Overall and Sectoral Sustainability Analysis of Pakistan Economy through Genuine Savings

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Acronyms and Abbreviations

AEC = agricultural energy consumption

ANV = agricultural net value added

AV = agricultural value added

C = consumption

CO = Carbon monoxide

CO2 = carbon dioxide

CPI = consumer price index

CWP = costs of water pollution

D = *d*epreciation of produced capital plus *d*egradation of environment plus ***d***eforestation and ***d***epletion of natural resources

EE = expenditure on education

g = GDP growth = economic growth

G = government expenditure

GDP = gross domestic product

GDS = gross domestic savings

GHG = greenhouse gas

GS = genuine savings

IEC = industrial energy consumption

INV = industrial sector value added

N_2O = Nitrate

NMVOC = non-Methane volatile organic compound

PM10 = particulate matter

S = savings

SEC = service sector energy consumption

SNV = service sector net value added

V = value added

WDI = world development indicators

Y =NI = national income

Abstract

The study analyzes weak wealth sustainability of Pakistan's economy by sectors and overall from 1971 to 2012 through the impact of genuine savings and value added approaches. On average the overall economy is sustainable due to adequacy of national savings but not sustainable due to domestic savings. Genuine savings and value added both give the same estimates. Since savings are one of the most important components of the wealth accumulation, therefore the study also estimated saving function of the overall economy in order to identify the determinants of the function and thus the determinants of wealth accumulation. Vector error correction model has been specified for analysis of saving function.

The study also analyzes sectoral sustainability of the economy. The study categorizes the economy into three sectors; agriculture, industry and services. Sectoral savings data are required to check sectoral sustainability of the economy through the impact of genuine savings. The data are not available and it is difficult to decompose the overall savings series into the sectoral savings. Therefore, the study uses value-added approach to genuine savings to check the sectoral sustainability. The approach isolates the sector and provides comparison of the net value added along with the consumption of the economy/sector. The economy/sectors is/are sustainable when net value-added is greater than or equal to the consumption. The study uses D for all negative indicators of the economy/sector. Therefore D is the sum of all natural resource depletion and costs of air and water pollutions. The study derived the D and consumption for economy/sector and subtracted D from the value added of economy/sector to get what the study called genuine value added of the economy/sector.

The agriculture sector is not sustainable even in single period of the analysis; values of genuine savings are negative throughout the period of analysis and the values are increasing in negative

dimension with respect to time reflecting large depletion of the wealth. On average industrial sector of the economy is sustainable, genuine savings of the sector are negative from 1971 to 1972 and then 1977 and 1978 and positive in the rest of the years. Service sector of the economy is sustainable; the values of genuine savings of the sector are positive throughout the period of analysis.

The role of agriculture sector in national wealth accumulation is negative. The service sector contribution in national wealth accumulation is positive. The role of industrial sector on average over the period of analysis is positive.

The relationship between D and value added is positive in the long run but there is no short run causality running from value added to D in each sector.

Chapter 1: Introduction

1.1 Background

Gross Domestic Product (GDP) is used to measure economic performance of an economy. Increase in GDP per capita is desirable as it enables households to have more income to spend on consumption of goods and services. However, when GDP growth declines, there are a number of adverse economic impacts such as low consumption and savings.

Rapid economic growth and advance technology, industrialization, modern transportation and communication system, along with synthetic chemicals, pesticides and modern health facilities etc. are lead to a high standard of life on the one hand and environmental damages such as air and water pollution and natural resource depletion on the other hand.

GDP growth is imperative for the welfare of society but should not be at the cost of resources' depletions and negative externalities i.e. degradation of the environment. It serves as an indicator of economic successes but provides no information about sustainability of the successes because the costs of resource depletion, environmental damages and land degradation are being ignored in GDP estimates. Nordhaus and Tobin (1973) say, "The path of national economic success is not the same as that of national sustainable development".

Sustainability of an economy requires a technique/approach which incorporates all of the variables ignored in GDP estimates. The Genuine Savings (GS) technique/approach is used as an indicator of sustainable development which incorporates all variables being ignored in GDP estimates. The technique/approach analyzes the changes in the net wealth of a nation; the economy is only sustainable if the changes do not have any negative repercussions.

The change in value of economic assets is called genuine savings (GS). It measures the net annual increase or decrease in a nation's wealth. GS is an elaborate measure of sustainable development. It takes into account depletion of natural resources, degradation of environment and change in human capital in addition to the traditional measure of change in produced capital. GS has an advantage over other concepts of sustainable development because it explicitly formulates the growth and environmental trade-off. While presenting resource and environmental problems in such a way that policy makers are more aware of this issue. The economy highlights which exhibits high economic growth without considering the depletion of natural resources and degradation of environment may face problem of sustainability because of low rates of GS. Low rate of GS decreases the chance of wealth sustainability of an economy. Rate of GS can be used to measure wealth sustainability of an economy. If, the genuine savings is positive the economy is leaving more resources for future generations and the economy is on a sustainable developmental path while a negative GSI indicates unsustainability.

In short GDP growth is an indicator of economic success while GS gauges the sustainability of an economy as Hamilton (2002) says, "Growth theory provides the intellectual underpinning for expanded national accounting and, through the measure of genuine savings, an indicator of when economies are on an unsustainable development path". The approach- for sustainability of an economy- that ignores depletion of natural resources and negative externalities would over estimate welfare of the society. With passage of time, the gap between actual welfare and estimated welfare would be larger and larger because of the continuous extraction of natural resources. This would reduce the stock of natural resources, especially, non-renewable natural resources which reduce the natural wealth of the economy. The decrease in welfare from additional unit of negative externality would be greater from previous unit (diminishing marginal utility in case of economic goods).

1.2 Research Gap

Literature is available on weak sustainability of wealth for many economies at macro level but the author found no literature on sectoral sustainability of wealth neither strong nor weak sustainability of wealth for any economy.

1.3 Objective of the Study

The objective of the study is to analyze weak sustainability of wealth for Pakistan's economy by sectors and overall. The study uses the GS approach where savings are the basic component of the approach. Therefore, the study also aims to investigate the determinants of savings.

1.4 Contribution of the Study

The study makes the following contributions:

a) Sectoral sustainability analysis of the economy

b) Net value added approach and Theoretical Contribution

c) D-series

d) Water pollution Cost

Let explain the contributions one by one:

1.4.1 Sectoral Sustainability Analysis of the Economy

The main contribution of the study is the idea to analyze the sectoral sustainability of the economy. The study divides the economy into three sectors: agricultural, industrial and services. Sectoral sustainability analysis through GS faces two problems; non availability of sectoral savings data and second inter- linkage across sectors. To resolve these problems, the study has used a new approach to GS called 'Net Value-added Approach to genuine savings'.

1.4.2 Net Value Added Approach[1]

To overcome the two problems of non-availability of sectoral savings data and inter- linkage across sectors, the study developed net value added approach. The approach isolates the three sectors and thus solves the problem of inter-linkage across sectors. To resolve the problem of non-availability of sectoral savings data, the approach subtracts the sectoral consumption and D from value-added of the sector to estimate sectoral genuine value added and then adds investment in human capital to get sectoral GS.

Theoretical Contribution: The increase in non-negative genuine value-added sustains total wealth with non-decreasing welfare. Valente (2004) positive GS reflects positive variations in welfare and do not imply sustainability at given point in time since sustainability should be based on non-declining welfare in long run. Genuine value added is the net contribution of economic activity after production and consumption to national wealth. Any policy that sustains non negative genuine value added would also sustain welfare of the society.

1.4.3 D-series[2]

The study generated a variable D which is called D-series. There are two reasons to use this name; the components included are started from the alphabet 'D', and are negative indicators of wealth sustainability i.e. deforestation, depletion of natural resources, depreciation of produced capital and degradation of environment.

1.4.4 Water Pollution Cost[3]

The variable which has been included in this study is water pollution costs. The World Development indicators 2014 (WDI) has calculated the GS but did not include one of the D

[1] For detail, see section 3.3.1 of the study
[2] Detail of D is given in section 5.3.1 for overall analysis, section 6.12.1 for agricultural sector, 6.16 for industrial sector and 6.17.1 for service sector
[3] For detail see section 4.1.10 of the study

components i.e. 'water pollution cost'. The study used Lin and Hope (2004) method to estimate the variable for Pakistan's economy and has incorporated it in the estimate of GS.

1.5 Importance of the study

The main issue of the environmental sustainability is lack of understanding with respect to environmental degradation. To address this problem, the United Nation celebrates various days to create awareness among individuals about the importance of the environment. As a result of the United Nations Conference on environment and development in 1992, most Governments have recognized sustainable development as a main objective of national policies. More than 175 nations signed sustainable development agreements at the Conference. Governments made policies to achieve the goal. To this end, the Government of Pakistan adopted the National Conservation Strategy (NCS) in 1992. The World Bank supported implementation of the NCS for the period 1992-1999 through the Environmental Protection and Conservation Project.

Ahmad and Farooq (2010) Pakistan's economy is the most urbanized in the region but exposure to urban and industrial pollution is negatively affecting sustainability of wealth and welfare of the society. To meet the needs of growing population the extraction of natural resources such as energy, mineral and forest etc. has been increasing over time. The historical analysis of negative indicators of weak sustainability of wealth demonstrates that the extraction rate of natural resources and environmental damages from economic activities is increasing over time; the consumption of energy (crude oil, natural gas liquids, natural gas, coal, lignite, combustible renewable waste and primary electricity) is also continuously increasing since 1971 in Pakistan. As a result emissions of carbon dioxide have increased over time due to industrialization and mass transportation. Since 1971 CO_2 emissions have been increasing due to production and consumption processes of the economy. The waste materials produced by the textile industry have been decreasing since 1980 but from 1988 onwards they have started increasing which has led to air and water pollution. Only water pollution from the food industry is constant but it is higher than the textile industry. Organic water pollution is fluctuating and it is the highest in the metal industry while lowest in the clay & glass industry. Particulate matter is increasing over time. Similarly, deforestation is about ten times higher than the regional average. The consumption of forest resources has been increasing since 1971, after 2001 it has started increasing at an alarming rate but from 2009 there is a decreasing trend. Cost of CO_2, cost of particulate matter and cost of water pollution are increasing exponentially with over time. The depreciation of produce capital is also increasing at polynomial of degree two, near exponential. Depletion of energy resource is also increasing over time. Although mineral depletion is the smallest component of the negative indicators but from 2004 it is increasing at a higher rate.

The above paragraph highlights the negative externalities and natural resource depletion in Pakistan which reflect the importance of the issue. The study analyzed weak wealth sustainability of the economy- overall and sectoral- through GS. GS incorporates the negative externalities and resource depletion. GS plays a role in gauging the weak wealth sustainability of an economy. According to GS, sustainability of an economy, its savings and investment in human capital must be at a rate, which can offset depletion costs of natural resources, air and water pollution costs, costs of land degradation and the depreciation of produced capital. In Pakistan, the behavioral movements of the variables are different over time; such as upward trends in the savings rate and investment in human capital are positive indicators of weak wealth sustainability but increase in carbon dioxide emission, air and water pollution, natural resources depletion as well as an increase in depreciation of produce capital etc. are negative indicators of weak wealth sustainability. According to Valente (2005), positive current genuine savings do not rule out ‘genuine dis-savings’ in the future. Movements of negative indicators may outweigh movements of positive indicators; this implies that if the economy is currently on a sustainable development path, this may not continue in the future and vice versa. Therefore, currently weak wealth sustainability of the economy may become unsustainable in the future. Therefore a time series analysis is required to assess sustainability of an economy. The study uses a time series analysis of GS to understand the long run movement and short run dynamics of various variables and predict the weak wealth sustainability over time.

Savings are the basic ingredient of GS and weak sustainability of wealth. Negative externalities and depletion of natural resources decrease GS at a given level of savings. According to Khan et.al (1992) the savings rate in Pakistan is very low, both in absolute term and relative to other countries of the region, "it is even lower than that of some South Asian economies with lower per capita income".

1.6 Structure of the Study

Chapter two of the study is literature review, chapter three deals with the model, methodology and data. Important variables of the study are defined and described in chapter four. Chapter five estimates the savings function for the economy. The sustainability of the overall economy through GS and 'net value added approach' is also discussed in chapter five while chapter six discusses the sectoral sustainability of the economy and the last chapter present the conclusions and recommendations of the study.

Chapter # 2: Review of Literature

2.1 Literature of Sustainable Development and Genuine Savings

This chapter focuses on literature related to sustainable development, concept of genuine savings and savings function. There are different views about sustainable development. Pearce, Makandia and Barbier (1989) consider sustainable development to be a social and economic system which ensures that real income, education standards, the health of the nation and general quality of life are improving. However, they have ignored the depletion of exhaustible resources, the cost of which would be faced by future generations. The Brundtland Commission (1987) has tried to uncover the problems faced by future generation inherited from the present generation. The commission suggested that the sustainability of an economy is “Development that meets the needs of the present without compromising the ability of future generations to meet their own needs.” This implies a better quality of life for present and future generations. This definition imposes certain limitations on technology and socio-economic institutions; it contends that technology is only sustainable if it does not damage the environment beyond an acceptable level. Otherwise, this could affect future generations’ ability to fulfill their own needs. Holdgate (1993) suggests that sustainability of technology may be judged on the basis of whether it increases production, but does not cross environmental and other limits.

