FACTORS INFLUENCING BIODIVERSITY OF MARINE FISHERY IN PAKISTAN

Submitted By

Aqsa shoaib abbasi

Supervised By

Dr. Anwar Hussain

DEPARTMENT OF ENVIRONMENTAL ECONOMICS

PAKISTAN INSTITUTE OF DEVELOPMENT ECONOMICS

(2016-18)

Pakistan Institute of Development Economic

CERTIFICATE

This is to certify that this thesis entitled: **Factors Influencing Biodiversity of Marin Fishery in Pakistan** submitted by Ms. Aqsa Shoaib is accepted in its present form by the Department of Environmental Economics, Pakistan Institute of Development Economics (PIDE), Islamabad as satisfying the requirements for partial fulfillment of the degree in **Master of Philosophy in Environmental Economics**.

Supervisor:

Dr. Anwar Hussain
Department of Environment Economics
PIDE, Islamabad

External Examiner:

Dr. Javed Iqbal
Assistant Professor QAU

Head,
Department of Environmental Economics

Dr. Abedullah Anjum
Head
Department of Environmental Economics
PIDE, Islamabad.

Dedicated to my beloved mother for her love, endless support, encouragement and sacrifices

ACKNOWLEDGEMENT

First of all thanks to Almighty Allah who has given me this opportunity of research All praise for Him, whatever I am today and what I will be in future is all due to His blessing on me. I thank ALLAH for the strength and guidance that helped me to complete the thesis.

I want to express height of gratitude to my thesis supervisor and thanks to my parents, husband, and siblings who helped and supported me.My class fellows and university fellows were a great help. They never let me down and whenever l felt down they pushed me to raise myself. Special thanks to Muhammad Azeem, Rizwan, Sidra ,Ghania and Shahzad ,who gave me the confidence and strength to achieve my goals. The care and the support that family provides plays a vital role. l am honored to have such parents who encouraged me. Last but not least special thanks to my better half, my husband Danish Aftab who always supported my education both financially and morally.

Contents

Abstract

This study investigates the factors influencing biodiversity of marine fishery in Pakistan followed by checking the validity of EKC using annual data 1980-2014. The impacts of fishing on trophic structure of ecological groups were assessed using fishery-based indicators. In this study, we use a set of fishery-based indicators the fishing in balance index (FiB). Augmented Ducky fuller confirms that all variables of external sector that are non-stationary at original series then at first difference it becomes stationary. Co-integration test also shows one co-integrating equation detecting long term relationship among the variables. The multiple linear regression model was predictable by using OLS method. The empirical findings suggest that rainfall has positive while temperature has negative impact on fishery biodiversity. The non-climatic factors like per capita income affects it negatively. In our study the EKC does not hold. Climate is hardly the biggest problem for fishermen overfishing, mismanagement and poor regulation are all larger problems right now. There should be a ban on illegal fishing and issued a proper license to professional fisherme

Chapter 1

INTRODUCTION

Fisheries are important natural resource contributing to employment opportunities, export earnings and food security (Fisheries, 2011). More than 80% of the overall world overfishing from oceans . The marine ecosystem is the essential for the marine life and also human being because its support livelihoods of people depending on coastal resources. The animal and plants depends on ecological variations even some areas are stressed and preserve their diversity by the help of anthropogenic activities which cause by human being. The fisheries are facing severe challenge of extinction due to numerous factors including water pollution, overfishing, habitat destruction and climate change. If it is continued with currssent status, after 40 years, there will be nothing left, known as seafood (Liu et al., 2009). Export is the main key determents of Pakistan the earning of export play essential role for national economy. In Pakistan, out of total fish catches, 71% export annually. Its share in the global market is about 0.25%. Pakistan is exported round about $ 60 million of marine food to different countries like China, Vietnam. Other markets for Pakistani seafood are Thailand, South Korea, Saudi Arabia, Indonesia, Malaysia, Bangladesh, Egypt, Hong Kong, Japan, Kuwait and the UAE, etc. (Sudhakar & Nazeer, 2015).According to Ansari 71 percent of total fish catch in Pakistan is from Marine. The Arabian Sea, in which the coastal areas of Sindh and Baluchistan, Thata and Badin which has now rich fish deposits of commercial significance. There are almost 30 species of

shrimp, 10 species of crab, 5 species of lobster and about 70 commercial species of fish including sardine, Hilsa, shark, Mackerel, Butterfish, Pomfret, Sole, Tuna, sea bream, Jew fish and Cat Fish, Shark, Eel and shrimp in costal lines of Pakistan, which indicates the strength of marine biodiversity in Pakistan across different species from marine. According to United Nation food and agriculture's report (2010), 31% of global marine fisheries are depleted and other 53% of stock is fully exploited due to harvesting and overexploitation of fisheries

Besides, the global per capita fish consumption has increased overtime (Ansari).while the production of marine fisheries declined (Moffitt & Cajas-Cano, 2014). This situation is challenging for the sustainability of fisheries resource. The marine fishing supports the consumption economy of 125,000 individuals in Pakistan. Fishing group are scattered along a 682-mile over the drift line of sea costal route, located in the middle of Sir Creek in Sindh Province and Jiwani in Baluchistan Province. Out of this 477 miles of the drift line is the part of Baluchistan and the staying around 205 miles lays in Sindh. Overall around 800 fish species are documented in Pakistan's coastal area. Tuna is very common Fish, which is living in open sea, under the deep water of Baluchistan Sea.

Different species like Palla fish is considered as a frailty is an anadromous fish that swims up the Indus River. Many other species like, green turtle (Chelonia mydas) and the olive ridley turtle (lepidochelys olivacea) that are also found in Pakistan in specific locations. More than 8 species of oyster and squid are also found in Pakistan. More than

15,000 vessels of different sizes take part in angling, from little to medium-sized vessels, extensive dispatches, and trawlers. The little water crafts are in the vicinity of 18 and 25 feet long and are utilized to approach the beach front waters. These anglers utilize different methods and equipment's, including the shrimp nets (thukri, phat), which are made by their own hands, in other words we can say handmade nets are frequently used for fich catching many areas. According to Khan and Khan (2011) the medium-sized aquatic craftsmanship going in a measure from 25 to 35 feet long utilize gill nets (rach Lara, lathay ka boycott. These and many other factors have specifically caused the extinction and threatening of species in many locals of water geography.

On the other side overexploitation and overused of these natural resources have declined their availability, the reason behind this is the loss of their natural habitats. Fast growth in human population is cumulatively enhancing the pressure on the country's natural resource/ecological pressures on basic available ecological bio productive resources. High influencing poverty and multidimensional poverty has increased and forced rural people to abuse and over harvest the available biodiversity at very unconvincing and unmaintainable rates (Baig & Al-Subaiee, 2009).Furthermore 4th national report has re-counted that availability of marine fisheries and shrimp catch has reduced in Pakistan and will be restrict to significantly limited amount in future. Increasing number of boats has led their tendency to hunt fish in surface water. The Main foundations behind this are, the purchasing power of people increase and consumption of food increase that make market pressures and fishing gear technology development, and an unregulated aquarium trade in wild species,

such as Siamese tiger perch, Arowanas, many barbs, characins and other tropical fish (Brown, Reid, & Rogan, 2014).

