The Macroeconomics of Flood: A Case Study of Pakistan

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Abstract
Climate change is a real threat explicitly for developing economies as large unexpected natural disasters generate destruction for economic and socio-economic factors. We use Autoregressive Distributive Lag (ARDL) cointegration model to figure out the dynamic response of output growth to flood shocks, using time series data for Pakistan between 1981 and 2014. The aim of the paper is to assess the long and short run dynamics of floods for economic growth. The results confirm a suitable long run relationship among GDP growth and its determinants: agriculture growth, non-agriculture growth, investment and affected areas by flood. We conclude that in case of Pakistan, we have a positive and significant effect of flood shocks on GDP growth and this impact is larger and more significant in the agriculture sector.
Keywords: natural disasters, GDP growth, ARDL, long run, short run, dynamics.

1. Introduction

In today's contemporary world, climate change is a real threat for the economies as large unexpected natural catastrophes such as tsunami, earthquake, and flood generate destruction for lives, livelihood, development and economic stability. Catastrophic events such as the Indian Ocean Tsunami 2004, Katrina hurricane 2005, Pakistan earthquake 2005 and the Sichuan earthquake 2008 had grabbed global media exposure. The United Nation's Integral Regional Information Network (IRIN) highlighted the fact that over the past decade, although the mortality rate by natural disasters had declined, but the number of people affected by it had risen almost three times to 2 million. (IRIN 2005). Therefore, it has been observed that the awareness related to the destructive nature of disasters have been widely spread among the public.

Considerable research in social and natural sciences has been devoted to enhance the ability to forecast disaster and to look at its preventive side. In the early 2000, the topic was more or less in the domain of other disciplines of social and technical sciences. (Cavallo & Noy 2010)

However, the research on economics of natural disaster and its consequences is still in its initial stage. Due to greater frequency along with the severity of natural disasters, the literature on the empirical economic impact of natural disasters has grown extensively during the last decade. Here, we are interested in cautiously inspecting the impact of flood incidents on economic prospects, in particular on the growth of Gross Domestic Product (GDP).The EM-DAT Global Disaster Database mentioned that among all the types of natural disasters flood is declared as the worst among all between 1985 and 2009, and accounts for 40 percent of all natural disasters.[1]

The risks associated with disaster differ noticeably from one country to another and it is thus sensible to examine the macroeconomics of disaster and the long and short run association between disasters and economic instability.

Pakistan is a vast and diverse country which occupies over 880,000 square kilometers (Km^2) and categorized by a broad variety of geography, ecosystem, climate and socio-economic zone. It is abandoned with natural wealth, such as natural gas reserves, fertile lands, and mineral deposits, but still strives to find stability between economic growth and environmental protection. Pakistan is a semi-industrialized economy which has developed from a principally agricultural-based to a service-based economy. Since 2001, there is a slow growth in the economy and still 32.6% of the population lives below the poverty line. In addition to this, still majority of Pakistan's people live beside the Indus River that is prone to austere flooding especially in the month of July and

[1] EM-DAT stands for Emergency Events Database and it is preserved by the Center for Research on the Epidemiology of Disasters (CRED) at the Catholic University of Louvain, Belgium. Most of the empirical studies rely on this database which is assembled from numerous sources, such as UN agencies, insurance enterprises, non-governmental institutions, research organizations, and press agencies.

August. According to the World Resource Institute (2013), Pakistan is 5th after India, Bangladesh, China and Vietnam in the list of fifteen highly populous countries which are most vulnerable and exposed to river flood risks all over the world. Inter-annual rainfall values vary considerably and often prominent to consecutive patterns of floods and droughts in Pakistan. However, most of the areas of the country receive very little rainfall. The unusual enormous rainfall of the 2010 monsoon caused the most catastrophic flooding in Pakistan's history, affecting one-fifth of the country. Since 2010, floods annually destroy millions acre of crops land and affect numerous people with a financial damage in billions of rupees along with the major damage to agricultural yields, infrastructure and other public and private utilities.

In September 2014, the National Disaster Management Authority (NDMA) and United Nations (UN) mutually conducted the Multi-Sector Initial Rapid Assessment (MIRA) and specified that 40 % of the markets of the affected areas by floods were not operating. Additionally, 55% of reported households were depended on agriculture, 12 % on livestock while 33% were engaged with non-farm activities for their livelihoods. The study declared that 62 % of the households had inadequate resources to buy food. (Economic Survey of Pakistan 2014-2015)

The sectorial breakdown of flood damages throughout 2014- 2015 are given in Table 1 in Appendix. It reveals that the infrastructure sector was severely damaged followed by housing and crops.

Pakistan is highly vulnerable to climate change and almost every year floods wash out the economic development of different areas. Economy faces high inflation with negative exports while high rehabilitation and reconstruction costs stimulate government expenditures. The situation is also not favorable for finance as there will be downward movement in balance of payments. Recurrent and frequent floods in Pakistan have ruined millions of crop lands, infrastructure and socio-economic life of the economy. It is thus reasonable to mention that nature is not solely responsible for this scenario while lack of risk management, policy gaps and weak implementation of appropriate strategies equally and mutually share the liability.

