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Do Income Growth and Trade Expansion Reallocate the Ecological Footprints? A Case Study of Pakistan

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This paper aims to disaggregate the ecological footprints of Pakistan in relation to income growth and trade expansion along with some other important explanatory variables, like bio-capacity, trade openness and energy use. This study has correspondingly investigated the EKC type relation between income growth and environmental pressure, using secondary data for the period of 1980–2015 for Pakistan. This paper has utilised the ARDL bound technique to determine short run and long run relation between income growth and per capita ecological footprints for selected economic activity. Study found that Pakistan is importing greater share of its total environmental pollution from other economies over the time as the income of country increases. Consumption ecological footprints are relocated due to Income growth in Pakistan. As the income grows up, negative environmental consequences[1] are traded across the borders but inflow is quite higher than outflow in case of Pakistan.

Keywords: Ecological Footprints, Income Growth, Trade Expansion. Bio-capacity

1. INTRODUCTION

The economy of Pakistan has experienced momentous growth for the last few years. The key macroeconomic indicators have shown significant improvement in last three years. According to Pakistan Economic Survey (2016), real GDP growth of Pakistan for the Fiscal Year 2016 is 4.71, which is the highest in last eight years. However, the decline in growth rate of (0.19 percent) is recorded in agriculture sector. Industrial sector has grown significantly by 6.80 percent followed by the growth of 5.71 per in services sector for the FY 2016. This indicates that economy of Pakistan has enhanced the Economic growth and Employment. In the time, when emerging economies are facing slow growth. Pakistan performed reasonably well in current economic competition. The economy has achieved fiscal consolidation without compromising the developmental and social protection expenditures. Through effective expenditure management strategies and better revenue generation techniques, economy of Pakistan has reduced fiscal deficit from 8.2 percent to 4.3 percent in last three years. Per capita income of Pakistan has shown progress from $1516.8 in FY 2015 to $1560.7 in FY 2016

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[1]This term is commonly used for CO_2 emissions embodied in products, which are produced, consumed and traded across the borders, which are negative environmental consequences of our socio-economic activities.

[Economic Survey of Pakistan (2016)]. The development of any economy has certain environmental implications. According to National Plan (2012-13), Federal and Provincial Government of Pakistan have funded over 200 projects, which are being implemented in environmental services for capacity building. These projects are based on provision of safe water facilities, risk management for Climatic changes and adaptations through Forestry, conserving the ecological infrastructure, Wildlife and Fisheries. These projects also includes sustainable urban management [Pakistan (2016)].

The association between the "Economic growth" and Environmental distinction can be decoupled. According to Aldy, *et al.* (2004) Economy has three sectors of development, Agricultural, Industrial and Services. Emissions increase in development of agriculture sector but these emissions are not very intensive, as compared to the Industrial sector emissions of any economy. Development or transforming economy towards services sector, with significant contribution to GDP than other sectors will consequently reduce the environmental pressure on the existing bio-capacity. Now here we need to know, the way overall [2]Ecological Footprints and the [3]bio-capacity of a nation changes over time, as the economy passes through the stages of development. In view of Hornborg (2001), the Ecological Footprints enable us to track the effects of income on national and international bio-capacity.[4] Ecological Footprints help us to evaluate the impacts and demands we are placing on our natural resources and environment [Aşıcı and Acar (2016)]. Humans are the most successful species on this plant. Nobody could have imagined 200 years ago the life; we are living today. We have been able to create a wide range of technologies and the construction of cities to live with.

It is quite plausible to think that, how the humans will remain successful to maintain the success in future. Ecological Footprint is tool, just like a bank statement, which measure, how much resources, we have that renew itself and how often do we use them? How much resource in terms of bio productive space we have to support the consumption and production, in the economy and to absorb the waste of these activities? That's what the Ecological Footprint measures. The resources are converted into the wastes which are renewed back to resource powered by Sun, again to waste and again to resource. [Galli, *et al.* (2007)] argued that this is life cycle process. Now the global supply side is roughly 1.8 hectares' per capita biological productive space, which is the possible budget that nature has provided. The demand side indicates 2.2 hectares on per person basis. Increasing population and energy use have increased the demand of natural resources in past decades around the world as well as in Pakistan as shown in figure one.

[2]"Ecological footprints measure land area required for production consumption and absorption of waste that is generated. It is an ecological accounting, which tell us the resource we actually have. And how much we are utilising and keeping the records of resources regeneration as well".

[3]"The available bio productive space for nation, population or an activity, that's helps in providing natural resources to sustain the life. It is the ecological infrastructure which country has developed or has naturally".

[4]"Initially income growth adversely effects environmental quality, because of scale effect. After achieving the certain level of growth, the economy is able to install environmental friendly technologies in the production sectors, which safeguards the environmental quality. This is technical effect. The channel of composition effect can also affect the bio-capacity of the nation positively; when inputs-mix in the production process is changed from dirty to clean. This is also expected at higher income level countries" Acar (2015). "This is how after achieving the growth stage, the demand for environmental quality increases and persuade in different ways. This situation is also known as Environmental Kuznets curve" (EKC).