1.1 Problem Statement

The marine fisheries are declining , and it is a global trend (Pauly & Chuenpagdee, 2007) Fish production is decreasing in the World day by day . According to the World Bank and Food and Agriculture Organization (2009), due to overfishing it become fifty billion dollars in net monetary losses during a many years. The fish production are increasing rapidly more than that of their productive ability. According to (Garcia & de Leiva Moreno, 2003) from 1970 to 1989, the global fishing effort raised by 332%,which show that a global abundance index decreased by 62%. Fishermen and different equipment like fishing vessels increased over the years followed by decline in fish production. According to (Salayo et al., 2008) the Fish stock was declined in the recent year between 5 to 30% due to overfishing in Southeast Asia.

Pakistan is not exceptional where the number of fishermen and large fishing boats increased. In areas near the coastline such as Badin, Gawadar, overfishing is the main reason for the fish stock depletion. The fishermen even don't care for fishing in the breeding seasons of fisheries. The use of illegal nets is increasing and the majority of the fishing boats carry these nets in both Sindh and Baluchistan coastline (Khan & Khan, 2011). In addition, the factors such as increase in the fish catch, increasing population and climatic variables are also the responsible factors affecting the sustainability of fisheries

resources in Pakistan .This study empirically estimates the impact of climatic and non-climatic factors on the biodiversity of fisheries in Pakistan..

1.2 Objective of the study

This study aims:

1) To determine the trends in the marine fisheries and its influencing factors in Pakistan.
2) To estimate the impact of various climatic and non-climatic factors on biodiversity of marine fisheries in Pakistan.
3) To check the validity of EKC in the fishery sector of Pakistan

1.3 Research Questions

1. Is the extinction in the marine fisheries taking place in Pakistan?
2. How much climatic and non-climatic factor impact on the biodiversity of marine fisheries?
3. Does EKC hold in the Fisheries sector of Pakistan if the relationship fisheries biodiversity and income is taken into account?

Chapter 2

LITERATURE REVIEW

This chapter breaks into different sections. Section 2.1 presents the sustainability of marine fisheries. Section 2.2 describes the marine biodiversity. Section 2.3 represents the Impact of environmental factor on the marine fisheries. Section 2.4 describes the anthropogenic factors. And 2.5 presents the summary of literature review.

2.1 Sustainability of Marine Fisheries

The marine resources is also considered as important part of the biodiversity of life, because it facilitates us with a range of ecological services and support recreation activity , scientific research, and tourism (Kelleher & Weber, 2006). Number of international efforts have been made to trend towards sustainable marine fisheries (Bhathal & Pauly, 2008; Pauly, Christensen, Dalsgaard, Froese, & Torres, 1998) argued that numerous factors, which affect the sustainability of fisheries, where increase of fish catches is due to geographic expansion and decline in tropic level. Besides, poverty, income, temperature, rainfall, number of fishermen and number of vessels are also the key determinants of the marine fisheries (Allison & Horemans, 2006).Marine fisheries are become depleted and under increasing threat and the change in climate is considered as the key factor responsible for fast-declining fish stocks (Fanning, Mahon, & McConney, 2009)

2.2 Marine biodiversity

Management of fisheries stock is of foremost concern for the fishery managers as far as the sustainable biodiversity of fishery is concern, it can be observed that the impact of declining marine fishery stock on biodiversity is obvious. Over millions of years the marine fisheries are change in genetic, species, and environment diversity from levels that have been achieved via natural selection. Fisheries and other anthropogenic changes which cause by different factors that is effect on marine biodiversity that would be required to develop strategies that will improve future ecological changes. As the Fisheries are foremost impacts upon the marine biodiversity, so it can be observed that the long-term sustainability of these fisheries may be dependent upon the actual diversity which have been change (Yates, Mellin, Caley, Radford, & Meeuwig, 2016).

There are many factors that threat to cause marine fish biodiversity one of them is overexploitation because of overfishing worldwide 40 local inhabitants of fish type have left and other factor are: habitat loss, climate change, loss of habitat , aggressive species, eutrophication and pollution are the stress for fishing stock declines and inhibit or prevent recoveries (Hiddink & Ter Hofstede, 2008).

To enhance the capacity of awareness to use in best way, and accountability in natural resource management under strict monitoring rules and regulation and given environmental laws. The performance of policies related to fisheries and their management around the global level, regional, national and sub-national levels can assed properly on

the basis of continues evaluation and reporting. This can deliver an easily understandable instruments for showing the status of fisheries resources and fisheries activity carried out in the every region, specifically the methods sued for fishing at different places and for assessing the trends which show the sustainable development goals (Ansari).The number of indicators used for the fisheries management and describing the biological system in which one of them is fishing in balance index (Degnbol & Jarre, 2004). ln (Pauly, Christensen, & Walters, 2000) he proposed an index that supports to calculate whether a fishery is balanced (FIB) in ecological terms or not another indictor marine tropic indicator are also allows us to assess whether a fishery is balanced or not in any region. The marine trophic index and fish in balance index (MTI & FIB) is one of the indicator which used for the fish and fishery component in developed and developing countries and is used for fish trophic levels, which is known as the one of most precise way of observing fish stock depletion. Here the methodology is derived from the time series data from 1950-2014 of marine tropic index and Fishing in balance index, however, the trophic levels is allocated for the all catches that come from per given of area and that is calculated by the weighting of species with the consistent catch level. This is the indicators that are specifies to use for changes in the state of ecosystem and its provisioning services which is caused by fishing. Trophic levels data are obtain from food and agriculture organization (FAO) based on the information on fish base and sea life base data bases as well as the UBC Sea around us project, While this type of data sets exist in FAO and 'Sea Around Us' project; issues of

reliability arose due to the difference in the species composition and the division of the data which might affect the weighting system (Danagalan, 2015).

2.3 Impact of environmental factor on the marine fisheries

Marine fisheries expose to rise in different factor like sea surface temperatures, ocean acidification, sea level rise, increasing storm intensity and altered ocean circulation, and rainfall patterns that are affect target species through a range of direct and indirect mechanisms. Different factors that become of sensitivity of fish stocks to these changes is due to the range of potential impacts to life cycles, species distributions, productivity, connectivity, organism performance, recruitment dynamics, , and access to marine resources by fishermen. Many fisheries are already suffering from changes in target species diversity and abundance, species distribution, and habitat area, as well as loss of fishing effort due to intensifying storms (Browman, Law, & Marshall, 2008; Smith, Fulton, Hobday, Smith, & Shoulder, 2007).Which means that, the vulnerability of marine fisheries to climatic factor. Vivekanandan, Singh, and Kizhakudan (2013) pointed out that both non-climatic factors, such as population level, and other factors like temperature related to climate change, may strongly influence the distribution and the availability of fish stock (Islam, 2013). Furthermore, change in climatic factor like temperature and rainfall have also unique and direct/indirect impacts on the fish mortality, which is the common fish processing activity in this region. Vulnerability of the fishery-based livelihoods is more sensitive to the climate variability, but the future livelihood vulnerability is also intimately linked with different factor like technological, demographic, and socioeconomic trends

and how they affect the ability of dependent households and communities (Johnson & Welch, 2009).