2. Historical Review of Floods in Pakistan

In last 68 years, Pakistan has experienced various disastrous events caused by heavy rain-fed floods. The country faced twenty two catastrophic flood events i.e. 1950, 1955, 1956, 1957, 1959, 1973, 1975, 1976, 1977, 1978, 19981, 1983, 1984, 1988, 1992, 1994, 1995, 2010, 2011, 2012, 2013 & 2014. On average, the country witnessed almost one flood in every three years between 1950 and 2011. Since 1950 -2014, these floods of different magnitudes affected massive regions in the provinces of Pakistan including FATA & Azad Jammu & Kashmir and Gilgit-Baltistan. Due to these major flood events the country had bared financial cost of more than US$ 38.055 billion while around 11,939 lives were lost, some 192,596 villages were ruined or damaged and a total area of 613,721 Sq.km was affected between 1950 and 2014.

According to the Annual Flood Report (2014), floods in 2010 were declared as the worst flood in the past 80 years in the region. The flood made a loss of 1,985 human lives and 17,553 villages (160,000-square kilometers) were drowned, affecting 21 million masses. In 2011 and 2012, floods claimed 516 and 571 human lives respectively. Pakistan lost 3,072 lives and $16 billion of physical capital was ruined by floods from 2010-2012. Even though, not any major flood shock was reported in 2013, yet around 69 people were killed by the monsoon rains, including 22 in Sindh, 18 in Baluchistan, 15 in Punjab and 14 in Khyber Pakhtunkhwa. The recent flood of 2014 had destroyed about 2.415 million acres of crops, affected 4,065 villages and population of about 2.600 million were suffered and claimed loss of about 367 lives. Over 107,102 houses and 250,000 farmers were affected. The total estimated flood damages for 2014 are US$ 0.44 billion and the recovery cost is US$ 439.7 million

3. Significance of the Study

The natural disaster in the form of flood is very common physical calamity that causes death, illness and loss of physical infrastructure which are pursued by subsequent effects on the economy in terms of income, sectorial structure of production, employment and inflation etc. On a ground note it should be accepted that floods can't be avoided but they can only be managed. Therefore we believe that the detail study of the dynamics of flood disaster, provide us a very useful tool to direct the adaptation outcomes. Our study is unique in a sense that a very few studies have been able to capture the empirical analysis of floods for the last few years. This study by our knowledge is the first to empirically portray the macroeconomic consequences of flood in Pakistan with a qualitative analysis supported by economic theory and reasoning.

4. Objective of the study

The focus of the study is to figure out the empirical assessment of flood and more specifically on long run and short run dynamic analysis. In this study, we have emphasized on the macroeconomic analysis because this strand of the literature is more uniform. The microeconomic literature, for example, is much diversified in terms of its research questions which are of various frameworks and particularly explores household coping methodologies. It would be difficult to associate the two components because they use completely diverse indicators of disaster outcome. For the purpose of our analysis we focused on essentially diverse determinants which are also very interrelated. Therefore, the study of growth effects of flood is essential to identify the role of natural catastrophes during the process of growth.

5. Theoretical Framework

Economists are well conscious about the firm cyclical features of economic activity since the work of Adam Smith (1776), David Ricardo (1810), Clement Juglar (1862) and many others. Over the years, two leading theories-the real business cycle theory (RBC) and the endogenous growth theory have endeavored to explain fluctuations in economic activity. The real business cycle model declares exogenous shocks as the prime reason for economic fluctuations. Otherwise there is stability in the economic system. The other school of thought proclaims that endogenous shocks are caused by intrinsic procedures that endogenously disrupt the economic system. Both schools of thought have their achievements and short comings.

The contradiction between these opposite models of economic fluctuation is a prominent impediment to evaluate the economic loss of natural calamities such as, earthquakes, hurricanes, droughts, floods and so on. In this regard, implementation of climate policies is highly required and to carry out such assessment the appropriate macroeconomic set up is crucial.

Overcoming the controversy between these two economic theories may help to construct significant assessment criteria. This may lead to eradicate the uncertainties in disaster assessments and policy costs. Additionally, the observation of exogenous shocks may provide a useful obstacle to give insights about overall economic performance and to achieve a cohesive theory to explain the economic fluctuations.

The economic context between economic instability and physical disaster is yet to be explored as these two models have not reproduced any concrete results to figure out the real impact of natural disaster on economic growth. However, these models assess to recognize the exogenous shocks (e.g. natural disasters) and endogenous dynamics.

6. Literature Review

The economic study of this field is still in its infancy stage. As a whole, the macroeconomic aftermaths of natural calamities appear to be vague. A brief examination of current empirical research studies may establish a clear perception. However, the impact may rely more on socio-economic and institutional circumstances and on the kind of natural disaster.

The first attempt was made by Albala-Bertrand (1993) to empirically depict the short run macroeconomic dynamics of natural catastrophes. Albala-Bertrand developed a unique systematic model of disaster incidence and its reaction, and collected dataset of disaster incidences. He observed 28 disasters in 26 countries during 1960-1979 and explored a positive impact on growth of GDP in the short run in selected countries. The study found that GDP was increased with high agriculture growth and construction output coupled with high capital formation. However, the inflation didn't show any change and the trade and fiscal deficits were also increased (the former sharply), and foreign reserves increased as well. In the meantime, any apparent impact had not been witnessed on the exchange rate.

Skidmore and Toya (2002) made the first inclusive empirical research in 2002 to analyze the long-run macroeconomic impact of natural disaster. The authors employed a cross-country analysis for the period 1960-1990 and used average GDP per capita for the period 1960-1990. The total number of significant disaster incidents was examined over the same period in respective economies. The study covered climatic and geologic disasters and explored a positive impact of climate disaster on economic development in the long run which tempted larger capital growth and total factor productivity. However, geological disasters showed an adverse impact on economic growth.

