of ECM term shows that the process of adjustment is not quick and 43% of the last year disequilibrium in unemployment from its equilibrium path will be corrected in present year.

CUSUM and CUSUMSQ plots is showing that the model is structurally stability within the 5% critical bound.

The focus of policy should be to attract local investment which would attract FDI to follow. Improving the local environmental conditions so that the quality of local products may be improved not only for local consumption but also for exports that will result in improving investment in other sectors subordinates to those ones, *e.g.* agriculture sector helps to improve the agro-industrial sector because it provides raw material to industry. It is important to provide the local producers with incentives and technical know-how on the one hand, and provide the private investors with government guarantee that their investment is in good hands. The government should control population growth and use debt for productive purpose. It is need of the day to improve the Law and order condition and to control the corruption to enhance the local as well as foreign investment to reduce the unemployment.

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