According to Neuman, Ruess, and Able (2004) there has been many changing in the fish behavior pattern due to the rise of temperature which also effect the fishing community further projection show that there will be impact on the distribution and abundance with temperature change. However, the research conducted by the Merino et al. (2012) has revealed there will be substantiality oceans will be more complex due to changing in temperature and because of temperature the chemistry of oceans will be change which will be impact the performance and survival of fisheries and many other species. During , Cheung et al. (2010) conduct the research which shows that the global catch potential is effected by climate change which effect the food supply chain on which oceans and livelihood depending on marine fisheries resources further he estimated that rise of greenhouse gases can affect the word wide distribution of maximum Catch potential by 2055. (Ayub, 2010) dissected the effect of temperature and precipitation was on the catch of fish and there is likewise decrease in amount of fish caught. The Changes in temperature and precipitation adjusted the catch of fishes however alternate variables, for example, finished angling, contamination and the decrease in freshwater flow may have impacted the fish and catch. Along these lines legitimate fisheries administration and its need to monitoring to address the challenges which come from global climatic changes and other environmental issues. According to Allison et al. (2009) due to the impact of climatic change on fishery are those countries which are vulnerable they contribute only 2.3% of

global GDP and they inhibitions of vulnerable countries are twice because they are mostly depended on fish for foods yet a big proportion of fish as captured by vulnerable countries and is exported. The distribution of fishery by environmental factor are likely to effect the large number of people which reduce the upcoming chances for the future economic growth, employment and revenue generated by export.

2.4 Impact of Anthropogenic factors on the marine fisheries

(Jiao et al,. 2015) about 70 years, particularly the time of 1990 to 2000, the degree of coastal area utilization had a continuous and significant increase throughout the previous year and the portion of natural coastline decreased to 40% sea being reclaimed or incredibly devastated amid 1991 to 2014.overfishing in the beach front zones during the previous quite a few years has been degraded inshore fishery due to increase expanded fishing vessels and vessel power. Climate change and anthropogenic impacts both are main factors which effect on the marine ecosystems and countermeasures in China.

Pauly and Zeller (2016) pointed out that massive increase of global fishing catch, human population growth and increasing consumption of marine fisheries are the responsible factors for fish stock decline. According to (Clausen & York, 2008) population growth leads to higher total fish catch (i.e., nations with larger populations had larger pressure build on the catches than other nations to satisfy the increasing demand they consume more). According to Garcia and Rosenberg (2010) growing need for nutritious and healthy food will increase the demand for fisheries products from marine sources.

According to Merino et al. (2012) the future demand for fish production increasing day by day due to economic development and growing population while fish yields constraint by nature where per capita fish consumption can only be maintaining if there is increasing contribution the volume and stability of worldwide fisheries. Another study conducted by Creel (2003) according to him the coastal region face many challenges and one of them is growing population and mainly this problem in developing countries further he estimate the booming population and economic and technology development are threat the marine ecosystem that provide the economic benefit and also population factor that effect the coastal region like population density, migration, urbanization and tourism. (He et al., 2014) also study about the economic development and coastal ecosystem change in china .According to him economic growth is because of growing population and that cause to damage coastal ecosystem ,the economic growth mean per capita income of people increase and that are threat to coastal biodiversity.

According to Dickson and Brander (1993) the condition of exploitation of fish stocks all inclusive, so as to maintain fish catch, ensure species that are in danger and limit additionally harm to the marine fish. However there is additionally collecting confirmation of change in various regions and the procedures that are realizing such upgrades should be examined, empowered and replicated in different zones. Indeed, even in the North Atlantic, where a few regions have been overfished for quite a long time, there are signs that the fight to get control over exorbitant fishing stress is step by step turning .Another study conducted by Tejerina-Garro et al. (2005) in which he estimate the capacity to secure

natural resources depends on the capacity to distinguish and anticipate the impacts of human exercises on ecosystem. This depends first on the limit in recognizing regular and human-instigated variety in ecological system. To accomplish this objective, it is essential for scientists to proceed to create and enhance multi-metric fish based index by representing the numerous conceivable sources of bury and intraregional variety in assemblages structure in natural conditions. An exceptional consideration ought to be given to investigate regular ecological impacts on practical measurements, which has been until now neglected. Representing these common varieties will incredibly improve index's intended work, i.e., to exclusively reflect anthropogenic unsettling influence impacts.

According to Bukola, Zaid, Olalekan, and Falilu (2015) the introduction of oceanic creatures to high concentrations of toxins may lead quickly to death. Here, there is a clear relationship amongst contamination and mortalities. However, introduction to amount of contaminations may prompt chronic damage, the implication of which require not be showed for a relatively long stretch. Exhibition to sewage slop has been ensnared with consequences for growth and protein union in like manner touch. Furthermore, liver harm in fish has been related with pollution by parts of sewage muck, cadmium. According to Miah (2015) because of different anthropogenic exercises, environmental change impact, expanded siltation and increase in the river basin, so the fish has been disturbed, dislodged or even annihilated. Amid most recent two decades fish production from inland water

declined around 20%. It has been discovered that the major generating zones have been moved to the lower estuarine.

2.5 Conclusion

By reviewing the literature the study comes to know that climatic factor like temperature, rainfall, wind, rise in sea level effects the biodiversity by contracting and expanding. Some other study also use non-climatic factor like PCI, number of fishermen ,number of vessels and population growth are the responsible factors for decline of fish stock. In developing countries like Pakistan booming population and technological development are threat to the marine ecosystem which provides the economic benefit. Pakistan is not the exceptional where the number of fishermen and large fishing boats increased. In areas near the coastline such as Badin, Gawadar, overfishing is the main reason for the fish stock depletion. The fishermen even don't care for fishing in the breeding seasons of fisheries. The use of illegal nets is increasing and the majority of the fishing boats carry these nets in both Sindh and Baluchistan coastline. So the study tend to determine the trends in the marine fisheries and its influencing factors in Pakistan and also estimate the impact of various climatic and non-climatic factors on biodiversity of marine fisheries in Pakistan.

Chapter 3

DATA COLLECTION AND METHODOLOGY

This chapter reveals information about nature of data used, sources of data, analytical framework, and analytical techniques used for this research.