In analyzing the impact of natural disaster country size is also directly associated to economic damages of natural disaster as the capability of mitigation measures can diversify the economic impact of natural disaster such as floods. A country's vulnerability to the effect of natural catastrophes can be determined by its level of economic development. It has been observed with great concern that mostly human and economic losses due to natural calamities in low income economies. Developed economies do not experience such high death figures (1.8 deaths) while a developing country typically experienced 9.4 deaths per million people annually. The difference is possible due to higher spending on preventive measures and legal implementation of mitigation rules which are infrequent in developing countries. [Kahn (2005) and Cavallo, Powell and Becerra (2010)]

A number of studies are of the view that economic development role in mitigating a country's vulnerability to catastrophic frequencies is vital. Skidmore and Toya (2007) emphasized on the effects of disaster on development by employing the OLS regression analysis and used a data of natural disasters in 151 countries during the period 1960 -2003. In this study, two trends of data had been employed which were obtained from the EM-DAT. One stressed on mortality rate to evaluate and assess the impact of disaster while the other trend viewed economic losses. The study revealed that economic development reduces the human and economic losses occurred due to natural calamities. Moreover, economies enjoying higher social and economic status in terms of education, trade openness and capital markets with limited government intervention suffer lesser. The researchers suggested further improvement in development of economic and social infrastructure for developing economies so that they may contribute in decreasing the vulnerability to natural disasters.

Raddatz (2007) assessed a vector auto-regressive model using panel data to estimate the short run dynamics of external fluctuations on output in developing economies. The research was done by taking data for 40 low income countries for the time span of 1965-1997. The estimates indicated that external shocks would have a modest effect on GDP per capita and output fluctuations can be largely determined by internal factors. However, climate disasters had a negative impact on GDP per capita (2% decline) per annum after the disaster. Consequently, Raddatz (2009) used the similar approach and extended the paper by examining the long and short run impact of numerous forms of natural disasters and selected economies from different income groups. He concluded that poorer and smaller countries were more exposed to climatic changes and output cost of these changes occurred during the year of the disaster. He further described that a country's level of external debt and output were not linked for any kind of disaster.

Hallegatte and Ghil (2008) investigated the macroeconomic responses to natural disaster using an endogenous business cycle (EnBC) model. The model exhibited cyclical activities which appears from the investment instability and a large response to natural disaster was observed for expansions than recessions. The study revealed that high development eras were also highly vulnerable to supply side shocks. Therefore, larger economic flexibility allows high response to these supply side shocks and thus decreases output losses. These findings highlighted the importance of the assessment of climate change losses that purely depends on long run growth models. Therefore, macroeconomic policies are crucial to prevent these crises.

Similarly, Noy (2009) found a short run negative impact using a panel database with the extended sample of 109 countries during the period 1970-2003. Noy examined three proxies of disaster damages the mortality rate; the victims; and the damages. He evaluated the differences in the size of population along with the size of the economy and timings of disaster events to highlight the potential factor of natural catastrophes. The regression results demonstrated the fact that natural disasters have a statistically significant and negative impact when it is estimated in terms of property loss. The author also mentioned that macroeconomic losses were much larger in developing economies than in developed economies. Additionally, Noy analyzed the causes of these adverse effects following catastrophes. The results indicated that economies with higher literacy rate, per capita GDP and government expenditures, better institutions and greater trade openness along with improved financial markets are more prospective to improve countries' macroeconomic activity after natural catastrophe.

Fomby et al. (2009) examined the macroeconomic aftermath of natural disasters and traced impact of four categories of natural disasters- floods, droughts, storms and earthquakes to highlight the significance of disaster. In this study authors pooled the experiences of various developed and developing countries and used vector auto-regression (VARX), which is used for the pooled panel sample of cross-country and time-series dataset. The study revealed that there is a negative impact of droughts on growth of the economy while floods likely to show a positive impact. This positive effect is even robust in developing economies and observed in both the agricultural and non-agricultural sectors. The study reviewed that a flood increases agriculture sector output by improving soil fertility after the year of flood. On the other hand, output declines in the year of flood. Hence, the benefits of this higher production are also relished by other sectors of the economy such as manufacturing and services sector and thus may lead to high growth of the sectors in the following years. However, this outcome was only favorable for moderate flood shocks. Severe flood incidences did not create any positive reaction on GDP growth and its two sectors.

In the similar line, the extension was made by Cunado and Ferreira (2011) to analyze the macroeconomic consequences of natural calamities and they found new proof for floods using an original dataset on 3,184 severe flood incidents in 118 economies. The data was taken for the period 1985-2008 and vector auto-regression (VARX) was employed in the existence of exogenous shocks and endogenous variables. Instead of defining severity of floods in terms of deaths by flood events, researchers generated a new variable "physical flood magnitude" coupled with other macroeconomic variables.[1] The results are much in line with the study made by Fomby et al. (2009) and showed flood's positive consequences on growth rates after the year of flood. However, the results contradict the perception that disasters are more likely to have an adverse impact on GDP growth in developing countries. The authors argued that this positive impact of flood on GDP growth is due to the dependence of developing countries on their agriculture sector growth.

Using correlation analysis, Soukopova (2012) observed the flood's impact on the growth of the 13 regions of Czech Republic for the period 1995-2010. The Czech Republic was thoroughly affected by floods between 1997 and 2010 and met damages over 172 billion CZK. Soukopova selected flood damage as the core

[1] Average flood magnitude= log (average duration in days * average affected area * average severity indicator)

indicator of flood with GDP growth, industry sales, gross fixed capital formation, and unemployment rate. The results contradicted the proposition that floods have an adverse long run impact on economic growth and concluded a positive neutral impact of floods on the economic growth for the Czech Republic. However, these impacts were not experienced for the current year but after one or two years of flood while other variables in the model showed greater impact on the development of the economy.