Pezzey (1989) believes that sustainable development is "a path along which utility does not exceed the maximum level that can be sustained forever by the economy". If utility is constantly above the maximum level then the economy is consuming the resources rightfully belonging to future generation while utility below the optimal level indicates that the performance of the economy is not efficient. Dasgupta (2001) believes that "A development path is sustainable if social welfare does not decline at any point along the path". Social welfare or utility of an economy would be sustainable if national consumption would not fall in the future. This implies that wealth of the nation would be maintained for the future generation. Hamilton and Hartwick (2005) in their paper state that sustainable development is the sum of the values of a heterogeneous set of assets (total wealth) which is equal to the present value of future consumption. If wealth of the nation directly or indirectly generates consumption (social welfare) of the economy then maintaining wealth of the nation has implications for sustainable development. This also implies that wealth of the nation will be maintained for the future generation. Hamilton et.al (2005) in a famous publication by the World Bank entitled, "Where Is the Wealth of Nation" consider sustainable development as "the process of maintaining wealth for the future generation". If total wealth is related to social welfare, then changes in wealth should have implications for sustainability. This is the basic intuition of Pearce and Atkinson (1993).

Therefore, sustainability of an economy can be judged from an analysis of change in wealth. . Pearce and Atkinson (1993), Hamilton and Ruta (2006) and Hamilton (1994) state that change in wealth or the real change in asset values of an economy is called Genuine Savings.

Hamilton et.al (2006) divided wealth into three categories, produced capital, human capital and natural capital; "Wealth of a nation consists of produced capital (buildings, machines, equipment and infrastructures) exhaustible resources, renewable resources, agricultural land and intangible capital (raw labor, human capital, social capital and quality of institutions)". The original approach of this principle was suggested by Irving Fisher in 1906 which stated that current wealth equals the present value of future consumption, and also identified two types of assets: movable assets or commodities and immovable assets such as land.

As mentioned in the first chapter, sustainability of a nation's wealth or of an economy's welfare cannot be judged from economic growth of the economy alone. Economic growth at the cost of assets (depletion of the resources and damages from the production and consumption process) would be illusory. Therefore growth of GDP is not an appropriate indicator for sustainability of an economy. A good indicator for sustainable development should account for the depletion of natural resources and environmental damages which should be subtracted from production of the economy. The concept of GS has been utilized to account for these damages and depletions and provides a better indicator for sustainability of an economy. As Hamilton (2002) says, "Growth theory provides the intellectual underpinning for expanded national accounting and, through the measure of genuine savings, an indicator of when economies are on an unsustainable development path". Therefore, GS is an appropriate tool to analyses sustainability of an economy.

Hartwick (1977) provided a rule for sustainability in resource dependent economies. The rule assumes that externalities are internalized through taxes and all resource rents are invested in produced capital. The rule says that a constant level of consumption can be sustained if the value of investment equals the value of rents on extracted resources at each point in time. This rule implies that if GS is set equal to zero at each point in time (that is, traditional net savings just equal resource depletion), then consumption can be maintained indefinitely, even in the face of finite resources and fixed technology. A negative GS implies that sustainability is rejected. Hamilton (2006) shows that this can be generalized to a rule that with constant positive genuine savings; such a rule will yield unbounded consumption.

Brow et.al (2003) to formulate a policy for sustainable development that a disaggregated GS analysis is required in order to understand the behavior of individual components of the indicator. Analog to this that a sectoral disaggregation is also imperative.

According to Lin and Hope (2004) the resource rich economy; United Kingdom is depleting natural wealth but the ratio of investment in produce wealth and human wealth to GDP is decreasing which depress the GS rate while Taiwan is doing well; the investment in produce wealth and human wealth is sufficient to offset the depletion of natural wealth. Johnson (2005) stated that the efficient utilization of natural resources is a basic factor in poor country for sustainable development and revenue from exhaustible resources should be reinvested efficiently and emphasized investment in human wealth. Lange (2004) found that Botswana reinvested rents from its exhaustible resource efficiently resulting in a remarkable increase in per capita wealth and Namibia did not adopt such policy and faced a decline in per capita wealth. Boos and Muller (2012) said that the slower economic growth of countries that rely on natural resources also has negative impact on GS. Boos (2015) viewed that genuine saving was the important indicator of weak sustainability. Controversial literature is also available on the validity of GS in long run and future perspective such as Ferreira et.al (2008) said that GS can be used as a signal of future consumption paths if and only if the estimates include adjustments for natural resource depletion. Hanely et.al (2014) concluded that genuine savings can be adjusted for growth in population, technical change and international trade, assuming a competitive framework. Valente (2008) stated that current positive GS are delivering false massage if a test of limiting condition in the capital-resource growth model is empirically rejected. Sato et.al (2012) Test sustainability from GS reflected future sustainability by simulating future paths of genuine savings. Thus the countries that were considered sustainable from observed paths were not sustainable from future sustainability's perspective. Ferreira et.al (2008) used panel data for sixty-four developing countries to test the adjustment effects of population growth that have considerable impact on estimates of genuine savings.

Pillarisetti and Bergh (2008) found that Fiji is at the top of GS rate chart with 38.6% and Chad at the bottom with -58.4% and the United States GS rate is 3. Hamilton and Clemens (1998) estimated GS rate for Pakistan economy: in 1970s the average rate was 3.5% similarly in 1980s the average rate was 5.4%, in 1990, 1991, 1992 and 1993 the rates were 3.8%, 1.6%, 5%, 4.7% respectively. McLaughlin et.al (2012) estimates GS for Britain; they found that GS was positive over 250 years which was consistent with improvements in well-being.

2.2 Literature of the Determinant of Saving's Function

There are two types of the determinants of savings function; economic factors and demographic factors. The economic factors include income, real interest rate, inflation, government expenditure and net foreign capital inflow. For demographic factors the study only includes dependency ratio since most of the literature given below identifies dependency ratio as a statistically significant factor affecting savings of the economy. Following is the literature on the determinants of saving's function.

2.2.1 Economic Factors

The Following economic factors affect the savings behavior of the economy.

2.2.1.1 Income and Growth

Income and growth are statistically significant determinants of household and corporate savings in an economy. Testing for the permanent income hypothesis, Qureshi (1981) found that income (the transitory and permanent income) and growth of income were highly significant determinants of household savings and the propensity to save from transitory income was higher than the propensity to save from permanent income. The marginal propensity to save in rural household was higher than their urban counterparts. Khan and Nasir (1998) found the same results.

Similarly Siddiqui and Siddiqui (1993) found that income was a significant determinant of the level of household savings and of the household average savings ratio. Growth rate is also a statistically significant determinant of corporate savings. Iqbal (1993) and another study by Nasir and Khalid (2004) found that the McKinnon[4] effect is valid in the economy because high income led to high savings. Qureshi (1981) also supports the McKinnon effect.

Economic activities generating income have statistically significant impact on private savings of the economy. Vincelett (2006) found that changes in economic output are statistically significant determinants of private savings in Pakistan.

The theoretical and empirical discussion specified that income and growth are the determinants of savings functions.

[4] For detail see chapter # 5, section 5.1

2.2.1.2 Real Interest Rate and Inflation

Real Interest rate and inflation both are significant determinants of household and corporate savings behavior in the economy. Qureshi (1981) found that the real rate of interest on financial assets such as bank deposits was found to exercise a strong effect on household savings. In addition to household savings, corporate savings behavior is also affected by real interest rate. Iqbal (1993) found that real interest rate was an important factor which affected corporate and household savings. Vincelett (2006) contended that the real interest rate on deposits significantly affects the savings rate in Pakistan.

According to the available literature, inflation affects both corporate and household savings behavior of the economy. Qureshi (1981) found that inflation was inversely related to household savings. Iqbal (1993) found that expected inflation affected corporate and household savings negatively.

2.2.1.3 Foreign Capital Inflow

Net foreign capital is also an important factor which affects savings behaviors in the economy. According to Iqbal (1993) net foreign capital inflow is an important determinant of public savings while worker remittances are important for the household sector. Khan and Rahim (1993) found that foreign loans are significant for domestic savings. Ahmad and Ahmed (2002) found the validity of 'substitution hypothesis' and rejected the 'complementary hypothesis', and argued that foreign capital is in fact is a substitute for domestic savings. Therefore, there is an inverse relationship between foreign capital and domestic savings**.** Mahmood and Qasim (1992) found a minimal substitution effect of foreign capital on domestic savings under IS policy and concluded that there would always be a weak adverse effect of foreign capital inflow on domestic savings under the policy but its adverse effect on public savings is statistically insignificant. Nasir and Khalid (2004) found the validity of complementary hypothesis and rejected the substitution hypothesis.

2.2.1.4 Fiscal Factors

There are mixed results in literature about Ricardian Equivalence for the economy. Nasir and Khalid (2004) say that there is no Ricardian equivalence[5] in Pakistan‘s economy as the savings are not significantly affected by the budget deficit but Kazmi (1993) finds that defense spending affects savings negatively.

2.2.1.5 Demographic Factors

As mentioned above, the impact of demographic factors on savings rate in Pakistan is a controversial issue. Leff (1969) found a significantly negative impact of dependency ratio on household savings. Similarly Burney and Khan (1992) found the same result for Pakistan‘s economy. Siddiqui and Siddiqui (1993) found that the dependency ratio was an important determinant of household savings behavior and Iqbal (1993) found the same result.

Faruqee and Husain (1994) and Husain (1995 and 1996) found that due to demographic shifts the overall structure of the population remained unchanged and the dependence ratio did not affect savings behavior.

[5] For detail see chapter # 5, section 5.1.

Chapter # 3: Theory and Methodology

The chapter deals with theory of sustainable development, formal model of GS, methodology, hypothesis and econometric model applied in the study. Let us first discuss theory of sustainable development:

3.1 Theory of Sustainable Development

Sustainable development indicates economic development; it also includes improvement in the environment which is beneficial not only for the present but also for future generation(s). Therefore, the cost of development should not be transferred to the future generation. Economic theories deal with the efficient use of scarce resources and the substitution of one resource for another to maximize welfare of the society. The traditional growth theories are based on savings, knowledge and/or technology but ignore the depletion of natural resources and negative externalities from economic activities. The process of using and consuming scarce resources should be based on a system which minimizes negative externalities and resources should not be exhausted before a reasonable time period. The economic activities may transfer the cost of development (natural resources depletion and negative externalities) to future generation(s). In other words economic growth without considering natural resources' depletion and negative externalities is development at the cost of future generation(s). For sustainability analysis, a model is required that also incorporates negative externalities and natural resource depletion. Hamilton et.al (2005) in a famous publication, entitled "Where Is the Wealth of Nation" addressed the issue and developed a technique of GS. They consider sustainable development as "the process of maintaining wealth for the future generation" rather than sustaining economic growth. Therefore, sustainability of an economy can be judged from the analysis of change in wealth.

Social welfare of an economy should be measured as the present value of future wellbeing or consumption which is reflected in the measurement of wealth, therefore any change in wealth provides important information about the welfare of society. Thus, the sustainability of welfare of the society is equivalent to sustainability of wealth of the economy or maintaining wealth for future generations, and the sustainability of an economy can be judged from the analysis of wealth and change in wealth. Change in wealth is called Genuine Savings, derived by Pearce and Atkinson (1993) and Hamilton (1994).

An economy's social welfare could be sustained if the economy's per capita consumption remains constant in the future and the environmental quality does not deteriorate. Social welfare sustainability analysis reflects long-term living standards of the society. According to the Solow model savings rate is an important determinant of the long run living standard; a higher savings rate carries the potential of a good living standard in the long run. Steady-state of an economy reveals living standard of the economy. A higher steady-state indicates a higher living standard. A rise in savings rate helps the economy progress from a lower steady-state to a higher steady-state. In short, savings is an important determinant of living standard in the long run. Once a higher steady state living standard is achieved by an economy, genuine savings model provides a gauge for measuring the living standard sustainability. According to the model more savings and investment in human capital increase the chances of the living standard's sustainability while negative externalities i.e. air and water pollution and depletion of natural resources etc. negatively affect sustainability.

3.2 The Model

Genuine savings model is developed on the basis of the following assumptions:

3.2.1 Assumptions of the Model

Following are the assumptions of the model:

3.2.1.2 The Agents are Rational

The model of genuine savings assumes that rational agents have perfect information; households maximize utility and firms maximize profit while the objective of social planners is to maximize social welfare. These assumptions imply that the rate of extraction of natural resource is optimal and there is no inefficiency in the economy.

3.2.1.3 Constant returns to scale

The model of genuine savings assumes that technology exhibits constant return to scale. This implies that'‘t’ time’s change in all inputs leads to‘t’ time’s change in output where‘t’ not equal to zero.