3.1 Study Area

The study was estimated the effect of various climatic and non-climatic variables on the sustainability of marine fisheries in Pakistan. To this end, secondary data from 1980-2014 used. The data for the study is taken from following sources mentions in table 1

Table 1: variables and the sources of data

Notation	**Construction**	**Variable**	**Unit**	**Sources**
Fishing in balance index	FiB= $\log[Y_k \times (1/TE)^{MTL_k}] - \log[Y_0 \times (1/TE)^{MTL_0}]$	**(Numerator)** Yik is the catch of species i during the year k, **(Denominator)**, TL*i* is the trophic level of species *i*. *Yi*0 the catch of species *i* during the year	Index	The "Sea Around Us" is an international research initiative and a member of the Global Fisheries Cluster at the University of British Columbia. The Sea Around Us assesses the impact of fisheries on the marine ecosystems of the world and offers mitigating solutions to a range of stakeholders
PCI		Per capita income	Current US $	International Featured Standards *(*IFS*)*

TEMP		Temperature	^{0}C	Metrological department is an autonomous and independent institution tasked with providing weather forecasts and public warnings concerning weather for protection, safety, and general information.
Rainfall		Rainfall	(mm)	Metrological department
Numbers of fishermen			Numbers	Handbook of fisheries statistics of Pakistan 2011 and Marine fisheries department Karachi

3.2 Variables of the study

Fishing in balance index, per capita income, PCI^2, Rainfall, Temperature and Number of Fishermen

3.3 Description of variables

This section presents the description and construction of variables.

i) Fishing in balance index (FIB)

The FIB Index is the dependent variable which will be taken from Sea around Us (SEA). This is the indicator used for the fisheries biodiversity. The indicator may take zero, positive or negative values. The positive values of the FIB index show that expansion takes place in the fisheries stock while negative values of the index shows contraction of the marine fisheries. The zero value shows in balance of the fisheries i.e. neither contraction nor expansion takes place (Bhathal & Pauly, 2008).

ii) Temperature

Temperature is one of the important climatic factors that affect the marine environment and fish population (Stenevik & Sundby, 2007).The marine food web structure and tropic level may also alter due to climatic factor (Müren, Berglund, Samuelsson, & Andersson, 2005). The factors like temperature related to climate change, may strongly influence the distribution and decrease the availability of fish stock (Islam, 2013). The data on temperature is obtained from the Pakistan Metropoligical Department. The main coastal areas Thata and Badin, so this study used only the average data of these two areas rather the average of the whole country.

iii) Rainfall

However, the heavy rainfall and increased water level have reduces the fish catch and also the catch per unit effort (CPUE) significantly. During rainy season fish migrate to the newly flooded areas and shallow edges and escape from fishing gear because of the water

level rise (PATRICK, 2016) .Rainfall data is taken from Pakistan Metropoligical Department. The average data of the Thata and Badin was used in the regression.

iv) A number of fishermen

Fishing is the dominant economic activity in the coastal area of Pakistan. It is estimated that the 400,000 fishermen and their families which are depend on the fisheries sector for their livelihood. Fishing down marine food web phenomena is mostly identified by FiB through which it can be observed that fish species over exploited when fish species are at the top of tropic chain, so the capture of fish increase when there is fish abundance (Doublet et al., 2014), with the increase in the number of fishermen, the fish catch would increase which would decrease the FIB index.

v) Per capita income

As the per capita income increases, the purchasing power of the population increase. With the increase in income, the fish consumption and demand would increase which finally put pressure on the fish catch. So, increase in the per capita income ultimately decrease the FIB index. To check the validity of EKC, the per capita income square variable is also be used.

3.4 Analytical tools

This section describes the diagnostic tests for the regression analysis.

i: Stationary of time series

To check the stationary of time series data I used Augmented Ducky Fuller (ADF) test. By stationary which mean the series with constant mean and constant variance. I have applied it to the study variables fishing in balance index, per capita income, Rainfall, Temperature and Number of Fishermen. In this study

.Null hypothesis shows that there is unit root. $H_{0:}\ \rho = 0$

Alternative hypothesis shows that there is no unit root. $H_{1:}\ \rho \leq 0$

$$\Delta Y_t = \alpha_t + \beta_t + \rho Y_{t-1} + \sum \gamma_i \Delta Y_{t-1} + \varepsilon_t \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3.1)$$

ii: Co-integration test and Error correction mechanism

Co-integration show the long run relationship between economic variables, if the two variables are co-integrated it mean that there is long run relationship between them, when the residual is non-stationary and variable is stationary so they are co-integrated and long run relationship exists. If all variables are integrated of I(0) the stationary be in level and VAR model followed by impulse response function and variance decomposition will be used. If all the variables are integrated of I(1) then Johansen co integration analysis will be carried while if the variables are I(1) and same as I(0), then ARDL bound test for co-integration will be applied.

There are two different approaches used to analyze the co-integration between time series data via Engle Granger approach and Johansen approach. Johansen (1988) developed

a method for finding that how many variables are co integrated with each other, it is one of the best test of co-integration. Johansen approach is better than Engle Granger approach as Granger approach require the large sample that have dependent, independent variables must be specified and also it is difficult in case when there are more than two time co-integrating relationship. If co-integration test confirm that there exist co-integration then we apply any of econometric model OLS, ARDL Model, ECM etc. and the regression will be not more spurious. In the present study after existence of co-integration among variables, we will apply OLS model for further analysis.

iii: Optimal lag selection

After check the stationary and order of integration of time series data, we estimate optimal lag length. To ensure the optimal lag length it is found from literature that different criterion like Akaike information criterion (AIC), Schwartz Bayesian Information Criterion (SBIC), Hannan-Quinn Criterion (HQC) are applied. In this study we are using (AIC) and (BIC) computed as:

$$AIC = -2l/ + 2n/T \quad \text{.....(3.3)}$$
$$BIC = -2l/T + n\log T/T \quad \text{.....(3.4)}$$

The proposed econometric model is given as under.

a) Econometric model

Fib = $\beta_0 + \beta_1 PCI + \beta_2 PCI^2 + \beta_3 Fishermen + \beta_4 RF + \beta_5 Temp + \varepsilon$

……(3.5)

The OLS was used to estimate the regression mode

Chapter 4

EMPIRICAL RESULTS

This chapter reveals the information about trends of different explanatory variables and analysis with testing the properties of time series. The steps mentioned in the previous chapter Data and Methodology have been followed in this chapter.

4.1 Trends in the marine fisheries and its influencing factors:

4.1.1 Trends in fishing in balance in Pakistan

Fishing in balance index is the dependent variable .The Convention on Biological Diversity (CBD) recognized this indicators to display biodiversity loss. The 'Marine Trophic Index' (MTI) is one of eight indicators identified for "immediate testing" This is the indicator used for the fisheries biodiversity. The indicator may take zero, positive or negative values. The positive values of the FIB index show that expansion takes place in the fisheries stock while negative values of the index shows contraction of the marine fisheries. The zero value shows in balance of the fisheries i.e. neither contraction nor expansion takes place. The trends shows that the fib index is increasing over the time in case of Pakistan.