Cavallo and Noy (2010) and Lazzaroni and Bergeijk (2013) provided a review of the literature on empirical studies of natural disasters.

In summarizing the emerging divergences in the literature it has been noted that the impact of natural disasters on economic growth depicts indecisiveness in results as the sign of the disaster impact on growth of GDP is yet to be explored appropriately. Furthermore, we reviewed the long run and short run research studies and explored that the long run literature of natural disasters is inadequate and its results are inconclusive. The scantiness of research in this field is due to the constraint of constructing appropriate methodologies.

7. Data Source and Methodology

We have spanned the time series dataset for the period 1981-2014 to observe the impact of floods on GDP growth and to evaluate its macroeconomic impact in Pakistan. The data for macroeconomic variables has been taken from the website of World Bank. The flood data has been taken from EM-DAT database which is the prestigious source for disasters dataset. GDP growth rate has been taken as the core variable and to disaggregate the analysis, the sectors of the economy are divided into agriculture and non-agriculture sectors (manufacturing and services). All these three variables are measured in percentage form. The study covers other macroeconomic variables- CPI, export, and investment. Flood variables include frequency of flood, deaths by flood, affected areas by flood and damages caused by flood. A brief description of variables is explained in table 2.

8. Empirical Methodology

This study is an initiative to figure out the impact of flood shocks on GDP growth and to examine how the theory works in the case of Pakistan. The paper tested the hypothesis that whether variables in the model have a long run and short run relationship using the Autoregressive Distributed Lag (ARDL) to cointegration methodology. The general model is defined as,

GDPG = f (AGRI, NONAGRI, CPI, EXP, INV, FREQ, DTH, AFF, DMG) ……………… (1)

Where,

GDPG = gross domestic product growth
AGRI = agriculture growth rate
NONAGRI = Non-agriculture growth rate
CPI = inflation rate
EXP = exports
INV= investment rate
FREQ = frequency of flood
DTH = deaths by flood
AFF = affected areas by flood
DMG = damages caused by flood

The data for GDP growth, agriculture growth, non-agriculture growth and inflation and investment has been taken in percentage form while exports and flood variables are in their level form. The empirical model of this study is as follow:

$$GDPG_t = \vartheta_1 + \vartheta_2 AGRI_t + \vartheta_3 NONAGRI_t + \vartheta_4 CPI_t + \vartheta_5 EXP_t + \vartheta_6 INV_t + \vartheta_7 FREQ_t + \vartheta_8 DTH_t + \vartheta_9 AFF_t + \vartheta_{10} DMG_t + \varepsilon_t \qquad (2)$$

Where ϑ_1 is intercept term and ϑ_2, ϑ_3, ϑ_4, ϑ_5, ϑ_6, ϑ_7, ϑ_8, ϑ_9 and ϑ_{10} are coefficients of agriculture growth rate, non-agriculture growth rate, inflation rate, export, investment, frequency of floods, deaths by floods, affected areas by flood, and damages caused by flood respectively. ε_t is a white noise residual term.

The entire estimation procedure consists of unit root test, ARDL to cointegration test and Unrestricted Error Correction Model (UECM).

8.1 Unit Root Test

The stationary property of the series is analyzed by using the Augmented Dickey Fuller (ADF) unit root test. The ADF test is appropriate if residual term appears to be time invariant. The estimated equation can be expressed as:

$$\Delta Y_t = \beta_0 + \beta_1 Time_t + \delta_{1\backslash} Y_{t-1} + \rho_j \sum \Delta Y_{t-i} + \varepsilon_t \text{ .... (3)}$$

The test for a unit root is applied to check whether δ_1 is identical to zero or not. The null hypothesis is that Y_t has unit root (Ho: $\delta_1 = 0$; Ha: $\delta_1 \neq 0$). If δ_1 is equal to zero, then the hypothesis is not rejected as Y_t contains a unit root.

8.2 ARDL to Cointegration Test

ARDL to Cointegration model was introduced by Pesaran and Shin (1999) and extended further by Pesaran, Shin, Smith (2001) to incorporate I (0) and I (1) variables in the same estimation procedure. The method is conveyed as it provides several benefits. The test is established on a single ARDL equation, it reduces the number of parameters to be estimated and the limitations on the number of lags can be applied to each variable separately unlike the Johansen approach. The methodology also does not require a pre-testing for the order of integration (0 or 1) of the variables used in the mode and generates both long and short run estimates. The basic ARDL model is as follow;

$Y_t = \beta_0 + \beta_1 Y_{t-1} + \ldots + \beta_k Y_{t-p} + \alpha_0 Xt + \alpha_1 Xt_{-1} + \ldots + \alpha_q Xt_{-q} + \epsilon_t$ .... (4)

Where random error term is denoted by ϵ_t.