3.2.1.4 Weak Sustainability

Maintaining the value of total wealth is called weak sustainability which assumes that produce capital is the substitute for natural capital. Maintaining the value of natural resources is known as strong sustainability. The model assumes that failure of weak sustainability is the inverse of maintaining the value of total wealth for future generation(s). The economies that fail to hold weak sustainability are also failing to meet the criteria for strong sustainability because natural resources are being depleted and converted to produce resources.

3.2.1.5 Closed economy with single resource

The model assumes that there is a single resource in a closed economy. The assumption is specific with the formal model of genuine savings developed by Hamilton et al (2006).

The resource may be used as an input of the production of a commodity that may be consumed, invested in produced assets or human capital, or used to abate pollution, so that:

$$F(K, R, H) = C + \dot{K} + EE + a \text{ .... eq.(1)}$$

In eq (1), F(K, R, H) is production function of the economy. K and H are physical capital input and human capital input of the production function respectively, while, R is the resource used as input in production function. Labor is assumed to be given; therefore it is excluded from the production function. The production function converts inputs into output. The output as the end result of production function which may be consumed and is named C, or may be invested in produced assets (that changes stock of the produced capital K) or human capital (that changes stock of the human capital H) or used to abate pollution ‘a’. Therefore, output of an economy is equal to consumption of the household plus investment in produced capital plus investment in human capital plus expenditure to abate pollution.

For simplicity the model assumes that only expenditure on education causes change in human capital stock of the economy. Therefore, change in human capital is based on the function of investment in human capital or expenditure on education.

$$\dot{H} = q(EE) \text{ .... eq.(2)}$$

Change in human capital stock $\dot{H}$ is positively related to expenditure on education EE. Increase in EE increases H and vice versa.

Economic activities (production function F, given in eq.(1)) produce negative externalities such as air and water pollution which damage the environment; in turns it affects human health and other beneficial organisms. The model also incorporates negative externality for economic activities, the cost of which would be faced by current as well as future generation(s). Under the given technology, the stock of pollution X is directly related to pollution emissions 'e' while inversely related to abatement (mitigating and averting) activities 'a' and natural dissipation 'd'.

$\dot{X} = e - d(X)$ ……………………………………..eq.(3)

Where e = e(F,a)…………………………………eq.(3)′

In eq.(3)′ the pollution emissions are a function of production F and abatement a. in eq.(3) $\dot{X}$ the change in pollution accumulation stock is the difference between emissions 'e' and natural dissipation of the stock. The higher pollution stock leads to more environmental damages and lower environmental services per unit of damage.

Environmental services 'B' are negatively related to the size of the pollution stock, so that

B = α(X), $\alpha_x < 0$ ………………………………eq.(4)

The renewable resources are assumed to be produced without any cost. The change in renewable resource stock is equal to the difference between growths 'g' and harvesting 'R' of the resource. While in case of exhaustible resources, change in its stock depends on extraction 'R' only, since the growth is zero. Thus:

$\dot{S} = g(S) - R$ ………………………………..eq.(5)

Where: S is the stock of renewable and exhaustible resources, g(S) is the growth of renewable resource and R is the harvesting of both renewable and exhaustible resources.

A renewable resource is depleted when harvesting is higher than the growth of the resource. Therefore, the difference between growth 'g' and harvesting 'R' of renewable resource reflects the change in the stock of resource $\dot{S} = g(S) - R$. Since the growth of exhaustible resource is zero, therefore, its depletion is estimated from its extraction ($\dot{s}$ = -R)

Under a fixed pure rate of time preference ‘r’ the consumers derived utility from the consumption of commodity ‘C’ and environmental services ‘B’. The utility function of the society is given below:

U = U(C, B) …………………………………..eq.(6)

Pezzy (1989) defined sustainable development as “a path along which utility does not exceed the maximum level that can be sustained forever”. Similarly, Irving Fisher in (1906) says that current wealth is equivalent to the present value of future consumption. Irving Fisher’s argument specifies the objective function of the model and Pezzy’s definition would lead us to maximization of the objective function as given below.

Wealth V is the present value of utility on the optimal path. A social planner then wishes to maximize wealth as follows:

$$\max V = \int_t^{\infty} U(C,B)e^{-r(s-t)} ds \quad \text{……………..eq.(7)}$$

Subject to

$$\dot{K} = F - C - a - EE, \ \dot{X} = e - d, \ \dot{S} = g - R, \ \dot{H} = q\,(EE)$$

Eq.(7) is the objective function and eq.(1), eq.(2), eq.(3) and eq.(5) are the constraints. Applying the current value Hamiltonian function results in the following eq.(8);

$H = U + P_k(\dot{K}) + P_x(\dot{X}) + P_s(\dot{S}) + P_h(\dot{H})$, …………….eq.(8)

Where

P_k = shadow prices of capital

P_x, = shadow prices of pollution

P_s, = shadow prices of resources

P_h = shadow prices of human capital

Deriving the static first-order conditions for a maximum, the Hamiltonian function may be written as:

$H = U(C,B) + U_c(\dot{K} - (1 - b_{eF})F_R(R - g) - b(e - d) + h/\dot{h})$……………(9)

The parenthesized expression in the second term of the above expression is equal to the change in real value of total assets. Natural resources are valued at the resource rental rate. In eq.(9), the term b_{eF} is the effective tax rate on production. Pollution stocks are valued at marginal abatement costs; b is the marginal cost of pollution abatement, which equals the marginal benefit of abatement at the optimal level. Human capital is valued at its marginal creation cost; 1/h is the marginal cost of creating a unit of human capital.

This expression serves to define genuine savings, GS as:

$GS = \dot{K} - (1 - b_{eF})F_R(R - g) - b(e - d) + h/\dot{h}$……………. (10)

For non-living resources, the term in growth g can be dropped from the expression (10), while for cumulative pollutants the term in dissipation d can be discarded.

Genuine savings consist therefore of investment in produced assets and human capital, while subtracting the value of depletion of natural resources and the value of accumulation of pollutants.

Finally, it is important to present the formula for calculating genuine savings from real data. For produced asset depreciation δK, resource rental rate n, and marginal social cost of pollution σ are given by:

$GS = GDP - C - \delta K - n(R - g) - \sigma(e - d) + EE$ ……………………..eq.(11)

Here GDP - C is traditional gross savings, which include foreign savings, while GNP - C - δK is traditional net savings. Current education expenditures 'EE' are essentially reclassified from consumption to savings. Depreciation of human capital also does not appear in this formula, since it biases the savings estimates upward.

3.3 Methodology of the Study

The following formula needs to be applied to estimate GS for overall economy. If the result is non-negative then the economy is on a sustainable development path.

Genuine Savings = Gross Domestic Savings – Consumption of Fixed Capital (Depreciation) + Education Expenditure – Air Pollution Costs – Water Pollution Costs – Depletion of Nonrenewable Natural Resources – CO_2 Damage Costs.

The GS approach cannot be used to analyze sectoral sustainability of the economy because of non-availability of data related to sectoral savings. Therefore, net value-added approach was derived for GS and this approach was used to analyze sectoral sustainability of the economy. Following is the derivation of net value-added approach from GS:

3.3.1 Net Value-Added Approach to Genuine Savings

Non-negative genuine value-added implies non-negative genuine savings which in turn implies the weak sustainability of the economy. Genuine value-added is equal to gross value-added less D less consumption plus investment in human capital. The increase in non-negative genuine value-added sustains total wealth with non-decreasing welfare. Following is the derivation of net value-added technique.

Let

D is the sum of all depletion costs, depreciation of produced capital, damages from emissions and degradation. D covers all the negative indicators of the economy's wealth sustainability such as air pollution costs, water pollution costs, and depletion of nonrenewable natural resources, CO_2 and PM10 damages and depreciation of produced capital.

GDS = Gross domestic product (GDP) – consumption (C) …………………..eq.(12)

Then

Genuine savings are the gross domestic savings and investment in human capital less sum of the all negative indicators:

GS = GDS + EE – D………………………………….eq.(13)

Substituting eq.(12) in eq.(13) results in eq.(14)

GS = (GDP – C) + EE – D ………………………eq.(14)

Positive GS reflects wealth accumulation and weak wealth sustainability. The Hartwick rule of zero GS also says that the economy's wealth is sustainable.

C = GDP + EE – D ……………………………………….eq.(15)

Eq.(15) is corresponds to Hartwick rule: GS = 0.

Reference to eq. (15); let V = GDP – D

Then

C = V + EE ---------------- (16)

Where: V is net-value-added

Interpretation of eq.(16): If consumption is equal to 'the net value-added 'V' plus education expenditure EE' then GS would be Zero and according to Hartwick rule the economy would be sustainable. It should be kept in mind that Equation (16) is based on the Hartwick rule of zero genuine savings.

The wealth of an economy would also be sustained weakly, if genuine savings are positive. Positive genuine savings imply that the economy is leaving more resources for future generations.

For positive GS

$C < V + EE$………………………………….. (17)

Interpretation of eq.(17); if consumption is less than 'the net value-added 'V' plus education expenditure EE of the economy' then GS would be positive and the economy's wealth would be sustainable.

For Hartwick rule eq.(16) and positive GS eq.(17)

$C \leq V+EE$ ………………………………………(18)

Eq.(18) is the combination of eq.(16) and eq.(17). If eq.(18) holds for an economy then the wealth of the economy would be sustainable, otherwise it would not be sustainable. According to net value added approach; the value of the assets of an economy would be sustained if economy consumes only its net value- added.

The study has tested the following hypotheses under the above model and methodology:

3.4 Hypothesis

Ho: $GS \geq 0$ the economy is sustainable

Ha: $GS < 0$ the economy is not sustainable

Using net value-added approach the hypothesis would be:

Ho: $C \leq V+EE$ the economy is sustainable

Ha: C > V+EE the economy is not sustainable

For sectoral sustainability the hypotheses are given below:

Ho: $C_i \leq V_i+EE_{ia}$ i^{th} sector is sustainable

Ha: $C_i > V_i+EE_{ia}$ i^{th} sector is not sustainable

3.5 Econometric Model

The study applied vector error correction mode to estimate savings function and D-functions of the study. The model captures both the short run and long run causalities. The study tested both the causalities and derived the long run coefficients from the model.

3.5.1 Procedure

The study first checked the stationarity of the time series. Since the order of integration of the variables is not same. Therefore, the ARDL co-integration test and vector error correction model have been applied to derive the long run coefficients and coefficient restriction test for short run causalities. The model diagnostic tests have also been applied.

3.6 Estimation of Variables

3.6.1 Water Pollution Cost

The data of water pollution are available from 1971 to 2006 in global development indicators. From 2007 to 2012 data have been extrapolated. But the study needs cost of water pollution. To calculate cost of water pollution, the study used the following method by Lin and Hope (2004).

$$CWP = P \times \Delta x \times WPI \times Pop \times CPI$$

Where:

CWP = cost of water pollution

$P \times \Delta x$ = house hold willingness to pay

WPI = water pollution index

Pop = yearly population of the economy

CPI = consumer price index

3.6.2 Particulate Matter

The data of particulate matter are available from 1990 onward. The study used trend extrapolation backward to estimate the missing data from 1971 to 1989. Since the series exhibits exponential trend.

Chapter # 4 Variables and Data

The chapter deals with important definitions and descriptions of the variables used in the study. The chapter also deals with the construction of variables and their methodologies. The data and source of the data are also mentioned in the chapter.

4.1 Definition and Description of Important variables

Many variables have been used in the study. Some variables affect the weak wealth sustainability of the economy positively and some negatively. These variables are defined and analyzed below:

4.1.1 Savings

The savings are defined as the difference between national income Y and public and private consumption C (S = Y – C). The study has taken gross domestic savings (GDS) variable from world development indicators (WDI (2014)) for savings. The definition of GDS in WDI is, "Gross domestic savings are calculated as GDP less final consumption expenditure (total consumption)". The variable has been adjusted for inflation at current prices as the study divided GDS by current consumer price index (CPI) for computing time series of real savings. The nominal savings are increasing with respect to time with deviations of around Rs. 491.32 billion over the average value of Rs. 403.93 billion. Therefore, the economy on average saves Rs. 403.93 billion each year. The maximum savings were Rs. 1665.86 billion in 2011 while the minimum savings were Rs. 4.85 billion in 1972. [see 'Fig 4.1a' and 'Table 4.1a'; given in the appendix to the chapter].

On average, the real savings of the economy for each year were Rs. 3.69 billion over the period 1971 to 2012. Maximum real savings were Rs. 14.88 billion in 2011. Similarly, minimum real savings were Rs. 0.043 billion in 1974. The deviations in real savings are Rs. 4.45 billion which is less than the deviations in nominal savings. [see ‘Fig 4.1b’ and ‘Table 4.1b’; given in the appendix to the chapter].

4.1.2 Income

Inflation adjusted income at current prices has been used as proxy for real income. The GDP data are available in WDI (2014). The study used the GDP as the sum of gross value added in all sectors of the economy and then adjusted it for inflation which is equivalent to the inflation adjusted sum of all factors’ income. In other words, the study has taken ‘the inflation adjusted sum of gross value added by all resident producers in the economy’ as real income for the analysis.