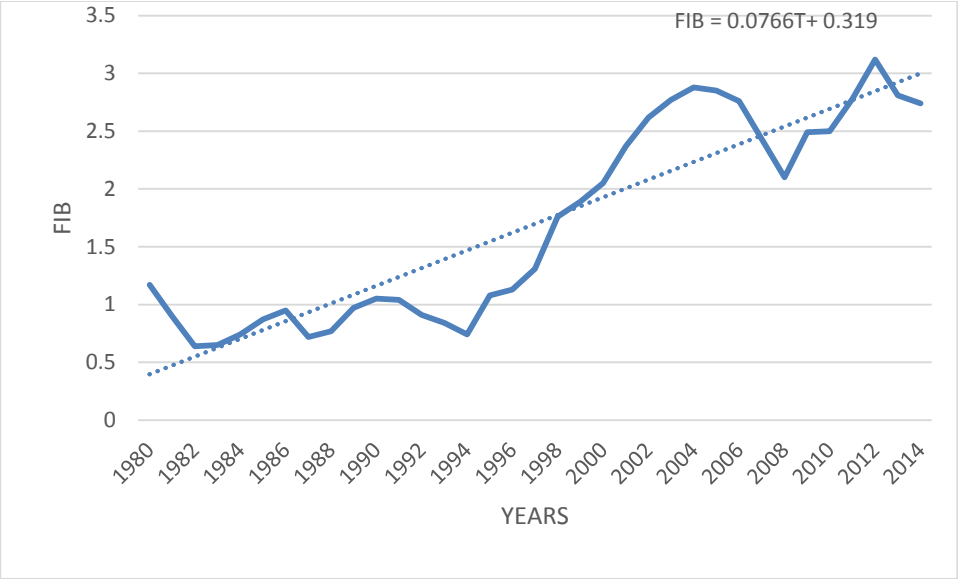


Figure 4.1 Trend of FIB in Pakistan

4.1.2 Trend of per capita income in Pakistan

The per capita income increases, the purchasing power of the population increase. With the increase in income, the fish consumption and demand would increase day by day which finally put pressure on the fish catch. In Pakistan it show that the per capita income increases, the purchasing power of the population increase. With the increase in income, the fish consumption and demand would increase which finally put pressure on the fish stock. The trends show that percapita income also increased over the time.

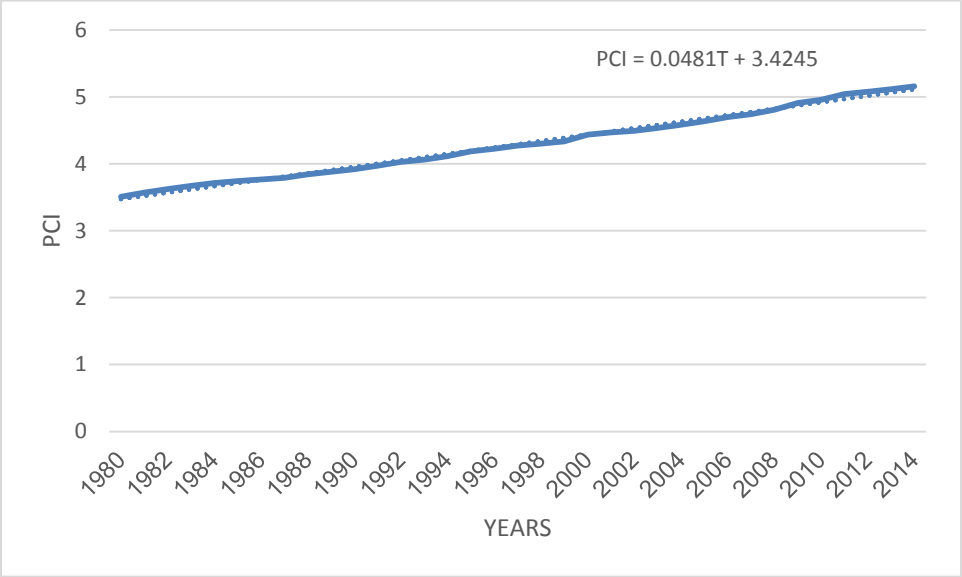


Figure: 4.2 per capita income

4.1.3 Trends in temperature in Pakistan

Temperature is one of the important factor that effect on the biodiversity of fisheries. The trend show that the early 1980 to till 1985 temperature is consistence then rapid change in them its increase then its decrease some fluctuation occur during 1995 to 2014.

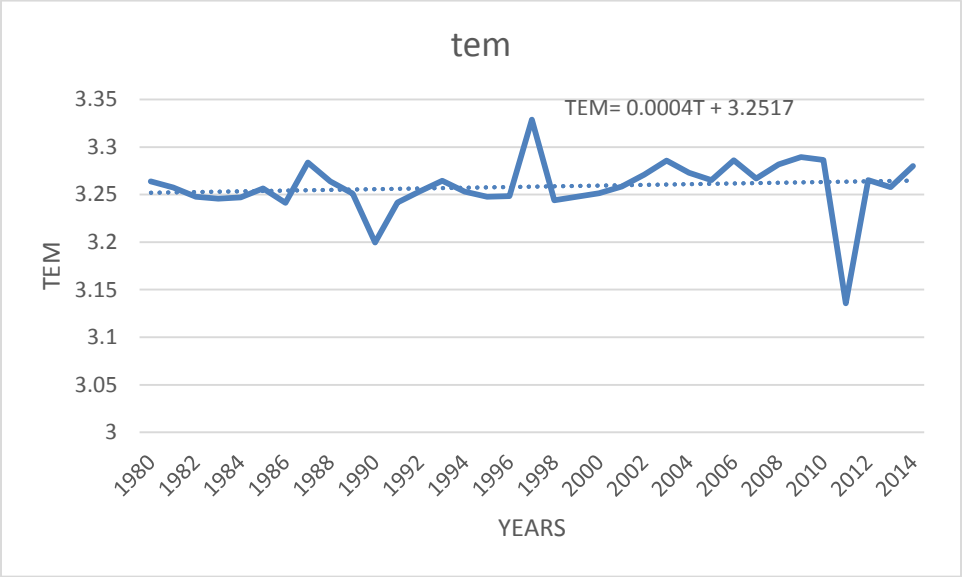


Figure: 4. 3 Temperature

4.1.4 Trends of rainfall in Pakistan

Rainfall is another climatic factor which shows that the how rainfall fluctuate during 1980 to 2014.The trend show that the highest rainfall in 2010 that cause of heavy flood after that the rainfall is lower than previous year.