Fig. 1. Pakistan's Eco Footprints and Bio-capacity 1961-2012[5]

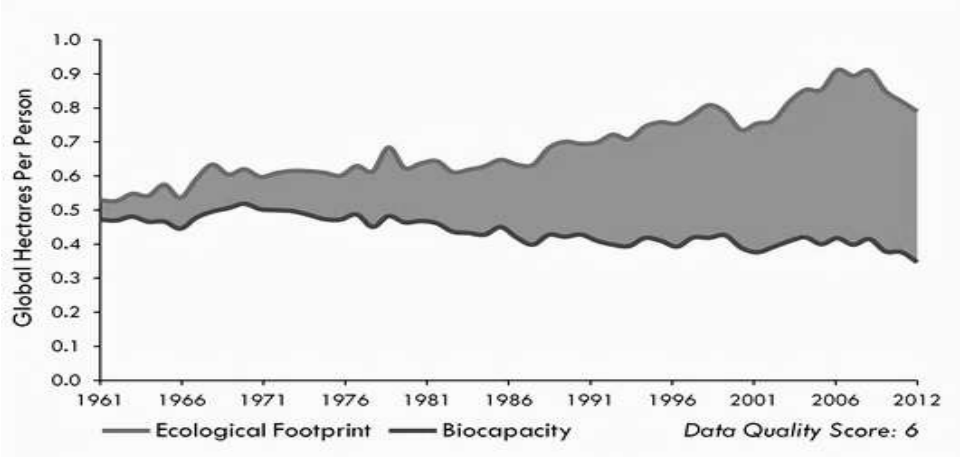


Figure 1 provides a pathway of per person resource demand also known as (Ecological Footprint) and per person resource supply also known as (Bio capacity) in Pakistan over a period of 42 years. Carrying-capacity fluctuates every year with management of national environment, ecology and farming practices, like: fertiliser use, irrigation type and also the trade across borders for technological developments. The upper line is indicating the ecological footprints, which shows increasing trend, while the line below is bio-capacity of the Pakistan, exhibiting declining trend. This study is designed to quantify the resource use allocation through traded commodities, using the component and compound approach[6] calculations against income growth of Pakistan. This paper has also focused the trade of bio capacity or biologically productive space through the imports and export of environmental friendly technologies and products across borders. From other perspective, use of high polluting inputs can restrict the bio capacity of nation. It will be interesting to know how the economy reacts, when the income is growing and trade patterns are changing over time, in a developing country like Pakistan. The investigation of Ecological Footprints reallocation against income growth is a policy oriented paper to ensure the trade decisions of clean products for economic as well as environmental sustainability of Pakistan, through encouraging the better environment friendly technology in production process of products. Researchers around the world have used the EKC for single country cases for example [Burgess, Bedford, Hobson, Davies, and Harrison (2003); Cole (2000); Daly (1993); De Bruyn (2000); Lekakis (2000); Stern and Common (2001)]. The current research has furthermore tested the existence of pollution heaven hypothesis (EKC). This is an exclusive case of ECO-footprints of selected commodities against income growth with some other explanatory variables for Pakistan. The paper focuses on decomposing Ecological Footprints of products into consumption and trade inflow of major commodities over time, from 1980

[5]This is data of GFN, while graphs and table regarding the same variables are given in chapter 6, which is the results chapter of current study.

[6] "This is a method for ecological footprints accounting. It is also known as bottom up method and top down method and the detail discussion on this term is given in chapter 5 in section 5.2.2 pages 36-37 last paragraph".

to 2015 in Pakistan. Also to investigate the EKC type, inverted U shape relationship for Income growth and consumption of various goods and services and subsequent Ecological Footprints.

2. LITERATURE REVIEW

2.1. Income Growth and Emissions

Looking back in 1980s the Economy of Pakistan was serving to 96 million population Economic Survey of Pakistan (1991-92), now this economy is providing, food, shelter, and infrastructure and defence services to 195.5 million people. In 90s the literacy rate was 29.5 percent and today it is 60 percent [Pakistan Economic Survey (2015)]. Economic indicators of Pakistan have portrayed a very active image of continuous growth throughout the history. Per capita Income growth has shown significant growth of 9.25 percent in dollars' term and 7.5 percent growth in rupees' term for the FY (2014-15) as compared to 3.83 percent in rupees' term for the FY (2016).

According to Pakistan Economic Survey (2016), per capita income was 746 USD in FY 2000, which declined to 663 USD in 2003. After 2003 per capita reached to 1053 USD in FY 2007, it has reached to $1,512 in 2014-15 and increased to $1,560 in 2016. Mehmood and Shahab (2014) argued that industrialising and economic growth over the time has drifted the emissions of Pakistan positively from 1990s. Per capita emissions of Pakistan were 0.41 metric tons in 1980s, which reached 0.63 metric tons per person in 1990s and to 0.96 metric tons per person in 2010. For sustainable development, Pakistan is facing critical challenges of current time, to manage the GHGs emissions at optimal level and increasing economic growth. By doing the county wise analysis of PIC nations (Pakistan, India and china) Irfan, Usman, and Kusakabe (2011) have done a decomposition analysis. The argument of their contribution was that, effect of CO^2 emissions and atmospheric emissions in Low Carbon Economy (LCE) is a reality, which cannot be denied. [Muhammad and Ghulam Fatima (2013)] found that [7]financial development and energy consumption are the most important factors of carbon emissions in Pakistan. The only solution to environmental problem, like global warming, is to lower the carbon emissions through better technologies deployment and special attention to reduce the emissions from high emitting sectors.