The average annual real income of the economy is Rs. 44.77 billion with dispersion of 22.88 billion over the period of analysis. The minimum annual real income was Rs. 14.21 billion in 1974 and the maximum was Rs. 87.21 billion in 2012. There is upward trend in the series with comparatively high deviations from 2007 to 2010 and comparatively low deviations from 1981 to 1991.[see Fig 4.2 and Table 4.2, given in the appendix to the chapter].

4.1.3 Inflation

Inflation has led to a persistent rise in price level of an economy. It is a flow variable while its corresponding stock variable is price level. Percentage change in price level is called inflation π; ($\pi = \Delta P$ %). There are two series available to measure inflation in the economy; consumer price index CPI and GDP deflator. The study has taken CPI inflation at base year 2000 as a variable of inflation from WDI 2014.

The series has no trend. It is fluctuating over 9.45 percent with dispersion of 5.35 percent. There are two outliers: one is 26.66 percent in 1974 which is also maximum value of the series and second is 20.29 percent in 2008 which is the second biggest inflation year. The minimum inflation occurred in 2003 increasing at the rate 2.91 percent. [see Fig 4.3 and Table 4.3, given in the appendix to the chapter].

4.1.4 Interest Rate

The real interest rate is defined as nominal interest rate less expected inflation. The real interest rate can be deduced by subtracting the current inflation from lag nominal interest rate. The study has taken discount rate as a nominal variable from State Bank of Pakistan (SBP) statistical bulletins and the CPI inflation from WDI 2014. The gap between discount rate and CPI inflation is the definition of real interest rate of the study.

There is no trend in the series; the series is fluctuating over the average value of 1.42 % with dispersion of 5.69%. The minimum value of the series was -15.66% in 1974. The reason for this is the hyperinflation in the same period. While the maximum value of the series was 10.27% in 1998. [see Fig 4.4 and Table 4.4, given in the appendix to the chapter].

4.1.5 Dependency Ratio

The variable of dependency ratio has been taken from WDI 2014. The source defines the variable as, "Age dependency ratio is the ratio of dependents--people younger than 15 or older than 64--to the working-age population-- ages 15-64".

The series has a slight upward trend from 1971 to 1992 then exhibits fluctuations over the trend line. The maximum dependency ratio occurred in 1992 at the rate 90.33 percent and after then displays a decreasing trend. The series ended at the minimum dependency ratio of 63.08 percent in 2012. [see Fig 4.5 and Table 4.5, given in the appendix to the chapter].

4.1.6 Foreign Capital

The study has used real net transfer from abroad as a proxy for foreign capital inflow. The variable of current net transfer from abroad is available in WDI (2014). The study adjusts the current net transfer from abroad for inflation and the resultant variable has been considered as real net transfer from abroad. WDI (2014) defined the variable as, “Current transfers comprise transfers of income between residents of the reporting country and the rest of the world that carry no provisions for repayment. Net current transfers from abroad are equal to the unrequited transfers of income from nonresidents to residents minus the unrequited transfers from residents to nonresidents”. Net income includes net labor income and net property and entrepreneurial income components of the SNA. Labor income covers compensation of employees paid to nonresident workers. Property and entrepreneurial income covers investment income derived from the ownership of foreign financial claims (interest, dividends, rent, etc.) and non-financial property income.

The annual average real net transfers are Rs. 3.23 billion with dispersion of Rs. 2.43 billion. There is an increasing trend from 1971 up to 1983 and it starts declining and becomes Rs. 2.6 billion in 1996 then again starts increasing till 2003. After 2003, the series shows large fluctuations. The maximum real net transfer from abroad were Rs. 11.23 billion in 2008 and the minimum was Rs. – 0.16 billion in 2011. [see Fig 4.6 and Table 4.6, given in the appendix to the chapter].

4.1.7 Depreciation of Produced Capital

Depreciation of produced capital represents the replacement value of physical capital used up in the process of production. It includes the costs of capital that physically wears out as well as capital that is scraped during the period of one year. The data of the variable have been taken from WDI (2014). The source defined the variable as, “Consumption of fixed capital represents the replacement value of capital used up in the process of production”. The data have been adjusted for inflation.

The annual real depreciation of produced capital is Rs. 2.35 billion with average dispersion Rs. 2.95 billion. Polynomial of degree three explains the trend in the series better than other trends. The minimum real depreciation of produced capital is Rs. 0.04 billion in 1971 which is the starting period of the series and maximum is Rs 10.18 billion in 2012, the end period of the series. [see Fig 4.7 and Table 4.7, given in the appendix to the chapter].

4.1.8 Carbon Dioxide CO2

Carbon dioxide emissions from production and consumption processes include carbon dioxide produced during the burning of fossil fuels, the manufacture of cement, consumption of solid, liquid, and gas fuels and gas flaring. But the study needs the variable of CO2 damages in monetary terms. The data of CO2 damages are available in WDI 2014. The damages from CO2 have been estimated by the source as, "Carbon dioxide damage is estimated to be $20 per ton of carbon (the unit damage in 1995 U.S. dollars) times the number of tons of carbon emitted". The series has been taken form the mentioned source and converted into local currency and then adjusted for inflation.

The trend in carbon dioxide damages is increasing from 1971 and after 1975 it is increasing at an accelerated rate. Consequently, the damages from CO2 are also increasing at higher rate. Polynomial of degree three better explains the trend in series better than other trends. The average annual real damage from CO2 are Rs. 0.2869 billion with dispersion of 0.3875 billion. The maximum real damage from CO2 was Rs. 1.4363 billion in 2012 and the minimum was Rs. 0.0015 billion in 1971. [see Fig 4.8 and Table 4.8, given in the appendix to the chapter].

4.1.9 Particulate Emissions Damage

The variable of particulate emissions damage is available in WDI. The study has taken the variable from this source. The source estimated the variable as, "Particulate emissions damage is the damage due to exposure of a country's population to ambient concentrations of particulates measuring less than 2.5 microns in diameter (PM2.5) as well as indoor concentrations of air pollution in households cooking with solid fuels. Damages are calculated as productivity losses in the workforce due to premature death and illness".

4.1.9.1 Extrapolation of missing values

The data of PM10 is available from 1990 onwards but the analysis requires the data from 1971 onwards. To estimate the missing observations from 1971 to 1989; the study extrapolated the exponential trend of the series backward.

The exponential trend explains the trend in the series better than other trends. The annual average real particulate emissions damage is Rs. 1.06 billion with average annual dispersion of Rs. 1.1788 billion. The maximum damage is Rs. 4.978 billion in 2012 and the minimum is Rs. 0.0889[6] billion in 1971. [See Fig 4.9 and Table 4.9, given in the appendix to the chapter].

4.1.10 Water Pollution Cost

Water pollution consists of contamination of water bodies such as oceans, lakes, rivers and groundwater caused by anthropogenic behavior, which can be destructive to organisms in water bodies. It occurs when pollutants are discharged into the water bodies without any treatment. The data of water pollution costs are available from 1971 to 2006 in global development indicators (GDI). The study did not find data from 2007 to 2012. The study extrapolated the data. The data of water pollution are available but the study needs the cost of water pollution. To estimate the cost of water pollution, the study used Lin and Hope (2004) method.

They have used the following formula to estimate water pollution cost faced by the society.

1. Forecasted Value.

$CWP = P \times \Delta x \times WPI \times Pop \times CPI$

Where

CWP = cost of water pollution

$P \times \Delta x$ = house hold willingness to pay

WPI = water pollution index

Pop = yearly population of the economy

CPI = consumer price index

The value of $P \times \Delta x$ (household willingness to pay) is not available in Pakistan. It needs to be investigated via survey method for future reference. A survey conducted by GALLup (2008) for Sindh province is available and the study used the data of that survey as proxy for the whole economy. The survey was conducted in New Sukkur, Sukkur, Rohri, All Talukas and Khairpur. Mean WTP for improved water services (Rupees per Month) are given in the Table 4.10.1 below

Table 4.10.1: Willingness to Pay

All Talukas	524.25
Sukkur	603.91
New Sukkur	247.36
Rohri	501.5
Khairpur	423
Average	460.004

Table 4.10: Water Pollution Cost

Mean	0.317448
Median	0.106274
Maximum	1.78294
Minimum	0.004112
Std. Dev.	0.437762
Observations	42

The Table 4.10.1 shows willingness to pay for water services in five different cities of Sindh province. To estimate annual willingness to pay for the economy the average of the five values was multiplied with 12; the result was Rs. 5520.048: the annual willingness to pay for the economy. The willingness to pay was adjusted for inflation. The real willingness to pay for year

2008 was multiplied with CPI base 2008 to generate nominal willingness to pay for each year. Then the nominal willingness to pay series readjusted for inflation and the series divided by current CPI. Then the Lin and Hope (2004) formula was used to estimate the water pollution costs.

There is an exponential trend in the series of water pollution costs. The above Table 4.10 shows the descriptive statistic of the series. The annual average real water pollution cost is 0.3174 billion with average annual dispersion of 0.4378 billion. The maximum real water pollution cost was 1.7829 billion in 2012 and the minimum was 0.0041 billion. The graph of the series is given in Fig 4.10 in appendix to the chapter.

4.1.11 Deforestation

The data of deforestation have been taken from WDI 2014. The source defined the deforestation as, "Net forest depletion is calculated as the product of unit resource rents and the excess of round-wood harvest over natural growth". The data have been converted into local currency and also adjusted for inflation and termed as real deforestation.

The average annual real deforestation is Rs.0.3136 billion with annual average dispersion of Rs. 0.48 billion. The maximum real deforestation was Rs.1.9569 billion in 2011 and the minimum was Rs. 0.0026 billion in 1971. [See Fig 4.11 and Table 4.11, given in the appendix to the chapter].

4.1.12 Depletion of Energy Resources

Depletion of energy resources is defined as product of unit resource rents and the physical quantities of energy extracted. It covers coal, crude oil, and natural gas. "Energy production refers to forms of primary energy--petroleum (crude oil, natural gas liquids, and oil from non-conventional sources), natural gas, solid fuels (coal, lignite, and other derived fuels), and combustible renewable and waste--and primary electricity, all converted into oil equivalents" WDI 2014. To derive real depletion of energy resources, the data have been converted into local currency and adjusted for inflation.

The moving average of period two explains the trend in the series better than other trend lines. The average annual real depletion of energy resources is 0.9769 billion with average annual dispersion of 1.56 billion. The maximum real depletion of energy resources was 5.285 billion in 2008 and the minimum was 0.0009 billion in 1971. [See Fig 4.12 and Table 4.12, given in the appendix to the chapter].

4.1.13 Mineral Depletion

Mineral depletion is defined as the product of unit resource rents and the physical quantities of mineral extracted. It covers tin, gold, lead, zinc, iron, copper, nickel, silver, bauxite, and phosphate etc. **in Pakistan** the extraction of some minerals is increasing such as bauxite, iron ore and lime stone etc, and some minerals show fluctuations over a gradual upward trend of extraction such as fair clay, gypsum Anhydrite, chromite, soap stone etc. While the extraction of some minerals show fluctuation over a stationary mean such as coal, Aragonite, fuller earth, Magnetite, Rock salt etc. mineral depletion covers the costs of all the above mentioned minerals. The data of mineral depletion have been taken from WDI 2014. The data have been converted into local currency and adjusted for inflation.

The average annual real mineral depletion is Rs. 0.0084 billion with average annual dispersion of Rs. 0.0197 billion. The maximum real mineral depletion was Rs. 0.782 billion in 2011 and the minimum was almost zero in the stated periods of the analysis. [See Fig 4.13 and Table 4.13, given in the appendix to the chapter].

4.1.14 Gross Domestic Product

The Gross Domestic Product is the market value of all final commodities produced within an economy in a specific time period. The study has taken the data of GDP from WDI 2014 and adjusted it for inflation. The source estimated the variable as. “GDP at purchaser's prices is the sum of gross value added by all resident producers in the economy plus any product taxes and minus any subsidies not included in the value of the products”.

The trend of the real GDP (inflation adjusted GDP) is growing exponentially. The annual average real GDP is Rs.31.923 billion with average annual dispersion of Rs.45.69 billion. The maximum real GDP of the economy was Rs.182.76 billion in 2012 and the minimum was Rs.0.482 billion in 1971. [See Fig 4.14 and Table 4.14, given in the appendix to the chapter].

4.1.15 Consumption

Consumption or total consumption is the sum of household final consumption expenditure and general government final consumption expenditure. The data of consumption variable have been taken from WDI 2014 and adjusted for inflation.

Consumption or real consumption is increasing exponentially with respect to time. Exponential fitting explains the trend in the series better than other trends. The average annual real consumption is Rs.28.23 billion with average dispersion of Rs.41.52 billion. The maximum real consumption was Rs.169.85 billion in 2012 and the minimum was Rs.0.4339 billion in 19171. [See Fig 4.15 and Table 4.15, given in the appendix to the chapter].