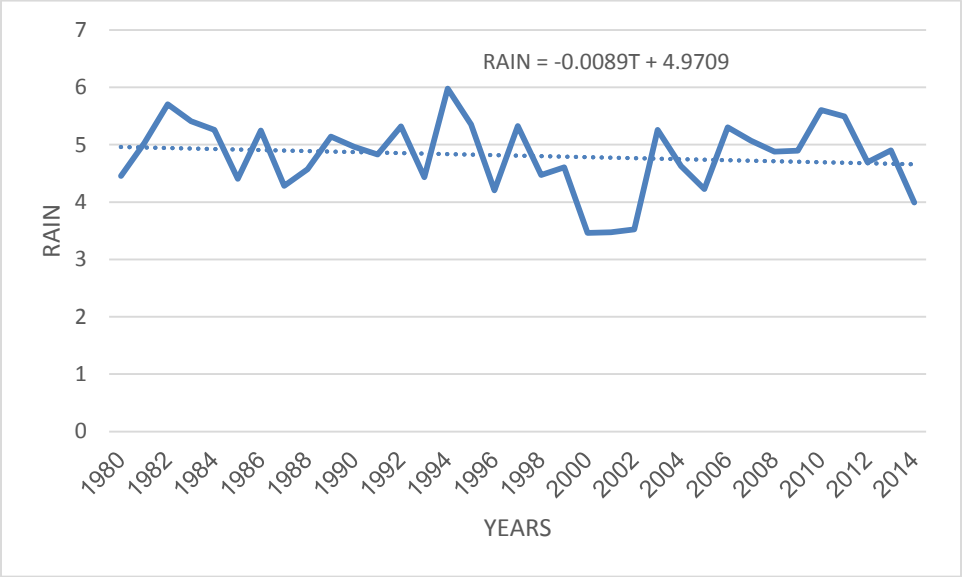


Figure: 4.4 Rainfall

4.1.5 Trends of number of fisherman in Pakistan

Fishing is the dominant economic activity in the coastal area of Pakistan. It is estimated that 400,000 fishermen and their families are dependent on the fisheries sector for their livelihood. The trend shows that the number of fishermen increase 1980 to 2010 but after that it become decrease that may become of flood and depletion of fish stock.

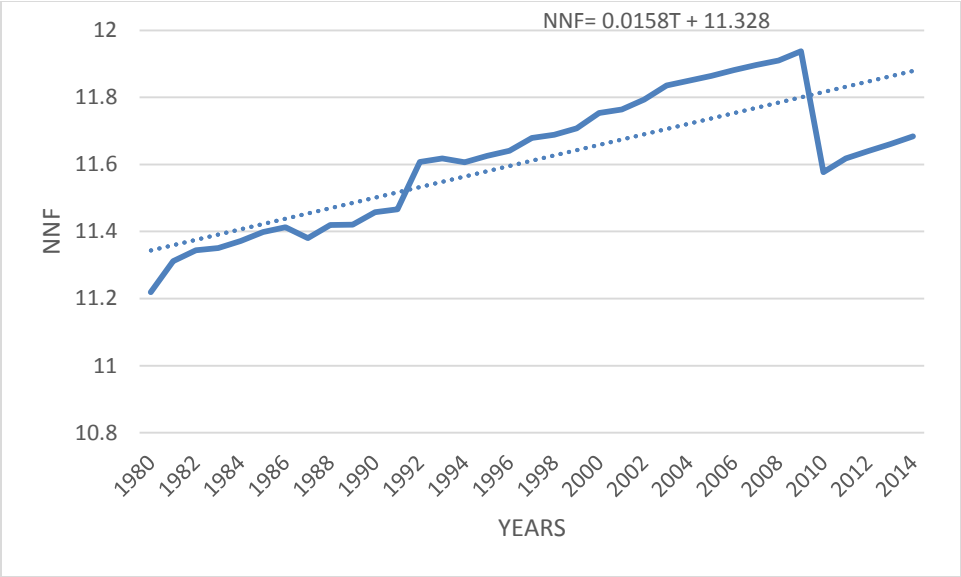


Figure: 4. 5 Number of fishermen

4.2 Testing Stationary

Before testing co-integration and error correction mechanism we tested unit root in order to find that whether the data is stationary or non-stationary. Augmented ducky fuller test (ADF) is applied and results are shown in the table 4.2.1

Table 4. 1 Estimated statistics of unit root test

Variables	ADF	Probability Values	Integrated
FiB	-0.3125	0.9128	I(1)
ΔFiB	-4.442	0.003	I(0)
Rainfall	-5.238	0.0001	I(1)
ΔRainfall	-7.5710	0.0000	I(0)
Temp	-3.2517	0.0255	I(1)

ΔTemp	-4.6233	0.0041	I(0)
NF	-1.84623	0.3527	1(1)
ΔNF	-6.2334	0.0000	I(0)
LPCI	-1.2752	0.873	I(1)
Δ(LogPCI)	-5.8012	0.002	I(0)
LPCI^2	-0.6695	0.9675	I(1)
Δ(LogPCI)	-5.837	0.002	I(0)

Table 4.1 shows the estimated output of unit root test. The null hypothesis H_0 for all variables like PCI, PCI^2, Rainfall, temperature, number of fishermen and FiB is not rejected in their original series, so we can say that the series are non-stationary. However, by taking the first difference of all variables, it is found that H_0 is rejected indicating that all variables are integrated of order one, I (1).

4.2.1 Co-integration Analysis

To study the long run relationship between FIB and climatic and non-climatic variables, Johansen test of co-integration (1988) is applied. Our analysis is based on the following steps.

Table 4.2: optimal lag length

Lag	**Log L**	**LR**	**AIC**	**SIC**	**HQ**
0	-183.1117	NA	11.8819	12.202	11,988

1	**31.599**	**322.066***	**1.525**	**4.0900***	**2.3752**
2	90.0315	62.0841	0.9355	5.744	2.5297
3	165.457	47.1411	-0.71609*	6.3377	1.62206*

After analyzing the results of unit root test next step is to choose optimal lag length. We determine the optimal lag length, because Johansen test of co-integration require lag length. As we have used annually data in our analysis, which results into small sample size, thus preference had given to Schwartz information criterion (SIC).The following table shows the selected lag length of SIC.

The above table 4.2 provides results of different criterions for lag order selection. However, only SBC are chosen and optimal lag length is one**,** lag (1). Lower the SIC value better will be the lower value of SIC is 4.09* with the optimal lag length suggested is one as an optimal lag.

4.2.3 Co-integration test

After applying augmented ducky fuller test (ADF) suggests that all variables like PCI, PCI^2, rainfall, temperature, and number of fishermen are non-stationary at level. So Johansen Co-integration test is applied to capture long run relationship. To investigate the co-integration relationship between variables, we have used trace test value and Maximum values.

Table 4.3 Trace Test Statistics

Unrestricted Cointegration Rank Test (Trace)			
Hypothesized		Trace	
No. of CE(s)	Eigenvalue	Statistic	Prob.**
None *	0.831313	133.7468	0.0000
At most 1 *	0.591693	75.01637	0.0181
At most 2	0.489540	45.45709	0.0826
At most 3	0.308086	23.26649	0.2332
At most 4	0.243007	11.11278	0.2047
At most 5	0.056679	1.925523	0.1652
Trace test indicates 2 cointegrating eqn(s) at the 0.05 level			
* denotes rejection of the hypothesis at the 0.05 level			

Table 4.4 Maximum Eigenvalue Statistics

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)				
Hypothesized		Max-Eigen	0.05	
No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.**
None *	0.831313	58.73047	40.07757	0.0002
At most 1	0.591693	29.55928	33.87687	0.1504
At most 2	0.489540	22.19059	27.58434	0.2108
At most 3	0.308086	12.15371	21.13162	0.5325
At most 4	0.243007	9.187261	14.26460	0.2709
At most 5	0.056679	1.925523	3.841466	0.1652
Max-eigenvalue test indicates 1 cointegrating eqn(s) at the 0.05 level				
* denotes rejection of the hypothesis at the 0.05 level				

The above table 4.3 provides estimated results of co-integration test. Both the trace test statistics and max-eigen value are used to check co-integration relationship between dependent and independent variable. Upper panel of this table provides the trace test statistics and max-eigen value are given in the lower panel in the table. Both tests clearly indicate that there is one co-integrating vector or co-integrating equation in model.