The increasing demand for coal in cement sector has shown 61 percent use of coal in FY 2011 as compared to 0 percent coal used by cement sector in 1990s. Over time Pakistan has faced negative environmental consequences of the industrial revolution. The industrial-led growth has increased the energy demand and thus, the environmental pollutions in the country. The industrial sector of Pakistan consumed 36 percent and transportation sector consumed about 33 percent of total energy whereas the overall consumption of industrial sector increased to 43 percent in 2010 [Shahbaz and Lean (2012)]. The concentration of greenhouse gases like, carbon dioxide (CO2) has increased to 35 percent since 1870 to 2000 but after 2001, the world has faced strong awareness and many countries have done strict enforcement of laws and acts to reduce

[7]Financial development indicates the private credits as percentage of GDP, which increasing per capita energy use, by encouraging consumer's purchasing power in short run. This type of assistance, often encourage consumers to buy electric appliances and thus increase overall the GHG emissions of the country.

the emissions to the certain limits for the public and ecological happiness [Attari, Kamal, and Attaria (2011)]. Citing the Clean Development Mechanism channels, the Kyoto Protocol, has implemented the rule of accomplishing the ecological obligations, for the rich counties and other working industries in any nation. This is a process when the demand for environmental quality is higher. This can be only done, if rich countries of world started to progress some diverse and sustainable projects for development to bring down the level of CO^2 emissions in low income counties [Hu (2002)].

2.2. Footprint of Production and Consumption

The production footprints of a product can be calculated as the summation of all resources utilised for the product of that specific commodity. These resources are harvested for energy purpose, which is needed for the product, these resources are harvested for building up the infrastructure and are generated within the geographical area of the nation for which the calculations are made. The direct demand for local or domestic biological productive space can be estimated from the production footprints directly, as well as the executed demand is designated by indigenous CO^2 emissions.

All the area required for the production, harvesting and processing of products from cropland, pasture lands forest lands and water bodies is included in the production footprints account of a product. Other than this the forest area or land area which can absorb all the carbon dioxide emissions cause by burning the fossil fuel, within the boundaries of the products producing country. A specific portion of these production footprints are exported to other countries in form of trading commodities. To calculate the furthermost frequently described kind of Ecological Footprint one should use the production footprints subtract the export footprints and plus the import footprints. Imports are counted as part of same type of footprints and That is called the consumption footprints [Borucke, *et al.* (2013)]. One of the research in 2007 reported that, Portland Cement Association (PCA) members estimated an average of around 927 kg of $CO^{2,}$ which are regularly emitted for every 1000 kg of cement production in the U.S [Marceau and VanGeem (2007)]. The ecological footprints of one activity might be effected due other activity as these are interlinked together.

2.3. Trade Pattern and Ecological Footprints of Pakistan

During the early stages the potential of accessible resources were not employed in more effective and sustainable ways, which indirectly abridged the growth of economy. In 1948-49, 99 percent of Pakistani exports were primary commodities like raw jute, raw cotton, raw wool, hides and tea. In 1950, the exports of Pakistan declined by means of 43.18 percent and received Rs 1343 million on account of exports. The economy was trading higher volume of primary good as compared to semi manufactured and manufactured goods. In 1960-61 Pakistan's exports were documented as Rs 540 million, improved the drive for the period of 1960s exports enhanced by 161.88 percent [Ghafoor (2002)]. The exports of Pakistan have notably improved from Rs 1998 million to Rs 29280 million in the decade of 1970s and progressed to Rs 138280 million in 1990-91 [Zaidi (2000)]. After 2001 the share of primary commodities was increasing. In (2001) it was 13 percent but in FY (2015) it has reached to 17 per cent [Economic Survey of Pakistan (2015-16)] According to Kemal, *et al.* (2002), which can also have

interpretation, which are plausible to economic, and may also be seen or understood very important for policy. Sustainability of resources and biological productive space for Pakistan is quite challenging due to the use of resources beyond the available capacity. But [Aşıcı and Acar (2016)] argued that the ecological deficits can be recovered by either importing or exporting the biological capacity across borders. Their investigation was based on cross sectional observations for more than 100 countries, and additionally important, Acar (2015) detected, that as the economy get richer, the countries are exporting products embodied emissions and have uncovered some of the factors that drive such behaviour.

According to [Andersson and Lindroth (2001)] the relationship of trade and environment is multidimensional. There are several ways that could possibly reallocate the ecological footprints of a nation. Positive allocation effect of trade is which enable the economy to specialise on products to produce it more efficiently on minimum resources. The second thing, trade can cause to negative income effects. Negative income effect is a situation, when economy income is enhanced due to trade, which increases the consumption of economy and finally higher their ecological footprints initially. Third is Negative rich-country-illusion effect which is also technique used on macro level? It's a kind of behavior, which highpoints the incorrect brand of rich countries that the life style of economy is justifiable.

This can be constructed for the imports of bio sink or bio capacity from less developed nations. Negative terms-of-trade distortion effect, it is a real story of lower class economies, the harsh reality of poorer economies, and their tendency towards the exploitation of natural resources beyond sustainable limits, only to sustain the terms-of-trade during high demand period. The possibility of trading the bio capacity with increasing income yields up in mind of poor nation. The economic growth is necessary state for better environmental conditions. According to Nordström and Vaughan (1999) ecological footprint tends to raise both in high income and low income countries due to such illusions.

3. DATA AND METHODOLGY

3.1. Theoretical Framework

The stand-up of ecological economics was seen in final eras of 20th century in connection to protect the environment and clench the actual taste of sustainable development. This branch of economics was a response to lack of biological groundwork in neoclassical economics. The intentions of infusing economics to moral philosophy was build a relation of ecology and resource management in reaction to the framework of unethical implications of neoclassical models depicting the humans as a rational and utility maximising species on the planet [Capra and Pauli]. Ecological economics is multiple dimensional efforts to manage the concepts and findings, coming from the nexus of nature and economic activities. Looking to background of the study area, ecological economics refers to the interaction between the ecology provide inputs to sustain and support our lives on one hand and on the hand resources are scares and increasing population need to manage it in way to go through the future.