Chapter # 5 : Overall Analysis

This chapter investigated the determinants of saving function and the overall weak wealth sustainability of the economy.

5.1 Justification of Savings' Function

Savings is one of the important determinants of national wealth especially because it produces wealth. Private savings are used to purchase capital goods to increase productivity, which enhances produced wealth[7] of the economy and compensates for the decrease in other component(s) of wealth. According to Ramsey (1928) the short run saving rate determines the speed of produce capital accumulation. Increase in savings rate would increase future consumption but causes current consumption to fall and reduction in current consumption would outweigh the long run advantages of a higher savings rate. The factors affecting current and future consumption would also affect savings or produce wealth accumulation of the economy. The most important factors affecting current and future consumption are expected inflation and real interest rate.

If individuals expect high inflation rate in future, they will increase current consumption and save less. High inflation rates tend to be related with high savings rates; many models have been developed to explain this phenomenon. Deaton (1977) conjectured that unanticipated inflation leads to involuntary savings or produce wealth accumulation. Individual consumers have no conceivable channel for differentiating between relative and absolute price changes. Since CPI is always issued after a period of time; it is probable that individuals may be confused about an increase in the general price level especially for an increase in some relative prices. Such an error will cause consumers to purchase less of everything; consequently they will plan to buy more

[7] Wealth has three components: produce wealth, natural wealth and human wealth.

substitute commodities in future. This will result in involuntary savings. Some economists believe that during inflation measured income and measured savings have a tendency to overestimate real income and real savings because measured income comprises interest payments on financial assets. The higher the inflation rate, the higher is the fraction of these payments which is just compensation to the asset-holders for the decline in the real value of their assets. The asset-holders cannot consume the compensation because they wish to maintain the real value of their wealth. But in the period of high inflation to sustain the consumption pattern would reduce the savings. Miller and Benjamin (2008) High inflation increases the opportunity cost of holding money and decreases the real interest rate or return on assets, to avoid the cost of holding money the individuals search the rewards in purchasing in unnecessary goods thereby reducing savings. Therefore, inflation effect on savings is ambiguous.

The classical macroeconomic model theorized that interest rate equates savings and investment and investment is the change in produce wealth or capital. This implies that interest rate determines savings. But the effect of high real interest on savings is ambiguous, the net increase or decrease in savings depends upon the strength of income and substitution effects of high real interest.

Mckinnon effect implies that a significant increase in GDP growth would increase savings and positively affect investments and in turn produce wealth or capital. The increased investment would also increase GDP, which would again increase savings. This implies that GDP growth and national income are included in the determinants of savings. Savings function of Keynesian model also specifies disposable income as a determinant of savings. Keynesian believe that savings is a luxury; the rich are expected to save a higher proportion of their income than the poor. Since the marginal propensity to consume lies between zero and one, this implies that higher income leads to higher consumption as well as to higher savings. This leads to the inference that income is an important determinant of the savings function. The life cycle hypothesis argues that savings permit individuals to transfer high income to a low income period; this implies that savings fluctuate over an individual's lifetime. Therefore current savings are also affected by expected income and lagged period income. The life cycle hypothesis predicts that savings increase with the age but tend to decline when age crosses a certain limit.

The net capital from abroad affects the wealth of the nation. Positive value of net capital from abroad increases produced and human wealth of the nation and compensates for reduction in natural wealth. There are two hypotheses about the relationship between foreign capital inflow and domestic savings; the "Substitution hypothesis" and "complementary hypothesis". The Substitution hypothesis recommends negative relationship between foreign capital inflow and domestic savings; this implies that foreign capital is in fact a substitute for domestic savings. While the complementary hypothesis advocates a positive relationship between the two variables, this implies that foreign capital inflow in fact complements domestic savings.

Public spending on long-lived capital goods, such as highways, school and hospitals etc. are considered public savings. Public savings also increase produced wealth of the nation and compensate for reduction in other components of wealth. The Government has two options to finance budget deficit; (i) tax now or (ii) tax later. If the government adopts the tax later policy and finances the deficit by either issuing bonds to the taxpayer or borrowing via loans; it must ultimately pay back the borrowed amount through taxation. Ricardo believed that taxpayers would recognize that they would have to pay a higher tax in future and therefore save more in order to pay for the future tax rise. This theory, called Ricardian Equivalence, was developed by David Ricardo in the nineteenth century. Similarly, increase in government expenditure increases the economic income through the multiplier effect; this may affect savings of the economy but this effect is captured in disposable income as a determinant.

Similarly the high dependency ratio is decreasing the wealth accumulation.

Savings is one of the basic variables of the study because GS is the savings plus education expenditure less D. since GS depends on savings, therefore, the factors which affect savings will also affect GS this implies that the determinants of savings are also determinants of GS.

5.2 Savings' Function

Vector error correction model has been used to estimate the economy's savings function. The literature review of savings function with respect to Pakistan- given in Chapter 2- establishes that the following factors affecting savings of the economy;

a. Dependency ratio
b. Income
c. Foreign capital inflow
d. Government expenditure
e. Economic growth
f. Inflation
g. Real interest rate

Government expenditure is part of income and growth rate is the rate of change of income. The study included income and excluded the government expenditure and growth[8]. Therefore, savings function has been specified as given below:

$S = f\ (Y, r, \pi, d_r, fk)$

Where

S = savings

[8] The study did as directed in foreign comments.

Y = income; (Expected sign ‘+’)

r = real interest rate; (Expected sign ‘+ or -’)

π = inflation; (Expected sign ‘+ or -’)

d_r =dependency ratio; (Expected sign ‘-’)

Fk = net foreign capital inflow; (Expected sign ‘+’)

5.2.1 Estimation of the Savings Function

Before estimating the dynamic OLS, it is necessary to check the stationarity of the time series variables used in the savings function. The study used augmented dicky-fuller (ADF) unit root test to check the stationarity of the time series variables. The results of ADF tests are given in the appendix to the chapter.

5.2.2 Stationarity of the Time Series

Out of six time series variables three variables; inflation, real interest rate and dependency ratio, are stationary at level and thus the order of integration of the variables is I(0) and the rest three variables; real savings, real income and real net foreign capital inflow, are stationary at first difference and thus the order of integration of the variables is I(1). Since the order of integration of the time series is not same therefore, the study used autoregressive distributed lag ARDL approach to co-integration to check the existence of long run relationship among the variables.

5.2.3 Test of Co-integration

ARDL approach to co-integration has been applied to the time series variables. The test rejected the hypothesis of ‘no long run relationship’. The study concludes that there is a long run relationship among the variables. The results of the test and procedure are given in Table 5.7, Table 5.8 and Table 5.9 in the appendix to the chapter.

5.2.4 Vector Error Correction Model

To run the VECM, first the study specified optimal lag 3, for details see Table 5.10 and Table 5.11 in the appendix to the chapter. Then the study ran the model, the results of the model are given in Table 5.12 in the appendix to the chapter. The coefficient of error correction term is negative and statistically significant, which implies that there is a long run causality running from real income, dependency ratio, inflation, real interest rate and real net foreign capital inflow to real savings. The negative and statistically significant coefficient of error correction term is also reflecting the speed of adjustment towards long run equilibrium. The study used Wald coefficient restrictions test to check the short run causalities running from real income, dependency ratio, inflation, real interest rate and real net foreign capital inflow to real savings. The study found the short run causalities running from real income to real savings, from dependency ratio to real savings, inflation to real savings and real net foreign to real savings. There is no short run causality running from real interest rate to real savings.

5.2.5 Diagnostic Tests

Table 5.14a given in the appendix to the chapter shows no serial correlation in the model. Similarly, 5.14b in the appendix shows that the model has no heteroscedasticity. Table 5.14c and 5.14d in the appendix show the normality of the residual and coefficient stability of the model respectively.

5.2.6 Results

The real income of the economy has statistically significant and positive effect on real savings in long run. Saving function, the complement of absolute income hypothesis is valid in long run. Any shock causes change in the level of real income and also influences real savings in short run and also causes deviation from long run equilibrium but error correction mechanism restores the long run equilibrium.

The impact of dependency ratio on real savings in long run is negative and statistically highly significant. It also influences real savings in short run. The deviation from long run equilibrium due to short run causation would readjust in three periods.

Inflation is not neutral; it affects real savings negatively in long run. High inflation increases the opportunity cost of holding money. To avoid the reduction in purchasing power of money individuals shift to comparatively high real consumption pattern and thus the real savings would decrease because in periods of high inflation the real interest rate in Pakistan's economy is negative. Inflation influences the real savings in short run as well and disturbs the long run equilibrium but the mechanism restores the equilibrium in the long run.

The real interest rate has statistically significant and negative effect on real savings in long run. This implies that the income effect of the real interest rate is dominant over the substitution effect. The model shows no short run causality running from real interest rate to real savings.

Real net foreign capital inflow affects the real savings. The relationship between the two variables is positive and statistically significant in long run. Therefore, the complementary hypothesis is valid. This implies that the real net foreign capital inflow is complement of the domestic real savings. There is also short run causality running from real net foreign capital inflow to real savings. The short run deviation form long run equilibrium is being corrected by the mechanism of the model.

5.3 Estimation of Genuine Savings

Genuine savings is real gross domestic savings plus real investment in human capital proxy for education expenditure less D.

5.3.1 D-Series

D is the sum of the negative indicators of the economy; the indicators that affect weak wealth sustainability negatively such as natural resource depletion, air and water pollution etc. therefore D is equal to:

D = Depreciation of produced capital + Deforestation + Damages from particulate matters, CO2 and water pollution cost+ Depletion of natural resources other than deforestation.

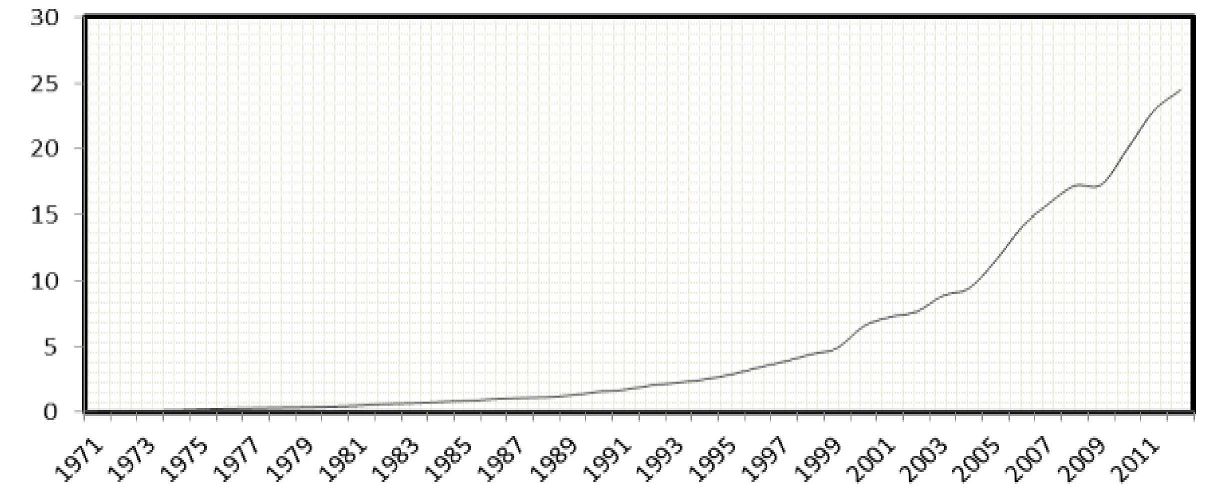
The sum of costs of all the above negative indicators of the economy is called D-series. The series consists of; consumption of fixed capital, damages from particulate matters, water pollution costs, CO2 damage, renewable resource depletion (livestock and forest resource depletion), energy depletion and mineral depletion.