To check the structural stability of estimated model we have constructed the CUSUM square test of stability. Figures 1 and 2 shows the CUSUM and CUSUM square respectively.

Figure: 1 Cumulative Sum of Recursive Residuals

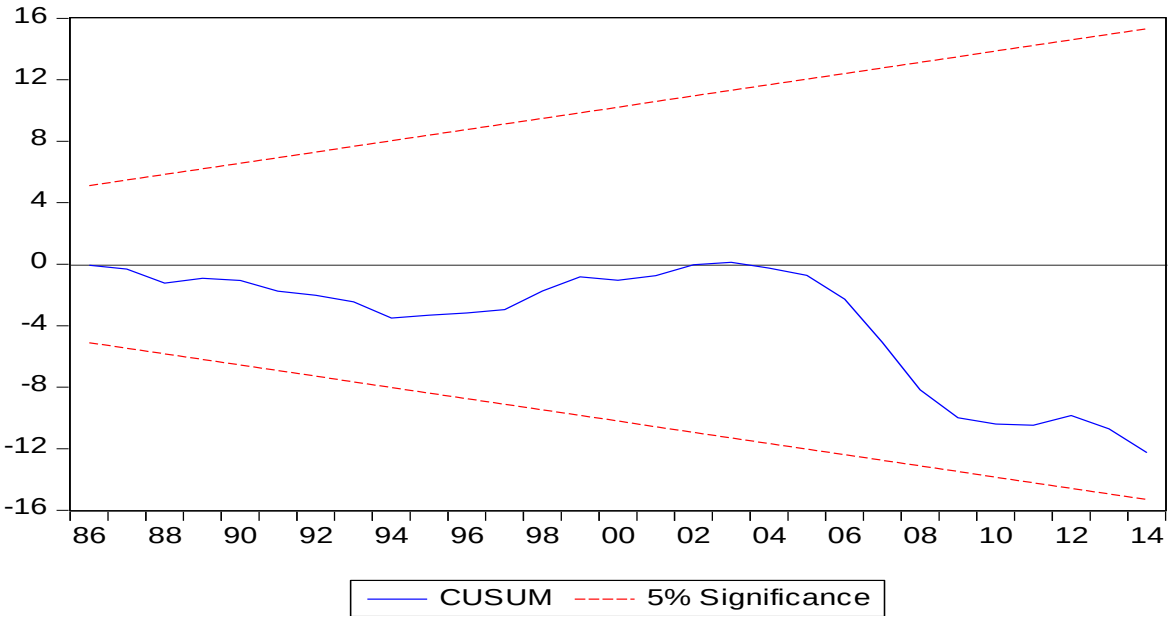
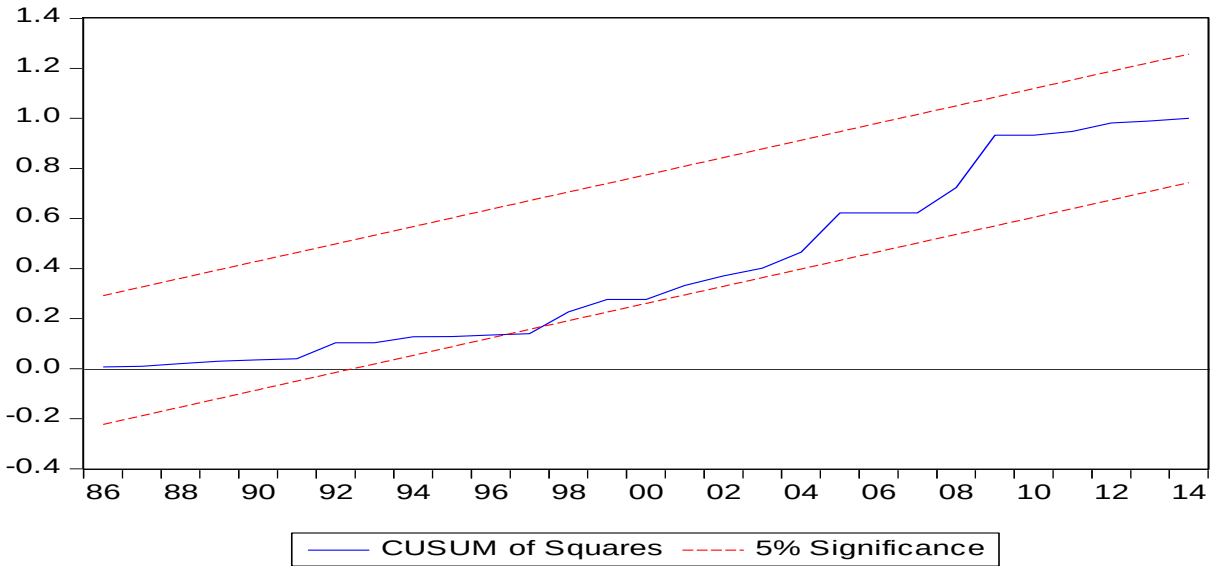


Figure 2 Cumulative Sum of Square Recursive Residuals



The above figures 1 CUSUM and figure 2 CUSUM square provide information that the co-efficient of the model are stable because both CUSUM and CUSUM square value is good that is inside the critical region.

4.3 Descriptive statistic

This section describes the descriptive statistics of explanatory variable used in the study. The explanatory variables, number of fishermen, rainfall and temperature. The total observation is 35. The Fishing-in-Balance *(FiB*) index was designed to account for the expansion and contraction of fishing fleets over time as reflected by the trophic level of the catches (Pauly *et al.* 2000; Bhathal and Pauly 2008; Kleisner and Pauly 2011). Thus, for a

given region, the FiB index relates the catches and average trophic level in a given year to the catches and average trophic level in an initial year to determine whether the change in mean trophic level is compatible with the transfer efficiency (TE) of that region .In case of Pakistan the mean value is 1.67 having positive sign to compare the mean value of dependent variable FiB of Pakistan the study also included two countries FiB mean value that are Canada and Algeria having mean -0.302 and 0.562 respectively. The result shows that Pakistan and Algeria both has positive mean value of FiB which tell us that fish catch are decrease over the time period and primary production of fishery occurs and the ecosystem is exploited by the fishery has been in fact expanded to lower level ,while in case of Canada the mean value is negative. The other explanatory variable like number of fishermen which has 112419.8 mean and 21908.79 standard deviation which is greater value then other variables its mean the number of fishermen increase day by day and fish stock decline while the trend shows that the throughout 1980 number of fishermen gradually increase but after 2010 it become decrease that may become of flood and depletion of stock while The fishermen still lack proper marine guidelines to trap fish and shrimp species at deep sea they really need to catch. .The other two climatic factor rainfall and temperature has 152.15, 25.94 are mean and standard deviation is 82.80 and 0.715 it shows that the impacts of climate change on the physical oceanography and the circulation of fish, the senior fishermen forecast these uncertainties could prove to be destructive for the life and livelihood of future generations.