The ARDL model defines the dependent variable by lagged value of itself and successive lag of the explanatory variable. The unrestricted error correction model (UECM) of ARDL testing is modeled as follow:

$$\begin{aligned}
\Delta GDPG_t = {} & \vartheta_1 + \vartheta_T T + \vartheta_{AGRI} AGRI_{t-1} + \vartheta_{NONAGRI} NONAGRI_{t-1} \\
& + \vartheta_{CPI} CPI_{t-1} + \vartheta_{EXP} EXP_{t-1} + \vartheta_{INV} INV_{t-1} + \vartheta_{FREQ} FREQ_{t-1} \\
& + \vartheta_{DTH} DTH_{t-1} + \vartheta_{AFF} AFF_t + \vartheta_{DMG} DMG_{t-1} \\
& + \vartheta_t + \sum_{j=1}^{a} \vartheta_j \Delta GDPG_{t-j} + \sum_{k=0}^{b} \vartheta_k \Delta AGRI_{t-k+} \\
& + \sum_{l=0}^{c} \vartheta_l NONAGRI_{t-l} + \sum_{m=0}^{d} \vartheta_m CPI_{t-m} + \sum_{n=0}^{e} \vartheta_n EXP_{t-0} + \sum_{O=0}^{f} \vartheta_O \Delta INV_{t-O} \\
& + \sum_{P=0}^{g} \vartheta_P FREQ_{t-P} + \sum_{Q=0}^{h} + \vartheta_Q DTH_{t-Q} + \sum_{R=0}^{i} \vartheta_R AFF_{t-R} + \sum_{S=0}^{j} \vartheta_S DMG_{t-S} \\
& + \varepsilon_t \text{...............(5)}
\end{aligned}$$

Where Δ specifies the difference operator, which is used to describe trend and ε_t is the residual term having normal distribution with zero mean and finite variance. The proceeding step involves the estimation of cointegration among the variables. In order to find the cointegration among variables in ARDL model, selection of appropriate lag order of series is required. We have used Schwarz Bayesian Criterion (SBC) to choose suitable lag length.

The null hypothesis of no cointegration is:

$$Ho : \vartheta GDPG = \vartheta AGRI = \vartheta NONAGRI = \vartheta CPI = \vartheta EXP = \vartheta INV = \vartheta FREQ = \vartheta DTH = \vartheta AFF = \vartheta DMG = 0$$

And the alternate hypothesis is:

$$H_1 : \vartheta GDPG = \vartheta AGRI = \vartheta NONAGRI = \vartheta CPI = \vartheta EXP = \vartheta INV = \vartheta FREQ = \vartheta DTH = \vartheta AFF = \vartheta DMG \neq 0$$

We will accept the null hypothesis of no cointegration if the estimated coefficients are equal to zero. The null hypothesis will not be accepted in case of non-zero coefficient values. Another distinct feature of ARDL procedure is that this also provides diagnostic tests which are usually conducted separately to test the problems such problems of normality, heteroskedasticity, serial correlation and specification of the ARDL to cointegration model.

Once long run association among variables is found, it is essential to find out short run impact of flood shocks on GDP growth in Pakistan. Therefore, the error correction model (ECM) is applied to figure out the short run impact of the model. The empirical equation of ECM is modeled as follow:

$$\Delta GDPG_t = \delta_0 + \sum_{i=1}^{a} \delta_{GDPG} \Delta GDPG_{t-i} + \sum_{j=0}^{b} \delta_{AGRI}\, AFGRI_{t-j} + \sum_{k=0}^{c} \delta_{NONAGRI} \Delta NONAGRI_{t-k}$$
$$+ \sum_{l=0}^{d} \delta_{CPI} \Delta CPI_{t-l} + \sum_{m=0}^{e} \delta_{EXP} \Delta EXP_{t-m} + \sum_{o=0}^{f} \delta_{INV} \Delta INV_{t-o}$$
$$+ \sum_{p=0}^{g} \delta_{FREQ} \Delta FREQ_{t-p} + \sum_{q=0}^{h} \delta_{DTH} \Delta DTH_{t-q} + \sum_{r=0}^{i} \delta_{AFF} \Delta AFF_{t-r}$$
$$+ \sum_{s=0}^{j} \delta_{DMG} \Delta DMG_{t-s} + \lambda ECM_{t-1} + \varepsilon_i \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (6)$$

Where λ is the parameter for speed of adjustment and ECM is the residual term that is obtained from the estimated cointegration model of equation.

9. Empirical Results

9.1 ADF test for Stationarity

For a more detailed examination of the final model specification of the ten variables, the stationary property of the series is analyzed using the Augmented Dickey Fuller (ADF) unit root test. The results of unit root test are summarized in table 3.

From this table it can be evidently seen that our model is a mix of variables as some of the variables are stationary at order zero I (0) and some are stationary at order one I (1). In our model GDPG, CPI, FREQ, DTH, AFF and DMG are significant at both i.e. level and first difference while AGRI, NONAGRI, EXP and INV are only significant at first difference.

9.2 ARDL Estimation Results

The prerequisite of ARDL approach implies that all variables can be integrated to the order of I(0) or I(1) or both. Once we have found that our data is well mixed the next phase involves the selection of lag length criteria. We have used Schwarz Bayesian Criterion (SBC) to choose suitable lag length. On the basis of SBC we obtained the ARDL (2,2,2,2,2,2,2,2,2,2,2) estimates. The ARDL regression results are reported in table 4.