5.3.2 Analysis of D-Series

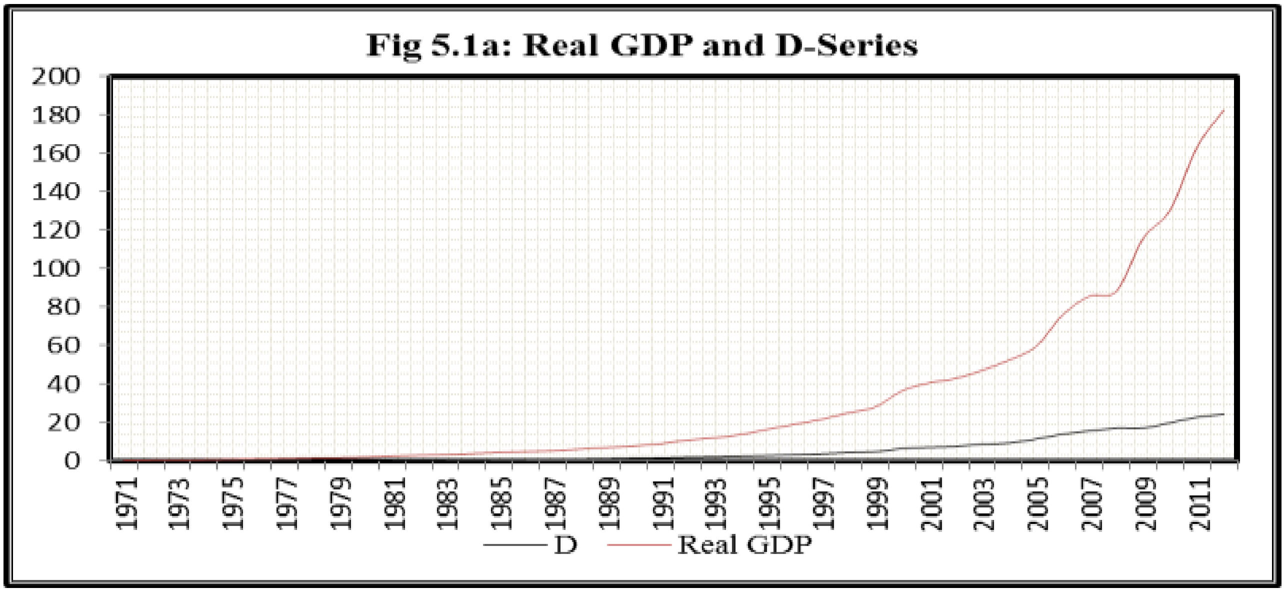
The study analyzes the behavior of D-series and its components. Most of the components exhibit of an upward trend with different cyclical behavior. Following is the analysis of D-series and its components.

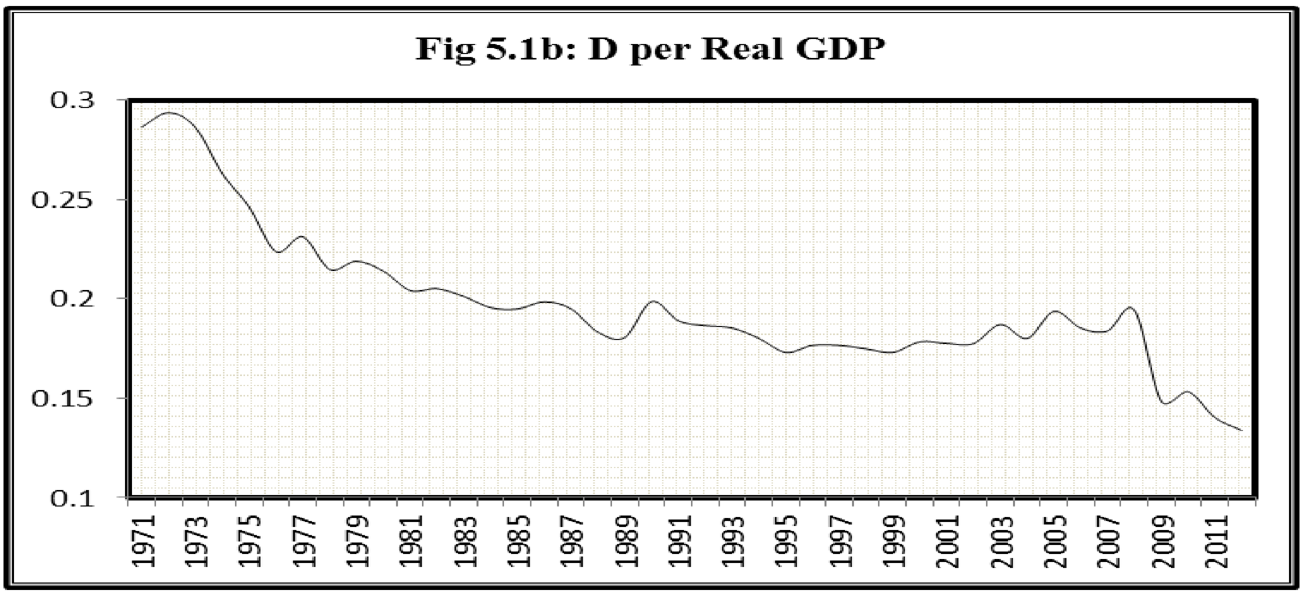
Polynomial of degree three trends is fitted better than other trends to the series. The average annual D is 5.31 billion with average annual dispersion of 6.88 billion. The series starts from the minimum 0.1381 billion and ends at the maximum 24.47 billion. Following fig 5.1 represents the D-series for Pakistan's economy;

Fig 5.1: D-series



The below fig 5.1a shows that the gap between real GDP and D is increasing, but there are some omitted variables due to non-availability of data in D-series such as degradation of land, depletion of livestock and fishery etc. A more accurate picture of the gap would be obtained by incorporating all the omitted variables included in the definition of D-series in the analysis. With the included variables it is observed that the gap is increasing, although the trend in D-series is increasing. Although the relationship between real GDP and D is positive but the increase in the gap with respect to time is a good sign for weak sustainability of wealth. Because with respect to time, a given level of real GDP is being produced at low value of the D.





The above fig 5.1b shows that there is a decreasing trend in D per GDP which is a good sign for weak sustainability of wealth. Since, to keep level of output (real GDP) constant at per unit there is a decrease in D with respect to time. D to GDP ratio at 0.2936 was the maximum in 1972 and minimum 0.133 in 2012.

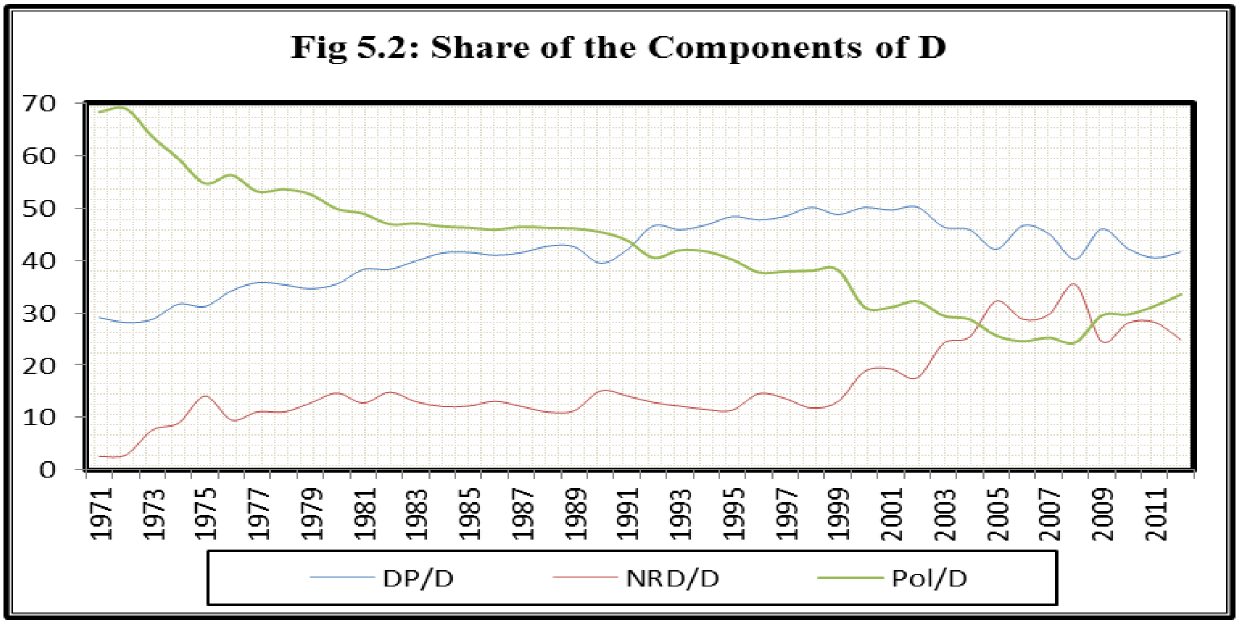
Econometric analysis shows positive and statistically significant relationship between D and GDP in long run. But the relationship in short run is statistically insignificant. The analysis is given in the appendix to the chapter.

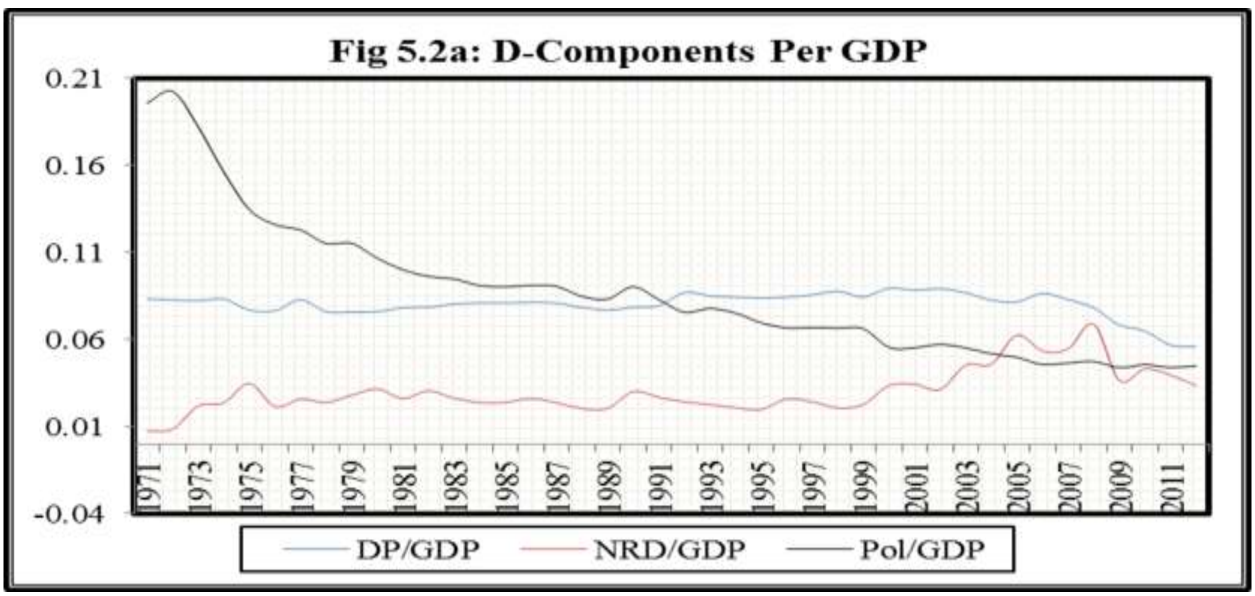
5.4 Components of D-series

D-series can be divided into three main components: produce capital depreciation, natural resource depletion and pollution. Natural resource depletion contains deforestation, energy depletion and mineral depletion. Pollution covers CO2, particulate matter and water pollution.

Fig 5.2 shows the plot of the share of the components of D. From 1971 to 1991 the share of pollution was the highest and the share of natural resource depletion was the lowest and remains the lowest till 2005. From 1991 to the end of the analysis the share of produce capital depreciation is the highest but decreasing. The share of pollution has been decreasing from 1971 to 2008 but has a slightly increasing trend onwards. The share of natural resource depletion has been increasing sharply from 1999 to 2008 and then decreasing again and same behavior holds for the components per GDP see fig 5.2a below. Table 5.16 given in the appendix to the chapter shows the descriptive statistic of the share of the components of the D. Although the share of pollution in D is decreasing from maximum 68.97 billion in 1971 to minimum 23.34 billion with average of dispersion 11.68 billion but the annual average share of pollution at 42.44 is still greater than the average annual share depreciation at 41.48 billion and annual average share of natural resource depletion at 16.07 billion. The maximum share of produce capital depreciation in D was 50.22 in 2002. The share of produce capital depreciation is the highest from 1991 to

2012.