The main effects, concerning ecological economics are scale, distribution, and allocation. Scale is the size of economy against the understanding to resources availability and sustainability. Scale is limited, that imply that economic growth is also limited. This is the actual priority of Ecological Economist to manage within limits of ecology and be restricted to some limits of growth. This is the point where the Ecological Economics is differentiated from Neoclassical, which believes in unlimited growth of an economy. Looking to other facts neoclassical school of thought refers to labour and capital resources allocation efficiently in a way that could maximise the production and economic growth [Standing, Jackson, Chen, Boudreau, and Watson (2008)]. But Ecological Economics focus on the efficient allocation of land and natural resources and consider these as factors of production. Natural resources are found to be only incompletely transposable by labour and manufactured capital. In ecological economics, the individual natural resources are also analysed to control, if they have the properties required for being allocated efficiently in the market. The current research is looking forward to the theories of ecological economic and trade economics. Scale effect, allocations effect (ecological handprints), technical effect and composition effect in association with economic growth of Pakistan.

3.2. Component and Compound-based Approaches

This research has incorporated two basic ecological foot prints approaches. The first is component based approach, which is also known as bottom up method. This method calculates the footprint of individual product. The inclusive precision of results is subjected to the comprehensiveness of the elements list as well as the reliability of the life-cycle assessment (LCA) of each identified component. Current method offers a high level of detail but has also some restricted distinct limitations. The component-based method also has some issues with gaps in available data and also with some proxies, like: indirect expenditures, which are not in the accounts of that organisation, Such as public infrastructure and martial financial records.

The only use of component based approach is not sufficient to conclude for national footprints significantly. The estimated standards through life cycle assessment method in the world are collected from different reliable sources of GFN, FAO etc. and these standards are incorporated to calculate the product specific Ecological Footprint for Pakistan. To overcome the shortcomings of component based approach, this study merges the application of both approaches to deal with case of nation Ecological footprints against the income growth and trade expansion of Pakistan. The results of this approach are more comprehensive than any sub national source besides LCAs and captures both straight and unintended consumption. Regarding the component method, there is no need to know, what share of the overall consumption resources were used for which purposes, as these are not perfectly documented in the records of statistical data groups [Wackernagel, *et al.* (2002)]. Current study has brought these issues into bright colours lights for future literature, by disaggregating and aggregating the footprints of Pakistan.

3.2.1. *Scale, Technological and Composition Effects*

The notion of this study is reflected by the theory that, income growth, Trade and industrial growth affects the environmental value in three different ways, the scale effects, technological effects and off-course the last but not least, the composition effects

[Grossman and Krueger (1991)]. To increase the level of output, higher level of inputs is needed and thus it requires more natural resources use in production process. This also implies the higher level of emissions and waste generation, which directly and indirectly affect the environmental quality. Economic growth therefore, reveals a "scale effect" that devours negative influence on environment. Conversely, the economic growth can also demonstrate the positive effects on environment through the composition effect: which is, as the income increases, the construction of the economic inclines towards transformation and progressively up surges the cleaner activities that are more environmental friendly and produce less pollution.

Environmental degradations have a tendency to intensifications structure of economy, which fluctuate from rural to urban or from agricultural sector to sector industrial, but also it started to fall with alternative operational change from energy intensive industry to services intensive industry. As a wealthy nation can have enough money to spend more on R&D [Komen, Gerking, and Folmer (1997)]. The technological development occurs with growth in income and other economic indicators and the obsolete technologies, which cause high pollution and degradation to environment, are substituted by advanced new and cleaner technologies, resulting in the improvement of environmental quality.

Table 1

Descriptive Data of Per Unit CO2 and Ecological Footprints of Products Selected for the Study

Year	Product Quantity (KG)	CO2 in (KG)	Ecological Footprints (Gha)	Country	Method	Source/References
1998	Cement 1000 Kg	1200	0.52	India	LCA	Malhotra (1998)
1993	Cement 1000 Kg	1250	0.55	India	LCA	Wilson Alex (1993)
2005	Cement 1000 Kg	927	0.37	USA:	LCA	Marceau, Medgar (2005)
2005	Cement 1000 Kg	900-1100	0.65-0.85	USA Portland	LCA	Environmental Protection, Agency (2005)
2010	Cement 1000 Kg	1500	0.39	Pakistan	LCA	World Development Indicators (2010)
2000	Cotton 1000 kg	2120	1.03	USA	LCA	LillemorLewan (2000)
2000	Cotton 1000 kg	3500	1.85	India Panjab	LCA	LillemorLewan (2000)
1999	Polyester1000 kg	1670	1.67	UK	LCA	Soth, J (1999).
1999	Plastic 1000 kg	2200	2.21	India Panjab	LCA	Soth, J (1999).
2005	Meat/lamb 1000kg	39200	21.63	Asia	LCA	Env- working group 2005 AFA
2005	Meat/beef 1000 kg	27000	14.86	Asia	LCA	Env- working group 2005 AFA
2013	Wheat 1000 kg	3400	1.5	Asia	LCA	FAO FWF, (2013)
2013	Wheat 1000 kg	2000	0.97	Europe	LCA	FAO FWF, (2013)
2013	Rice 1000 kg	5000	2.63	Asia	LCA	FAO FWF, (2013
2012	Rice 1000 kg	2700	1.36	Pakistan	LCA	WWF (2012)
2012	Fish 1000 kg	11009	5.97	Pakistan	LCA	AFP (2012)
2013	Fertilisers	4600	3.6	Middle income	LCA	YARA (2013)
2011	Fertilisers	1950	1.8	European Union	PRD	European commission (2011)
0000	Sequestration	1400	1.4 Co2/ per 1 Gha	Uk	Forest	UK Forest, Ministry