In detecting the annual response of the growth rate, we have found that the agricultural sector is positively contributing in improving the growth of the economy as coefficient of agriculture growth is 7.71 and significant but only significant for the year of the flood. Later on long run estimates confirm a significant and positive relation in long run. First, the delay in agriculture growth could be due to the fact that a positive effect of floods on productivity of land emerges on the subsequent harvest period. Second, Pakistan relies on more traditional and less intensive methods of agriculture and thus the impact takes time to be driven may be in two or three years and in our study its two years. (Fomby et al.2009)

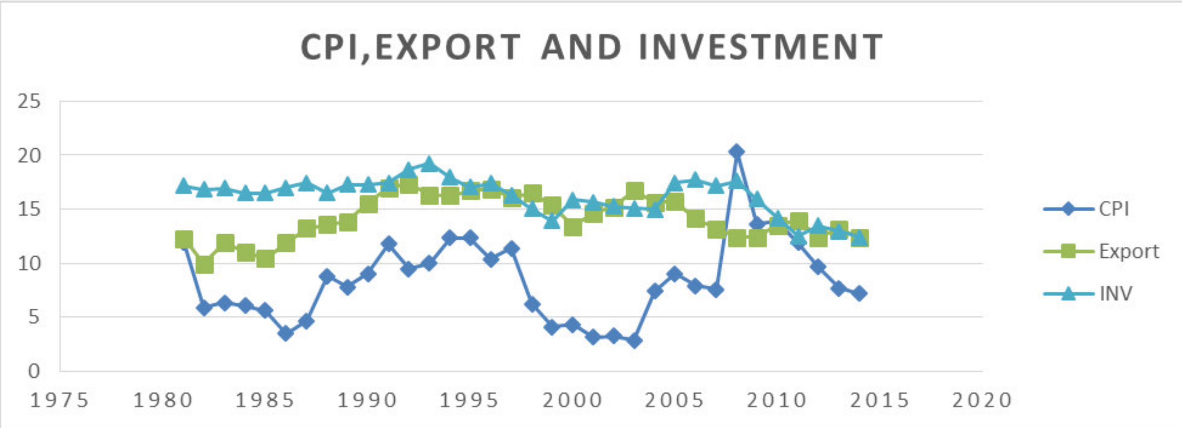
Similarly, non-agriculture sector also has a positive significant impact on GDP growth as the sector has strong forward linkages with the agriculture sector. This impact could be due to a relatively higher significance of the agriculture sector in Pakistan and thus the growth of agriculture sector extends to manufacturing and services sector. However, estimates are significant for the current year but not for the years after floods. The long and short run estimates confirm the positive and significant impact of agriculture and non-agriculture sector on GDP growth.

Apart from this disaggregated analysis the sole focus of this study is to define the macroeconomic impact of floods and thus we include inflation rate, export and investment in our model.

We have found inflation instability in Pakistan annual data. The results revealed that the inflation rate is positively and significantly associated to GDP growth for the current year however for the years after flood there is a change in trend (negative but insignificant). Even though, we can anticipate a price hike for the short time period in the year of flood due to shortage of supply and less control over prices in the rehabilitation process but there is still an ambiguity in the inflation rate. Therefore, on a concluding note we have declared inflation volatility in our analysis which makes it difficult to identify any flood impact.

Analysis for export pattern is crucial to observe trade specifications as most of the exportable goods are provided by agriculture sector. Yet again we end up at unconvincing result as positive and significant trend of exports has been figured out for the year of flood and negative and significant impact after the year of flood. Inconclusive result of exports on GDP growth is quite obvious. Reliance on exports of primary goods, no diversification and market concentration, limited trade, variability in demand and supply, low price elasticity, and low commodity specialization are the main factors for export instability in Pakistan. Consequently, these factors lead to a high degree of export instability on average in Pakistan. Recurrent and frequent floods have further deteriorated the situation as since 2010 every year the economy witness negative balance of payments as a result of decline in exports.

Most of the recent studies (Noy 2009, and Cunado and Ferreira 2011) tempted us to include investment in our model as the variable could be used to capture the farmer's self-protection and government reconstruction efforts after flood. The value of regression coefficient of investment (INV) is .85 and shows a negative impact on GDP growth with an insignificant value for the current year and significant for the years after flood. Thus, we found a negative relationship of investment on GDP growth rate which is not compatible with the economic theory. The investment hasn't shown any robustness and we found a feeble indication that investment immediately surges on average after the flood event. This might be attributable to the fact that capital formation gets shifted temporarily to some safe destinations from flood prone areas. Additionally, frequency and intensity of floods in Pakistan have created a sense of insecurity and high risk among farmers which might restrict them to invest more long term investments and this also discourages government agencies to invest in infrastructural projects in these areas. Consequently, flood prone areas receive low level of investment in agricultural and non-agricultural sectors. Same results are found in the long and short run which is the alarming situation for the economy of Pakistan. A graphical presentation of the above macroeconomic variables is illustrated in the figure below.



The frequency of floods has no significant impact on GDP growth as the severity of flood is much more relevant instead of frequency of floods. The coefficient of variable "DTH" has shown positive but not significant impact on GDP growth. Therefore, we conclude that "DTH" is a disruptive variable to capture the impact of flood shock on GDP growth. These results are compatible with the study made by Cunado and Susana Ferreira 2014.

In the meantime, affected areas by flood (AFF) have a positive and significant impact on growth of GDP and following year of flood. Intuitively, this seems quite contradictory as flood causes significant losses for the socio-economic conditions in any economy. Overwhelmingly, this positive impact could be because of the fact that floods raise the underground water table and soil moisture level and increase water availability in water reservoirs to improve the forecasts for cropping season. Besides this, increased soil fertility from silt and lots of nutrients deposited by the floods enhances the productivity of several crops. We have also found positive and significant impact of affected area by flood in the long run.

Damages show a significant negative impact on GDP growth after the year of flood as every year the economy observes damages to physical infrastructure i.e. residential housing, telecommunication, roads and electricity systems along with other valuable infrastructure. These primary effects are followed by economic losses such as decline in agricultural productivity due to loss of crops. Moreover, output cost of floods mostly occurs during the year of the flood.

By examining the four proxies for flood we conclude that floods have a propensity to have a positive impact on GDP growth in Pakistan as the affected areas nourish the agriculture land and thus enhance the agriculture output.