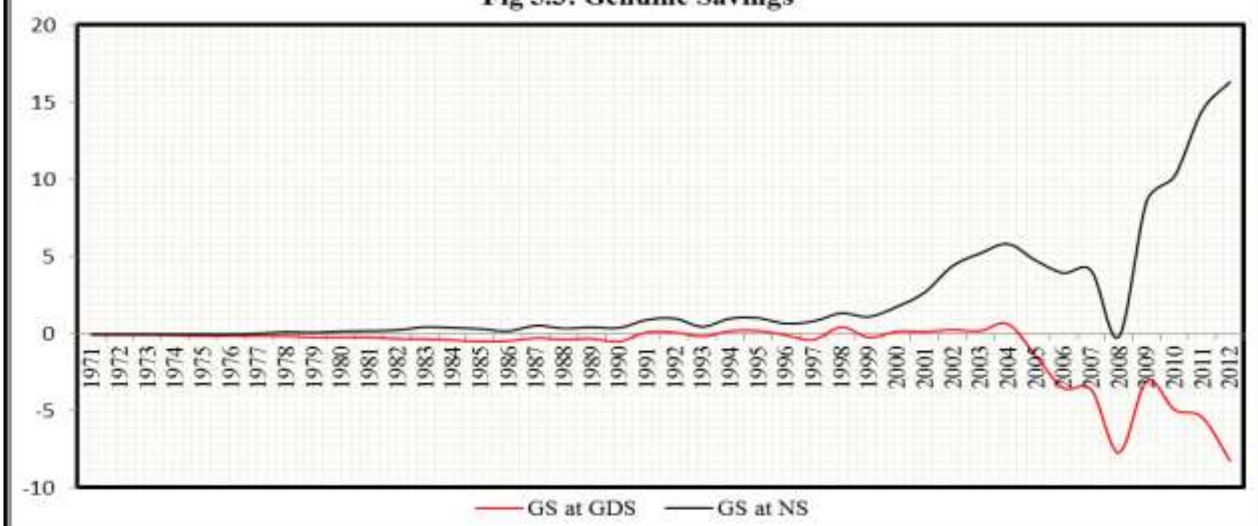


5.5 Weak Wealth Sustainability: Genuine Savings Approach

Savings of the economy and investment in human capital are positive indicators of weak wealth sustainability of the economy, while D-series is the sum of all negative indicators of the economy. First, adding the positive indicators of sustainability and then subtracting the value of

D from the sum if we get the result as non-negative then wealth of the economy is sustained otherwise the economy would face wealth's sustainability problem. An important point of genuine savings is ascertaining whether the economy's savings and investment in human capital are sufficient enough to compensate the D-series. If they compensate the D-series than the economy would be sustainable and genuine savings would be positive otherwise the economy would not be sustainable. This implies that Genuine savings is the change in the economy's wealth. If the change is zero or positive, this implies that savings and investment in human capital are sufficient to compensate all the D factors, it is also sufficient for wealth sustainability. Consequently, the economy's wealth is sustainable and negative change implies that our savings and investment in human capital are not sufficient to compensate the D of the economy; the economy's wealth would not be sustained for future generation(s). The formula for genuine savings is $GS_t = S_t + EE_t - D_t$. The formula gives information about the economy's wealth sustainability each year. The non-negative GS implies weak wealth sustainability of the economy. Following fig 5.3 shows the estimated GS for Pakistan's Economy is:

Fig 5.3: Genuine Savings



The above fig 5.3 is the genuine savings estimates for the economy. There are two lines in the fig: GS at GDS and GS at NS. GS at GDS is the genuine savings at gross domestic savings: GDP less total consumption. GS at NS is the genuine savings at national savings: national income less total consumption plus net transfers. The economy faces weak wealth sustainability problem at gross domestic savings since most of the years the GS is negative. For a few years the values of GS are positive; 1991, 1992, 1994, 1995, 1998 and from 2000 to 2004. Roughly speaking, from 1991 to 2004 the economy sustained the wealth but form 1971 to 1990 and from 2005 to 2012 the economy is not on weak sustainability path at the gross domestic savings. GS at national savings are positive from 1978 to 2012 except for 2008. Weak wealth sustainability holds from 1978 to 2012 except for 2008.

During the period of analysis the economy depleted Rs. 42.7307 billion wealth of the future generation(s) at gross domestic savings, but economy contributed Rs. 92.6277 billion to the wealth of future generation(s) at gross national savings. The gap between wealth depletion and contribution is net contribution to the wealth of future generation(s). Therefore the net contribution to the wealth of the future generation(s) is Rs, 92.6277 less Rs. 42.7307 equal to Rs. 49.897 billion.

5.6 Weak Wealth Sustainability: Net Value-Added Approach

Genuine savings give information about savings of an economy, investment in human capital proxy expenditure on education EE and the negative indicators called D of the economy but give no information about the consumption and production of the economy. The net value-added approach takes into account both variables; consumption and production of the economy and reaches the same conclusion as the genuine savings approach. This approach compares consumption with net value addition of the economy. If value of the consumption is higher than the net value added than the economy is not sustainable which implies that the current generation is consuming wealth of the future generation(s) or change in wealth is negative. If net value added of the economy is higher than or equal to the consumption than the economy is on a sustainable path, this implies that current generation is leaving more for future generation(s) or at least does not affect the consumption of wealth of the future generation(s). Basically the approach is derived from genuine savings but this approach uses a few different variables and takes different paths to reach the same conclusion as of genuine savings. Since the path of the analysis is different, therefore, the policy conclusion may be different or may suggest an alternate policy. Other than the economy's overall sustainability the study also analyzes sectoral sustainability of the economy. Sectoral savings data is required to check sectoral sustainability of the economy. The data is not available and it is difficult to decompose the overall savings series into the sectoral savings. Therefore, the study uses net value-added approach for GS. Hamilton and Hartwick (2005) presented the idea that the sum of the values of a heterogeneous set of assets (total wealth) is equal to the present value of future consumption, and this is also the definition of weak wealth sustainability for this study. Sustainability is defined as 'maintaining the nation's wealth for future generations. The nation's wealth may be consumed or it may be saved or there may be an amalgamation of both. The basic question of genuine savings is what should be the savings rate of current generation in order to maintain wealth of the nations for future generation? However, the basic question of the value added approach is, how can an economy increase its consumption level without depleting wealth of the future generation? If the current generation consumes its net value-added, then total wealth would be sustained for the future generation(s) because the current generation only consumes what it is contributing to the economy.

It total wealth is related to social welfare, then changes in wealth should have implications for sustainability – this is the basic argument presented by Pearce and Atkinson (1993). When generations transform assets from one form into another they are adding some values in order to transform the old form into the new one, if a generation consumes just the addition than total value of the resources would be sustained for future generation.

If the addition into the economy and the subtraction from the economy are equal than they will cancel out each other and the values of resources of the economy would be sustained but their structure may be different because assets are being converted from one form into other. So, if an economy consumes its net value-added then the economy would be on a sustainable path.

To check the sustainability of an economy we have to test the hypothesis H: $C \leq V + EE$; (the symbol explanation is given below) the economy's consumption is equal to its net value-added plus the expenditure on education.

Let

GS = Genuine Savings, GDS = Gross Domestic Savings, EE = Expenditure on education, D = Depletion, depreciation, damages and degradation (Air Pollution Costs, Water Pollution Costs, Depletion of nonrenewable Natural Resources, CO_2 Damages Costs and depreciation of produced capital), GDS = Gross Domestic Product (GDP) – Consumption (C).

Than

$$GS = S + EE - D$$

$$GS = GDP - C + EE - D$$

$$C = GDP + EE - D \qquad \text{(Hartwick rule: } GS = 0\text{)}$$

Let

$V = GDP - D$

Then

$C = V + EE$………………(1)   where V is net –value-added

If consumption is equal to 'the net value-addition plus the spending on education' then GS would be Zero and the economy would be sustainable. Equation (1) is based on the Hartwick rule of zero genuine savings.

The economy would also be sustained if genuine savings are positive. Positive genuine savings imply that we are leaving more for future generation.

For positive GS

$C < V + EE$-----------------------(2)

If consumption is less than the net value-added plus the spending on education than GS would be positive and economy is sustainable.

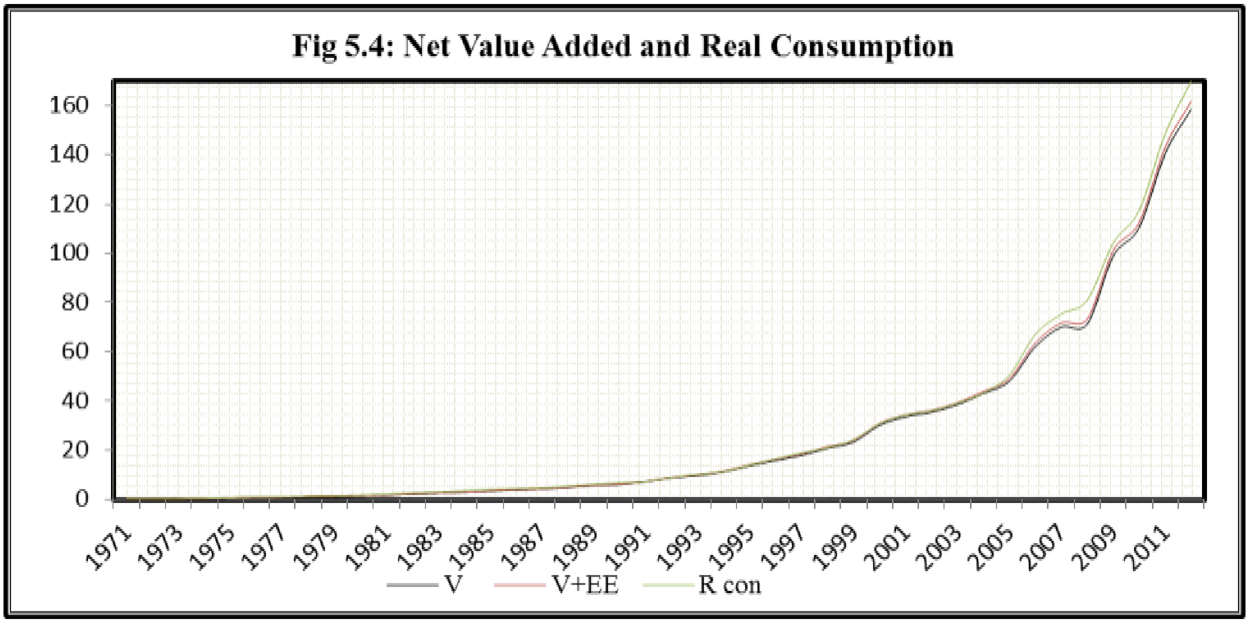
For Hartwick rule and positive GS

$C \leq V + EE$ -----------------------(3)

Equation (3) is the combination of equation (1) and equation (2). If equation (3) holds for an economy then the economy would be sustainable, otherwise not. According to this approach an economy's assets would be sustained if the economy consumes just its net value-added.

After estimating D-series, D series need to be subtracted from GDP; this will give net value-addition V (V= **GDP – D**) of the economy then add investment in education with V and then compare it with consumption of the economy.

Fig 5.4 contains graph of V, V+EE and real consumption:

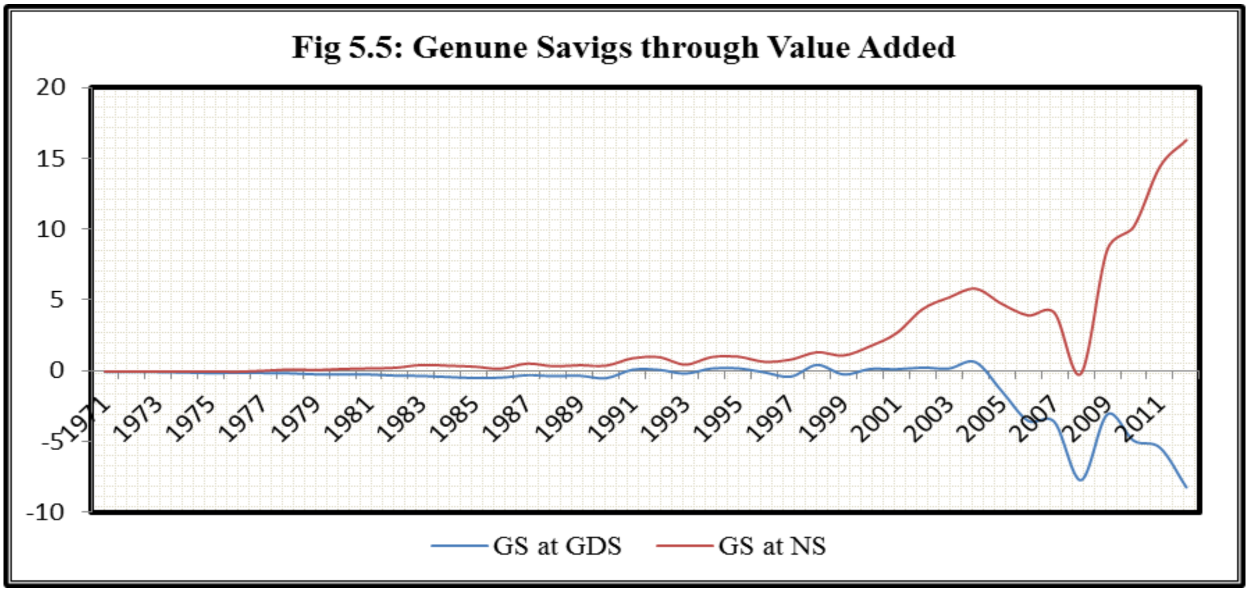


According to the net value added approach to GS the economy would be sustainable if consumption C of the economy is less than or equal to net value-added plus expenditure on education EE of the economy.

$C \leq V + EE$ OR

$V + EE - C \geq 0$

If V+ EE –C is positive then genuine savings are also positive and the economy is sustainable, and if it is equal to zero than genuine savings are zero and according to Hardwick rule the economy is also sustainable. Following is the graph of genuine savings estimated through the net value added approach.



The above fig 5.5 estimated GS through value added approach which is same as in Fig 5.3. Therefore, to check weak wealth sustainability of an economy one can use GS approach or value added approach.

Chapter # 6 Sectoral Sustainability of Economy

The economy is categorized into three main sectors with reference to supply: agricultural, industrial and services while one sector relating to demand side is the general consumption of the economy; both household and government consumption is representing this sector. The study also analyzes the net value added of the three sectors first and then compares the value added with the corresponding consumption of the sectors by household and government. If the net value added plus EE of the sectors is equal to or more than the corresponding consumption of the sector than the sector would be on a sustainable development path.