The standards of per ton emissions of Fish, Meat, Wheat and Rice for mentioned countries are converted to Gha by author; these are calculated through Lee and Peng (2014) formula of CO_2 conversion with yield factors.

$$Carbon\ footprint\ (gha)\ =\ CO2\ emissions\ (tons)\ \times\ (1\ -\ 1/4)/1.8$$

This is UK standard but for final estimation as mentioned in methodology, the data is processed country specific standards and conversions factor components. There are some other standards like: the conversion factor for land area sequestration for one tonne of CO_2 in hectares is (0.19) and global hectare equivalence factor is (1.17), previously used by Nicola Hogan in University of Limerick's (2014). The study has also utilised these standards to estimate the imports ecological footprints. Where the conversion from CO_2 to land acers needed to engross it, which has done through this formula in Excel: = (CO_2 tons*0.19) and to-covert from acers to Global hectares, the study has utilised the formula = (100 acers*1.4).

Table 2

Variables of the Study

Variables of the Study	Symbol	Variable Source and Unit
Per Capita Income Growth	DPCIG	Statistical year books of Pakistan in millions
Consumption Footprints per Capita	DCFP	Standard are taken from GFN, further authors calculations (Gha)
Import Foot Prints per Capita	DIMFP	Import Footprint per capita in Global hectares (Gha) Global Footprint Network, 2012 and Author's calculation
Production, Footprint per Capita	DPFP	Production Footprint Per Capita Global hectares (Gha) Global Footprint Network, 2012 and Author's calculations
Exports Footprints per Capita	EXPFPC	Standards are taken from literature, GFN, author calculations.
Openness to Trade	DOT	Openness to Trade exports + imports, percent of GDP (WDI)
Biological Capacity	DBC	Global hectares (Gha) Global Footprint Network, 2012
Energy Use per Capita	DEUPC	Energy use per capita Tonne of oil equivalent WDI (2014)
Population Growth	DP	Taken from WDI in millions and Economic Survey of Pakistan (2015-16)

3.3. Nature of Data Used / Sources

The data of income growth is taken from World Development Indicators and statistical yearbooks of Pakistan. The study has used time series data for investigation process, where the selected commodities of trade is considered from 1980–2015, (35 years) as time series units. The data of traded commodities, wheat, cotton, rice, cement, fertilisers, and some other selected items is taken from statistical year's book of Pakistan and Pakistan economic surveys for the time of 1980–2015 and some other sources like WDI, IFX and Federal Board of Revenue etc.

3.3.1. *Ecological Foot Prints of Imports*

To calculate the ecological footprints of imports, first of all the data of selected commodities, Rice, Cotton, Wheat, Plastic, Polyester, Cement, Fertilisers, Petroleum products, Livestock Meat, Paper and Fish was converted into million tons' units imported. After converting to the units imported for all commodities, the data was further treated for imports ecological footprints calculations by multiplying the per unit standards with the total units imported for selected products for the time period of 1980 to 2015. In next step, we sum up all the products footprints and subsequently the whole data set of the import ecological footprints was transformed to a single time series of imports ecological footprints series. For example, if we have imported from China in million tons for that, we use the formula: total imports of specific product cement in 1980*3.5 (3.5 is Per Ton Ecological Footprint standard of China), which provided the value of Imported Cement Ecological Footprints. And so for other products in specific year with their specific standards, but if any country hasn't developed standard for specific product at that point, the author of current research has used the standard of adjust country or a country in same income group.

3.3.2. *Ecological Foot Prints of Exports*

Per unit Ecological Footprints will be taken for selected commodities Rice, Cotton, and wheat livestock meat, Plastic, Cement and Fertilisers from Global Foot Print Network, other literature and worldwide published researches. One unit of each commodity standard Ecological Footprint is multiplied by total units exported to calculate the Ecological Footprints of exports. Furthermore, calculating exports footprints, one unit of production footprints of a good is multiplied by total exported units and the value for each product ecological foot prints is derived for of exports. All the products are taken from 1980 to 2015, where data series is merged to one time series for all the selected commodities by adding the horizontally all the product 1 + product 2 + product 3 eco footprints for specific year and so on.

3.3.3. *Ecological Foot Prints of Production*

The present study calculates production ecological footprints by collecting the estimated standards published by GFN and other researchers at different studies, reports and articles. Per unit ecological footprints standards of Cement, Fertilisers, Wheat, Rice, Plastic, Polyesters, Papers and Fish products are multiplied by quantity produced to calculate the production footprints of any commodity. And at last stage, to make it single series, the horizontal summation of products ecological footprints is done, as Eco Foot Print of product one + Eco Foot Print of product 2 +Eco Foot Print of product 3 and so on. This is included in the consumption ecological footprints

3.3.4. *Ecological Footprint of Consumption*

It's important to investigate the direct and indirect bio-capacity, which is needed to nourishment of people's daily consumption. Consumer based approach is used, while calculating the Footprints for each area and type of few products. The Ecological Footprint of consumption (EFC) can be calculated as

$$EFc = EFp + EFi - EFe \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (3.1)$$

EFP is the Ecological Footprint of production and EFI and EFE are the embodied footprints traded inside the goods imported and goods exported, respectively. One of the benefits from the calculation of footprints at the national level is that, the level of aggregation, where the detailed and consistent production and trade data are available [Mózner (2013)].