Table 4.5 Descriptive statistics of fishing in balance index variables:

Country	Mean
Canada	-0.302
Algeria	0.561

Table 4.5.1: descriptive statistics of variables

Variable	**Minimum**	**Maximum**	**Mean**	**Standard deviation**
Fishing in balance index (Fib)	0.640	3.12	1.697	0.864
Number of fishermen	74521.0	1528887.0	112419.8	21908.79

Rainfall	31.90	394.50	152.15	82.80
Temperature	22.95	27.02	25.94	0.715
PCI	3.509	5,157	4.290	0.4947

Source: author calculations

4.4 Results of the factors influencing marine fishery in Pakistan

Before estimating OLS model we have estimated JJ test for co-integration and confirm that there is exist long run relationship among all variables. Now we will estimate OLS model and regression will be not more spurious, because co-integration is the solution for spurious relationship. Now we estimated OLS regression but after analysis we find that OLS regression result are subject to autocorrelation problem and according to CLRM if there is problem of autocorrelation it will lead to biased result. So we will remove the problem of autocorrelation by applying LM test statistic are given as under.

Table: 4.6 auto correlation test

Auto Correlation Test

Breusch-Godfrey Serial Correlation LM Test:

F-statistic	1.029978	Prob. F(2,18)	0.3771
Obs*R-squared	2.875318	Prob. Chi-Square(2)	0.2375

The above result confirm that there is no problem of autocorrelation. Null hypothesis is that there is no autocorrelation while alternate hypothesis is there is autocorrelation. In above result probability value is 0.3771 which don't reject Ho and we conclude that there is no autocorrelation problem. Now we have removed the problem of autocorrelation and we will apply OLS model which will be valid and interpretable

Table 4.7 Regression results of the factors influencing marine fishery in Pakistan

Variable	Coefficient	Std. Error	t-Statistic	Prob.
PER_CAPITA_INC	-7.278858	3.735130	-1.948756	0.0611
PCI_2	0.968531	0.409480	2.365272	0.0249
RAINFALL	4.729026	2.367299	-2.268671	0.0552
LTEM	-24.74307	10.90642	-2.268671	0.0309
LNF	2.987182	1.705661	1.751334	0.0905
C	-2.242087	5.312948	-0.422004	0.6761

The above estimated results we found that. Per capita income has also significantly negative relationship with FIB, by increasing one percent in PCI bring -7.278 percent FIB

likely to decrease. As shown in the result above one we can see that there is positive sign of PCI^2 which mean that EKC does not hold in case of Pakistan. There is 0.968 percent increase in FIB while Rainfall has significantly positive relationship with FIB so increasing in one percent of Rainfall the FIB will increase by 4.729 .Variable temperature has also negative impact on FIB as increasing in one degree temperature there will be -24.7430 Degrees decrease in FIB because average temperature has significantly negative relationship with FIB these two climatic variable highly impact on the fish stock in Pakistan. According to "Allison" et al (2009) identified Pakistan as one of the four Asian countries (the others being Bangladesh, Yemen and Cambodia) among the most vulnerable to climate change impacts. For marine fisheries, changes in ocean surface temperature will also impact many Coldwater species resulting in shifts in marine food webs and ecosystem function. Additionally, temperature driven changes in currents could affect species migration patterns as well as growth, survival and reproduction rates ultimately impacting future catch sizes. Another explanatory variable number of fishermen has significantly positive relationship with FIB so by increasing in one percent of number of fishermen FIB will increase by 2.9871. It is estimated that the 400,000 fishermen and their families which are depend on the fisheries sector for their livelihood. Fishing down marine food web phenomena is mostly identified by Fib through which it can be observed that fish species over exploited when fish species are at the top of tropic chain, so the capture of fish increase when there is fish abundance (Doublet et al., 2014),due to overfishing cause decline in future fisheries catch will lead to decreased revenue for fishing

communities in Sindh and Baluchistan resulting in increased poverty and food insecurity. Other industries indirectly tied with marine and freshwater fisheries will also suffer. The overall status for all the major fish stocks of Pakistan is that they are all below target biomass. Result shows that there are signification relationship of independent variables with dependent variable (Fib).

Chapter 5

CONCLUSION AND POLICY RECOMMENDATION

5.1 Conclusion

The present study has been designed to investigate the factors that impact on the biodiversity of marine fisheries in Pakistan by taking updated data set .the study investigate the fishing in balance index (Fib) and the factors which may have impact on this index during the time period of 1980-2014. The study made estimation using data taken from Marine fisheries department Karachi, Metrological department and world development indicator (WDI).The study employed Johansen test of co-integration and OLS to analyze the data set. The econometric analysis confirm that climatic and non-climatic variables are non-stationary at level while taking first difference it become stationary. The Johansen test of co-integration analysis reveals that there is one co-integrating vector. Before estimating OLS model the study estimated JJ test for co-integration and confirm that there is exist long run relationship among all variables. Further the study estimated the OLS model and regression will be not more spurious, because co-integration is the solution for spurious relationship. The study reached on this conclusion that the climatic factors like rainfall and temperature effects the fishing imbalance index, i.e. expansion of FIB occurs due to rainfall, it has direct relationship. However temperature effects it negatively so due to climate change it is projected that effect fish stock marine ecosystem and fisheries. The

non-climatic factors like number of fishermen have positive impact on it, and also PCI have negative relationship with FIB index. In our study the EKC is not hold.

5.2 Policy Recommendation

1) The per capita income increases, the purchasing power of the population increase. With the increase in income, the fish consumption and demand would increase which finally put pressure on the fish catch. So, increase in the per capita income ultimately decrease the FIB index.so its need to increase the fish stock.
2) There is need to limit the fish catch or stooping fish catch in the breeding season. Overfishing, mismanagement and poor regulation are all larger problems right now .There should be a banned on illegal fishing and issued a proper license to professional fishermen.
3) Fisheries are important economically, socially and biologically for the people of Pakistan. Given that current climate change forecasts list Pakistan as especially vulnerable to fisheries collapse, it is essential for the government to plan appropriate mitigation measures to deal with this scenario

5.3 Limitations of this research

1) The data on FIB index was available till 2014 so it can be improved research if the data is available.

2) The data on Number of vessels is not available, that's why the study excludes this variables.

5.4 Future suggestions

- The primary study needs to be conducted through which we can find other new and unique factors which effect on marine fisheries biodiversity.
- There are no official surveys of marine stocks available with fishermen to know the exact fields of fish and shrimp on the sea for target fishing so its need to adding that the practice of targeted catch will help marine species grow fast and their depletion could reduce

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