9.3 Long run ARDL Estimates

The estimates of long run are reported in Table 5. We have found that long-run relationship can be exist if we include agriculture growth (AGRI), non-agriculture growth (NONAGRI), investment (INV) and affected areas by flood (AFF) in the model. The results reveal that GDP growth is positively associated to the agriculture growth, non-agriculture growth and affected areas by flood. The negative effect of investment on GDP growth contradicts our theoretical expectation that as the investment increases, GDP growth increases. The long run estimates confirmed a positive and significant effect of flood shocks on growth of agriculture sector and thus on growth of GDP in the long time period.

9.4 Short run ARDL Estimates
A negative and significant coefficient of the term of ecm (t-1) is an indication of the dynamic adjustment of the variables and further provides evidence of unidirectional long run relationship. The value of ecm (t-1) for the Model is (-2.2084) that indicates adjustment of short run variables to long run variables by 220 percent. Short run estimates of ARDL are depicted in table 6 in Appendix.

10. Conclusion and Recommendations

The goal of the study is to assess the macroeconomic functioning of the economy on which the flood impact fall in the context of Pakistan from year 1981 to 2014 using ARDL to cointegration framework. The procedure is unique in a sense that it does not involve pre-testing for the order of integration (0 or 1) of the selected variables and provides both long run and short run outcomes. Literature review has established the fact that the positive and negative impact of natural disaster is yet to be explored as there is still an uncertainty regarding the long and short run outcomes. The entire estimation procedure consists of two stages. First, we have checked the stationarity of the data using ADF unit root test and found that variables are well mixed. The second step encompasses the estimation of long and short run estimates of flood on GDP growth. The results confirm that there exist a relationship between GDP growth and flood and selected macroeconomic variables The ARDL results have indicated that agriculture and non-agriculture are positively and statistically significant and consistent with the theory both in the long run as well as in the short run. However the impact takes time to driven up due to the reliance on less intensive and old farming techniques. Besides this, macroeconomic variables are found to be inconsistent with the GDP growth theory. These inconclusive results are portraying the macroeconomic instability of the economy and this situation makes it more difficult to examine the actual macroeconomic impact of floods on GDP growth rate. Flood variables are very much in line with our expectations and we found insignificant impact of death and damage on GDP growth. Meanwhile, affected area by floods and damages showed significant impact on GDP growth. Furthermore, long run estimates have approved the long run association among GDP growth, agriculture, non-agriculture, investment and affected area by floods. A negative and coefficient of the ECM term is an indication of the dynamic adjustment of the variables with the adjustment speed of 220 percent. Our results prove the long and short run relationship and interconnection between GDP growth, flood and macroeconomic variables and thus we conclude that floods tend to have a positive impact on GDP growth.

Throughout the history of Pakistan, floods have caused great losses and brought myriad distress for people. Meanwhile, these floods nurture the land fertility and foster high agriculture output. To prevent the economy from this austere crises here are some recommendations to decrease the flood damages and to develop the positive consequences of floods in Pakistan.

- A high crop loss, export shakiness and investment instability has raised the average cost of floods in Pakistan and thus confines the economy to benefit from the positive outcomes of floods. Therefore, moderate flexibility in macroeconomic variables seems to be optimistic that will allow the economy of Pakistan to react more rapidly and efficiently to the flood shocks. This may also help to reduce the flood costs as well. Consequently, macroeconomic stabilization policies are highly desirable. The approach may give an insight to attain a firm long term average growth. Inspite of their high short run costs, this approach can yield positive aftermath over long run.
- Availability of government funds for an extended period of time may curb the non-linearity and time deviation of recovery procedure in Pakistan. This may allow affected businesses and individuals to project and implement their reconstruction strategies.
- The devastation of floods in Pakistan has also enhanced the requirement of strong regional cooperation process at highest governmental level. The focus of this process must be on better technical association including anticipation, mitigation and response to unexpected arrival of natural hazards and allocation of more funds to Disaster Risk Reduction (DRR) policies. Besides these, public awareness and communication, stimulation of flood warning systems, launch of relief and evacuation centers in high risk cities and districts and implementation of appropriate response strategies can also yield positive outcomes for the economy.

In the nut shell, it can be concluded that macroeconomic assessment of floods now can no longer be ignored and instead of depending more on disaster aftermaths, we should focus on the preventive side.

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Appendix

Table 1: Flood Damages by Sectors

Sectors	Damages (Rs. billion)	Damages (US$ billion)	Damages (in percentage)
Community Physical Infrastructure	17.16	0.17	39.09
Housing	12.59	0.13	28.67
Crops	10.91	0.11	24.85
Livelihoods	2.74	0.03	6.24
Disaster Risk Resilience	0.35	0.003	0.80
Livestock	0.23	0.002	0.53
Total	43.9	0.44	100

Source: NDMA Damages & Recovery Needs Assessment Report (2014)

Table 2: Variables Description

Name	Description	Source	Notes
GDPG	Real GDP growth rate	WDI (2014)	Proxy for Economic Development
AGRI	Agriculture growth rate	WDI (2014)	Economy of Pakistan is highly dependent on agriculture output
NONAGRI	Non-agriculture growth rate	WDI (2014)	Variable contains growth rates of manufacturing and services sector
CPI	Inflation rate	WDI (2014)	Captures price fluctuations during flood
EXP	Exports	WDI (2014)	To observe trade impact of flood
INV	Investment	WDI (2014)	Proxy of investment is Gross capital formation(% of GDP) to figure out the investment decisions and reconstruction endeavors
FREQ	Frequency of floods	EM-DAT (2014)	Annual number of floods
DTH	Deaths by flood	EM-DAT (2014	Number of people killed by floods annually
AFF	Area affected by flood	EM-DAT (2014	Area covered by floods in square kilometers
DMG	Damages by flood	EM-DAT (2014	To figure out the costs of flood assessment