The current study has used a very logical methodology to calculate the bio capacity for each product or we can also use it on total sum of product ecological footprints. The emissions in tons are divided on Global average of all kind of productive spaces yield, (2.34) multiply by the land equivalency factor for EF to covert it in global hectares, which is (1.4), to determine the biological productive space in land in global hectares' unit for Pakistan. *For example:* Emissions tones / Global average forest yield 2.34 = Hectares of bio-productive area* Land equivalency factor 1.4 = Bio Capacity in Global Hectares.

3.4. Econometric Methodology

This study has used annually time series data of selected trade goods and income growth with other covariates, from 1980 to 2015 for Pakistan. First the author has used the unit root test (ADF) for checking the stationary of the variables and the variables were stationary at first difference and some were stationary at level. None of the variable in this study was stationary at 2nd difference.[8] After final test on data estimation, ARDL model was applied, to investigate the short run as well as long run relationship among the variables of interest. After the confirmation of results the series are co integrated, the econometric model on this series are no longer spurious. This technique provides better compensation in contrast with earlier and old-style Co integrating methods. This function was constructed on base of a concept, that (PCCEFP) Per Capita Ecological Footprints of Consumption are reallocated due to per capita income growth, and squared term of income growth. The effects of other variables like, (OTT), trade openness, (BC) bio capacity, (POPG) population Growth, and (ENPC) Energy per capita are included in the modeling for more precise measurement.

3.4.2. *Model Specification*

Functional form of ARDL

Model for Relationship between Income Growth and Consumption Per Capita Ecological footprints with one lag optimum number of lag through checking AIC SIC criteria

$$DPCCFP_t = \alpha_t + \beta 1 DPCIG_t + \beta 2 DPCIG_{t-1} + \beta 3 DPCIG_t^2 + \beta 4 DPCIG_{t-1}^2 + \beta 5 DOTT_t + \beta 6 DOTT_{t-1} + \beta 7 POPG_t + \beta 8 POPG_{t-1} + \beta 9 DBC_t + \beta 10 DBC_{t-1} + \beta 11 ENRGPC_t + \beta 12 ENRGPC_{t-1} + \Sigma_t consumption \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (3.1)$$

4. RESULTS AND DISCUSSION

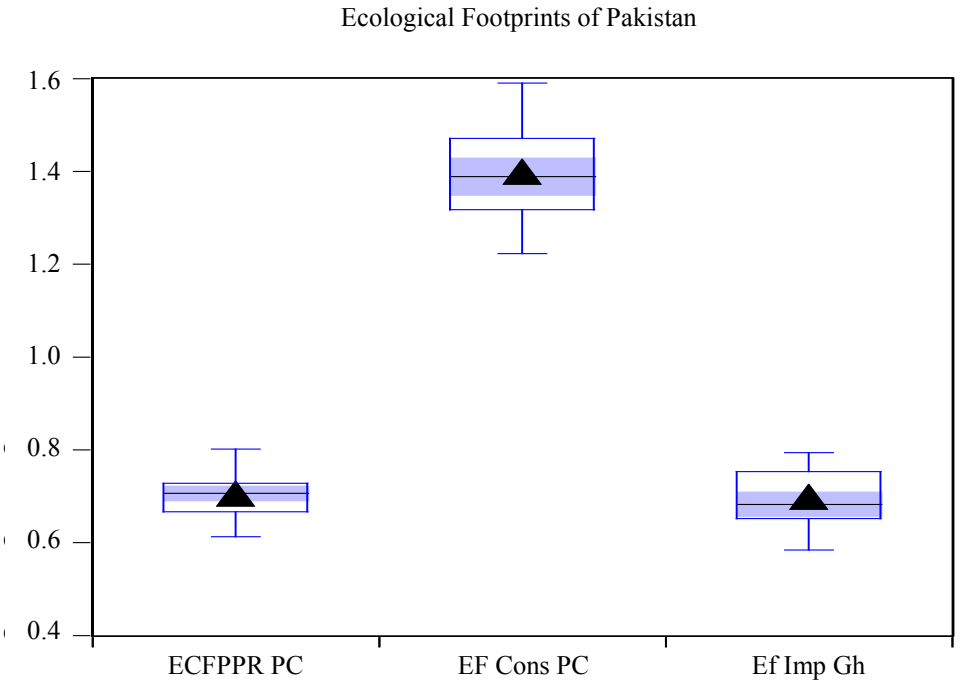
4.1. Descriptive Statistics

Figure 2 shows that, the Production Per capita Ecological Footprints of Pakistan is very close to import Ecological Footprints but quite smaller than Consumption Footprints per capita. These findings are aligned with results of Acer (2015) and Adly (2015) argued

[8]See appendix A for detailed data diagnostic tests .

that when initially income raises Ecological footprints of imports nurtures faster than Production footprints of developing countries. In case of our estimations, imports footprints are less than production footprints with minor difference. Higher Consumption foot prints are the confirmation Pakistan has gone through consumption driven pollution. The imports footprints of Pakistan contribute 45 percent to its total Consumption Footprints. It implies that Pakistan also need to pay attention to manage the incoming pollution along with own country produced emissions.

Fig. 2. Ecological Footprints[9] of Pakistan by Economic Activities

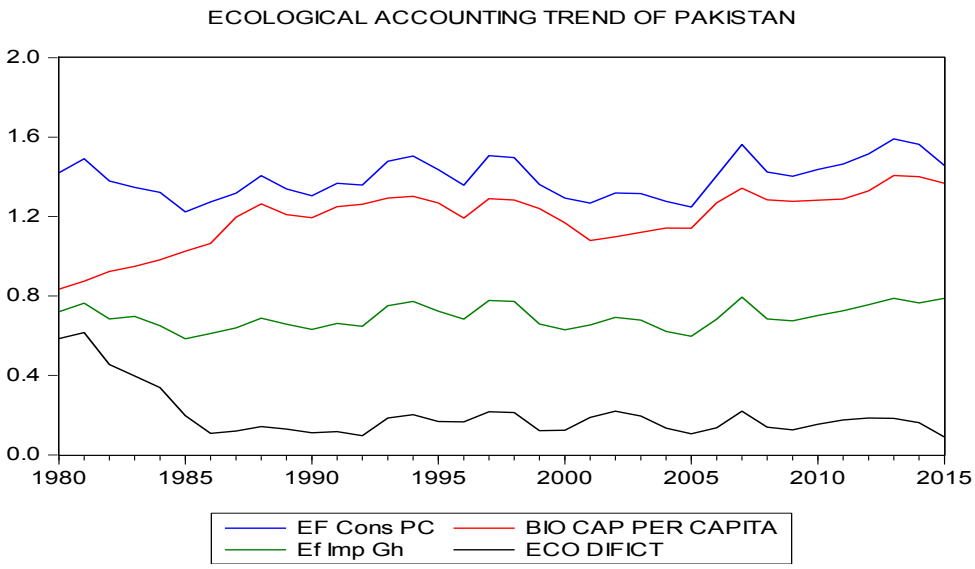


4.2. Ecological Accounts of Pakistan over Time

Figure 3 shows, increasing bio capacity due to agriculture intensification with better seeds, better technology, conversion of barren lands to cultivable lands and changing the imports composition to cleaner goods appears helpful for Pakistan, to reduce the Ecological deficit in the future, as we move towards development. The economy of Pakistan has increased the agriculture land area, water storing capacity, through dams and water reservoirs. But unfortunately, Pakistan is still an ecologically deficit economy. Because what the nature can provide around the year Pakistan is using 33 percent higher than that. However, the gap between ecological footprints and bio-capacity is decreasing and it is expected that bio-capacity will take the lead in few years, if said environmental budget is efficiently managed. For detail see Appendix.

[9]On X axis's it shows ecological footprints for which, the Unit of measurement is land required in Gha and on Y axis's different economic activities.

Fig. 3. Ecological Accounts of Pakistan over Time[10]



4.3. Diagnostic Test on Data Used

This study has used ADF test to check the stationary of the data considered for the analysis. Also, to check the order of Co integrating for each series, current research has employed Unit root test. The study has confirmed that each series is 1(1) however 1(0) series are also the part of study data sets, but not any single series was integrated of order 1(2). To ensure that the results are not spurious, furthermore current study has used some other tests. The diagnostics test included Durbin Watson test to check autocorrelation for each series, LM test for serial correlation, where all the series of the data is brought away from all the econometric issues, without forgetting the multicollinearity and heteroscedasticity.[11]

4.4. Income Growth and Consumption Footprints

Initially real income growth has increased the Ecological Footprints of Pakistan. But current income growth has no significant relationship with Ecological Footprints of Consumption. It means that Per Capita Consumption Ecological Footprints are not responding to Current Income growth. However, the income growth squared is negative and statistically significant. The Eco-Footprints of consumption is positive affected due to increasing population and upgrading scale of production to higher level, which impose

[10]The unite of measurement for ecological footprints is land required in Gha for specific activity, person or a product to support daily resource use over the year.

[11]To proceed with best results, current study has follow, Cameron (1994) by converting the linear function to log linear model, so we write the function as follows, The Consumption ecological footprints, per capita is dependent on Log of Per capita Income Growth (LPCIG), Log of Squared term of Per capita Income growth (LPCIG^2), which is added to equation to track the linearity of relationship between the income growth and per capita footprints of consumption, which implies, that squared term determines the turning point of the relationship. In other words, the response of consumption footprints per-capita to income growth per capita is observed through this squared termed, which provide the evidence of EKC.

scale effect to current nexus of Income Growth and Ecological Footprints. Current study indirectly indicates, that reallocation seems as a result of composition effect, where imports composition changes have been observed over time. Increasing income some time effects the demand patterns, which might be a movement toward dirty goods and this composition might also be sometime comprised of cleaner products as well. Nation's Ecological Footprints are drawn up by increasing bio capacity [12]Acer (2015). Pakistan Consumption Footprints are positively associated with Trade openness, which implies the theory of negative income effect. Which postulates, that trade increases income, which leads to higher consumption and Energy per capita and thus increase the ecological footprints of a nation? However, the relation between energy Per-capita and environmental pressure is statistically not significant in our estimation. Pakistan footprints are positively associated with increasing [13]Bio capacity and strongly significant. This effect has led by intensified agriculture and efficient utilisation of available resources as compared to past for specific products.

ARDL Bounds Test for Income Growth and Consumption Footprints

Here in this case the F Statistics value is greater than each critical bound value, especially the upper bound value. There is no need change the variables. It allows us to reject the null hypothesis and we proceed further to check the long run and short run relationship between these variables through ARDL Co integrating form as well as long Run form.

Table 3

Relationship between Income Growth Consumption Footprints

ARDL Bounds Test Sample: 1980–2015, Null Hypothesis: No Long-run Relationships Exist		
Test Statistic	Value	K
F-statistic	[14]12.03373	2
Critical Value Bounds		
Significance	I0 Bound	I1 Bound
10%	3.17	4.14
5%	3.79	4.85
2.5%	4.41	5.52
1%	5.15	6.36

[12]In this case economy has rich resource background and thus tries to utilise it for more development, which causes adverse environmental consequences in form of emission to the atmosphere.