Table 3: Unit Root Test Results

Variables	Level	1st Difference
GDPG	-4.376225*	-8.225650
AGRI	-2.856606	-6.244836
NONAGRI	-2.781135	-5.187945
CPI	-2.961069*	-7.141125
EXP	-1.421449	-6.687932
INV	-1.824428	-5.075244
FREQ	-3.769873*	-5.128610
DTH	-6.347902*	-7.893916
AFF	-5.510049*	-9.262632
DMG	-6.347902*	-7.893916

Note: * indicates the significance at level

Table 4: ARDL Estimates

Regressor	Coefficient	Standard Error	T-ratio [Prob]
DPGROWTH(-1)	-.94436	.15027	-6.2842[.100]
GDPGROWTH(-2)	-.26402	.083590	-3.1585[.195]
AGRI	7.7122	.95171	8.1036[.078]
AGRI(-1)	2.3742	.83574	2.8408[.215]
AGRI(-2)	.77188	.40531	1.9044[.308]
NONAGRI	5.6051	.83108	6.7443[.094]
NONAGRI(-1)	3.8897	.78739	4.9399[.127]
NONAGRI(-2)	.86513	.65694	1.3169[.413]
CPI	.78374	.071818	10.9128[.058]
CPI(-1)	-.16472	.059233	-2.7809[.220]
CPI(-2)	-.33131	.060024	-5.5197[.114]
EXP	1.2756	.11503	11.0890[.057]
EXP(-1)	-1.3411	.19754	-6.7891[.093]
EXP(-2)	-1.2735	.12929	-9.8501[.064]
INV	-.85422	.20634	-4.1399[.151]
INV(-1)	-1.7267	.22687	-7.6110[.083]
INV(-2)	-1.1945	.17771	-6.7213[.094]
FREQ	.32720	.15011	2.1797[.274]
FREQ(-1)	-.53385	.17561	-3.0400[.202]
FREQ(-2)	.22113	.15130	1.4615[.382]
DTH	.0035010	.5851E-3	5.9839[.105]
DTH(-1)	.0051006	.8317E-3	6.1330[.103]
DTH(-2)	.0035346	.6385E-3	5.5358[.114]
AFF	.5831E-6	.6751E-7	8.6364[.073]
AFF(-1)	.1464E-5	.1827E-6	8.0168[.079]
AFF(-2)	.7981E-6	.1454E-6	5.4903[.115]
DMG	-.2446E-6	.2754E-6	-.88815[.538]
DMG(-1)	-.2078E-5	.3540E-6	-5.8692[.107]
DMG(-2)	-.2886E-5	.3376E-6	-8.5495[.074]
C	-955.2516	176.0995	-5.4245[.116]
T	-.52789	.11418	-4.6232[.136]

Source: Author's own estimation

Table 5: Long Run ARDL Estimates

Regressor	Coefficient	Standard Error	T-Ratio[Prob]
AGRI	4.9169	.51742	9.5026[.067]
NONAGRI	4.6911	.47558	9.8641[.064]
CPI	.13028	.036167	3.6022[.172]
EXP	-.60636	.10409	-5.8255[.108]
INV	-1.7096	.14343	-11.9187[.053]
FREQ	.0065539	.12180	.053808[.966]
DTH	.0054955	.0011443	4.8024[.131]
AFF	.1289E-5	.8265E-7	15.5901[.041]
DMG	-.2359E-5	.4212E-6	-5.5996[.113]
C	-432.5573	48.8747	-8.8503[.072]
T	-.23904	.051663	-4.6269[.136]
Adjusted R^2= .98663	**AIC = 25.9574**	**SBC = 3.2384**	

Source: Author's own estimation

Table 6: Short Run ARDL Estimates

Regressor	Coefficient	Standard Error	T-Ratio[Prob]
dGDPG1	.26402	.083590	3.1585[.010]
dAGRI	7.7122	.95171	8.1036[.000]
dAGRI1	-.77188	.40531	-1.9044[.086]
dNONAGRI	5.6051	.83108	6.7443[.000]
dNONAGRI1	-.86513	.65694	-1.3169[.217]
dCPI	.78374	.071818	10.9128[.000]
dCPI1	.33131	.060024	5.5197[.000]
dEXP	1.2756	.11503	11.0890[.000]
dEXP1	1.2735	.12929	9.8501[.000]
dINV	-.85422	.20634	-4.1399[.002]
dINV1	1.1945	.17771	6.7213[.000]
dFREQ	.32720	.15011	2.1797[.054]
dFREQ1	-.22113	.15130	-1.4615[.175]
dDTH	.0035010	.5851E-3	5.9839[.000]
dDTH1	-.0035346	.6385E-3	-5.5358[.000]
dAFF	.5831E-6	.6751E-7	8.6364[.000]
dAFF1	-.7981E-6	.1454E-6	-5.4903[.000]
dDMG	-.2446E-6	.2754E-6	-.88815[.395]
dDMG1	.2886E-5	.3376E-6	8.5495[.000]
dC	-955.2516	176.0995	-5.4245[.000]
dT	-.52789	.11418	-4.6232[.001]
ecm(-1)	-2.2084	.22044	-10.0180[.000]

Source: Author's own estimation