[13]Bio capacities help us to produce more, which ultimately increase the supply of resources from nature. It can be done by the potential optimisation of bio capacity through regional planning of land use, specially, water resource management and arable land management. It also includes efforts of better resource management to gain higher marginal benefits. These efforts enhance our aggregate production and supply of food and other usable goods, which increases the ecological footprints in same direction.

[14]The F-Statistics is decision-making value, if it is less than upper bound value. It is inconclusive to reject the null hypothesis, that there is no long-run relationship. In this case, we often drop or we add some variable to model.

Table 4 shows long run coefficients of Income growth and its squared term are statistically significant, which validate the existence of Traditional EKC inverted U shaped relationship in Pakistan in long run. It is also noted that short run and long run coefficients are responding the same way but only current income growth in short run is insignificant to reallocate the footprints of consumption in Pakistan. In long-run current income growth and Squared term of Income growth have got the expected signs and strongly significant. Population growth shows positive but statistically insignificant impact on consumption ecological footprint. This implies Pakistan Consumption footprints are surprising but it is the resulting changes in combination of products consumed every year. Bio capacity in long run is highly significant and Pakistan Footprints do a quick reply to increasing bio capacity by positive significant sign. Now this plausible to think, what will be left to future generation? This is good for growth but it might be a doubt for sustainable development. In long run consumption, Per capita Ecological footprints of Pakistan does show any significant relationship with Energy Per capita but however the sign is positive, which means, increasing energy use is leading to high Ecological Footprints in future.

Table 4

Ecological Footprints of Consumption Per Capita Income Growth in ARDL Co-integrating and Long Run Form

Dependent Variable: Ecological Footprints of Consumption Per Capita, Selected Model:
ARDL (1, Sample: 1980–2015)
Short Run Coefficients Co-integrating Form

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(PCIGRW)	0.308122	0.558901	0.551299	0.5865
D (PCIGRW (–1))	–0.891535	0.382376	–2.331568	0.0284
D(PCIGRWSQ)	–15.065934	4.749748	–3.171944	0.0041
D(OTT)	2.466511	2.535393	0.972832	0.3403
D(POPG)	0.000158	0.000806	0.195852	0.8464
D(BC)	0.464024	0.097117	4.777988	0.0001
D(ENPC)	0.000038	0.000450	0.084028	0.9337
Coint Eq(–1)	–0.549348	0.103562	–5.304521	0.0000

Coint Eq = EFCPC – (3.7330*PCIGRW –27.4251*PCIGRWSQ + 4.4899 *OTT + 0.0003*POPG + 0.8447*BC + 0.0001*ENPC + 0.0967)

Long Run Coefficients

Variable	Coefficient	Std. Error	t-Statistic	Prob.
PCIGRW	3.732991	1.538742	2.426002	0.0232
PCIGRWSQ	–27.425130	11.525478	–2.379522	0.0256
OTT	4.489889	4.854778	0.924839	0.3643
POPG	0.000287	0.001449	0.198271	0.8445
BC	0.844682	0.196410	4.300613	0.0002
ENPC	0.000069	0.000825	0.083479	0.9342
C	0.096742	0.371365	0.260502	0.7967

5. CONCLUSION AND POLICY RECOMMENDATION

5.1. Conclusion

Our study found that Per capita ecological footprint of consumption and Income growth is significantly co integrated in long run and also provides the evidences regarding the EKC hypothesis. The imports products ecological footprints are smaller than footprints of products produced in Pakistan, which is good for us in terms of saving the biological productive space in Pakistan. It means if we produce same products in Pakistan, it will cost us higher resource use and extractions from our reserves. If these products are imported from other countries on reasonable economic transactions, it is possible that these products might help Pakistan to increase the welfare of increasing population in future. It is not only the income growth but also other economic indicators that might lead to deviating the patterns in environmental quality of Pakistan. Yet again our study has provided some evidences of EKC existence in Pakistan for disaggregated analysis through ARDL bound tests and co integrating technique. This study found that exports footprints of Pakistan is quite smaller than the imported footprints, which indicates that Pakistan is not a production based pollution driven country but a consumption based pollution driven economy. Pakistan is importing high of its consumption share in total ecological footprints from other countries in form of products. But for Pakistan evidences are supported by ground realities for observable and changing responses from one economic activity (agriculture sector) to another economic activity (industrial sector) from one kind of pollution to other kind of pollution.

5.2. Policy Recommendations

Consumption Footprints are reallocated by GDP growth in long run, which might be significantly reduced by deployment of environmental friendly technologies and inputs composition changed in the production process of under research products. So, it is required for policy makers and implementers to be aware of, the inputs used in production of commodities and standards of emissions allowed for a firm. Products with high resource requirements should be imported from countries, with specialisation in production of such products, it will help us to save biological productive space of our own economy for future generation. And it will increase our social welfare as of saving the environment and resources. It is very important to reduce the emission of garment making and tinning industries in Pakistan, which are putting higher environmental stress on hosting economy as well as the receiving economies for the products we export.

5.3. Limitations of the Study

(1) The per unit ecological footprints standards of all the products are not yet available easily, so that's the reason of including selected products of production, consumption and trade.
(2) The data of distance from port to port was not efficiently organised, distance is the temporary limitation of the study, it might be covered up in working paper if the data was convincing to use.
(3) Double counting is a limitation, which do not allow us to include all the products, which are included in consumption basket of consumers in Pakistan.

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