[9] $C_i \leq V_i - D_i + EE_i$ if this inequality holds then ith sector is said to be sustainable.

6.1 Sector wise D-series

Sectoral sustainability analysis requires sector wise D; the negative indicators of each sector responsible for environmental damages and resource depletion are included in D. In D-series seven major variables are included for overall economy; CO2, depreciation of physical capital, energy depletion, mineral depletion, forest depletion, particulate matters and cost of water pollution. The analysis requires development of sector wise D from these seven variables.

6.1.1 Sector Wise Components of D-series

The study faces sectoral data limitations, following are the details of sector wise components of D-series:

6.1.1.1 Carbon dioxide and Particulate Matter

According to task force on climate change, planning commission of Pakistan (2009); Pakistan was ranked at 149th place on the basis of its per-capita greenhouse gas (GHGs) emissions

[9] For derivation see chapter # 5

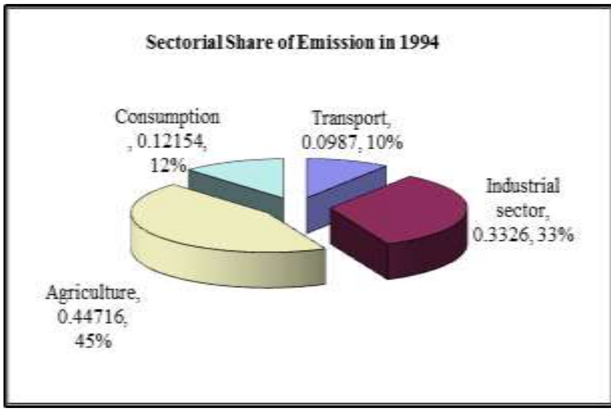
including land use change while it climbed to the 135th place when land use change was excluded. The main factors responsible for GHG are the use of coal, natural gas, oil, wood and wood waste, charcoal, biomass and wastes in consumption and production activities of the economy. Its CO2 contribution to the global CO2 emissions from fuel combustion amounts to only 0.44% and its per capita CO2 emissions correspond to about one sixth of the world average. The world per capita CO2 emissions are 4.18 tCO2 per capita while Pakistan's are 0.76 tCO2 per capita. According to the above two GHG inventories, Pakistan's overall GHG emissions increased during 1994-2008 on per capita basis at the rate of 1.6% per annum. Out of the total GHG emissions in 1994, the energy sector was responsible for 47.2%, agriculture for 39.4%, industrial processes for 7.3%, land use change and forestry for 3.6% and wastes for 2.5% of the emissions respectively. While in 2008 the corresponding emissions have been estimated with the shares of various sectors as: energy 50.7%, agriculture 38.8%, and industrial process 5.8%, land use change and forest 2.9% and waste 1.8%. There is a mismatch between the definition of the sectoral data and the definition of the study's sectors. After matching the definitions the estimated shares of sector-wise emissions are given below in Table 6.1:

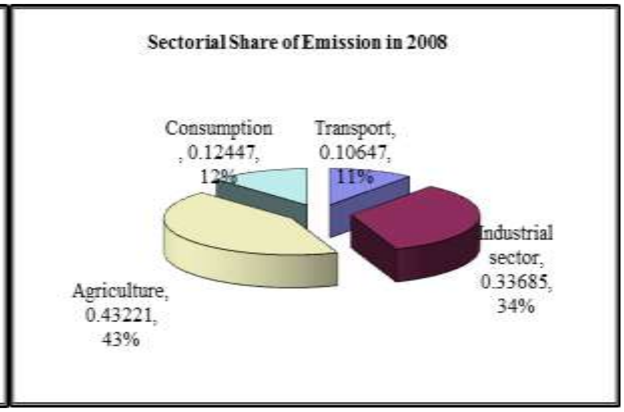
Table 6.1: Sectoral Share of Emissions

Sectors	1994	2008	Average
Transport	0.0987	0.10647	0.102585
Industry	0.3326	0.33685	0.334725
Agriculture	0.44716	0.43221	0.439685
Consumption	0.12154	0.12447	0.123005

Source: Pakistan climate change policies and actions, Sep 2009, Task force on climate change, Planning commission

The highest share of emissions was 44.7% in the agriculture sector in 1994 while the lowest was 9.9% contributed by the transport in the same year. This same situation was displayed in 2008 but the agriculture share decreased while the transport share increased. There was a minor increment in the share of industry and consumption in 2008 as compared to 1994. The following is a pie chart based on the shares of emissions by different sectors of Pakistan's economy:





The composition of GHG in 2008 was estimated to be about 54% CO2, 36% Methane (CH_4), 9% Nitrous Oxide (N_2O), 1% carbon monoxide (CO) and 0.3% non-Methane volatile organic compounds.

6.1.1.2 Share of Industrial Emissions

The share of CO2 in the industrial sector is 76.22 as percentage of total CO2 emission while it is 41.05% of total GHG emissions. The share of methane CH_4 emission in the industrial sector is 10.42% of total methane and 3.75% of total GHG emissions. Similarly, N_2O comprises 7.00% of total nitrate emissions and 0.62% of GHG emissions. Carbon monoxide's share is 8.53% of total CO and 0.06% of total GHG emissions. The share of non-Methane volatile organic compound is 16.86% of total NMVOC and 0.05% of total GHG emission.

6.1.1.3 Share of service sector

CO2 share of service sector is 18.42% of total CO2 and 9.92% of total GHG emissions. The share of methane CH_4 emission of the sector is 0.23% of total methane and 0.08% of total GHG emissions. Similarly N_2O takes up 1.78% of total nitrate emissions and 0.16% of total GHG emission. Carbon monoxide's share is 75.59% of total CO and 0.495% of total GHG emissions.

The share of non-Methane volatile organic compound is 83.13131% of total NMVOC and 0.164% of total GHG emission.

6.1.1.4 Share of Agriculture Sector

Agriculture sector's share of CO2 is 5.35% of total CO2 and 2.88% of total GHG emissions. The share of methane CH_4 emission of the sector is 88.89% of total methane and 30.58% of total GHG emissions. With respect to N_2O the agriculture sector takes up 91.21% of total nitrate emissions and 8.19% of total GHG emission. Carbon monoxide's share is 15.88% of total CO and 0.104% of total GHG emissions.

Enteric fermentation in cattle in the form of methane and N2O from agriculture soils was responsible for about 21% of the agriculture sector's GHG emissions. Rice cultivation and manure management stood at a level of about 6%.

Following Table 6.2 is the summary of the sectoral emissions of different components of emission:

Table 6.2: Sectoral Share of Emissions

	CO2		CH4		N2O		CO		NMVOC	
GHG source Categories	% of total CO2	% of total GHG	% of total CH4	% of total GHG	% of total N2O	% of total GHG	% of total CO	% of total GHG	% of total NMVOC	% of total GHG
Industry	76.22	41.05	10.88998	3.75	7.00137	0.62	8.53	0.055	16.86	0.053976
Service	18.42	9.92	0.228225	0.08	1.78636	0.16	75.59	0.495	83.13	0.266003
Agriculture	5.35	2.88	88.88179	30.58	91.2123	8.19	15.87	0.104	-	-
Sum of the Share	99.99		100		100		99.99		99.99	

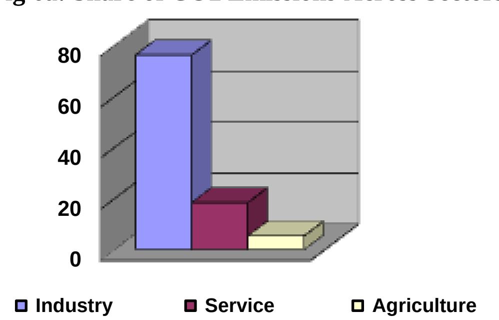
Source: Pakistan's Climate Change Policies and Actions, September 2009, Task Force on Climate Change, Planning Commission of Pakistan.

6.1.1.5. Across Sectors

The share of CO2 in GHG is 53.85% out of which 41.05% is associated with the industrial sector, 9.92% with the service sector and 2.88% with the agriculture sector. The highest CO2 emitting sector is the industrial sector followed by the service sector and the lowest emissions are attributed by the agriculture sector. The main factor responsible for the highest emissions of CO2 in the industrial sector is fuel combustion activities. The energy industry is the leading emitter of CO2 followed by manufacturing and then other industries. Besides fuel combustion activities fugitive emissions from fuels consist of solid fuels, oil and natural gas. The emission of CO2 in the industrial process comes from mineral products, chemicals and metal production. The emission of CO2 in the service sector comes from the transport section. Similarly changes in forest and other woody biomass stocks are responsible for agricultural CO2 emissions.

Following fig 6.a shows the share of CO2 across sectors:

Fig 6a: Share of CO2 Emissions Across Sectors



Industrial sector is responsible for 76.22 % of CO2 emissions which is the highest share while the service sector's share is 18.41% and the agriculture sector is emitting 5.35%.

6.2 Methane CH_4

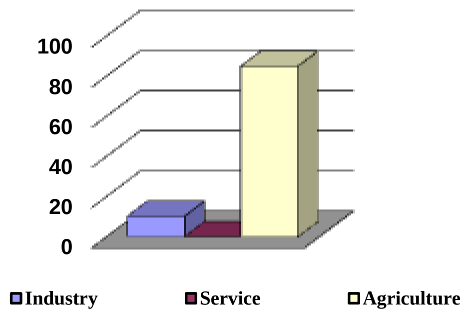
The share of CH_4 in GHG is 34.41%; 3.74% associated with the industrial sector, 0.078% with the service sector and 30.587% with the agriculture sector. The highest CH_4 emitting sector is the agricultural sector followed by the industrial sector and the lowest CH_4 emitter is the service sector.

The causes of methane emission are followings:

- Enteric fermentation is the leading emitter of methane in agriculture sector; Second leading emitter is manure management, then rice cultivation followed by field burning of agricultural residuals.
- In the industrial sector; fuel combustion activities of energy and manufacturing industries
- While fugitive emissions from natural gas, solid fuel and oil and are responsible for the emissions by the service.

Following fig 6b contains the share of the methane emissions by the three sectors:

Fig 6b: Share of Methane Emissions Across Sectors

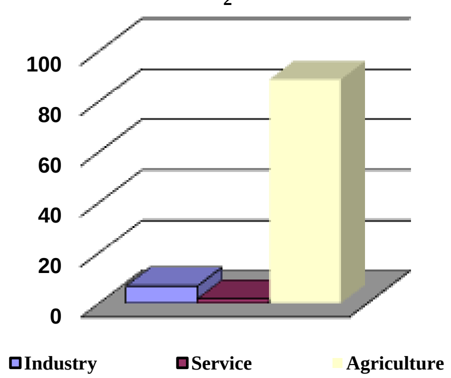


The agricultural sector is responsible for 88.88 % of methane emissions which is the highest share while the share of industrial sector is 10.88% and the service sector is emitting only 0.228%.

6.3 Nitrate N_2O

The share of N_2O in GHG is 8.97% out of which 0.628% is associated with industrial sector, 0.16% with service sector and 8.19% with the agriculture sector. The highest N_2O emitting sector is agriculture followed by the industrial sector and the lowest N_2O emitter is the service sector. Agricultural soil is the leading emitter of N_2O in the agriculture sector and second leading emitter is rice cultivation followed by field burning of agricultural residuals. In industry, the energy industry and manufacturing industries emit the highest level of N2O while the manufacturing industry has a larger share in this emission. In the service sector transport is responsible for the emissions.

Fig 6c: Share of Nitrate N_2O Emissions Across Sectors



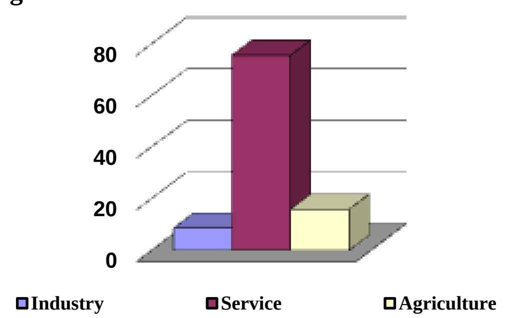
The agricultural sector is responsible for 91.21% of N_2O emissions which is the highest share while the share of industrial sector is 7.00% and the service sector is emitting only 1.78%.

6.4 Carbon monoxide CO

The share of CO in GHG is 0.66% out of which 0.06% is associated with the industrial sector, 0.49% with the service sector and 0.10% with the agriculture sector. The highest CO emitting sector is the service sector followed by the agriculture sector and the lowest CO emitter is the industrial sector.

Causes of CO emission are, in the service sector transportation which is responsible for the highest emission of CO, in agricultural sector; the field burning of agricultural residuals is responsible for CO Emissions and in with respect to industry, the combustion activities of the energy industry, manufacturing industries and other sub-sectors along with fugitive CO emissions from fuel, oil and natural gas contribute to overall CO emissions. Additionally, the industrial process also contributes to CO emissions via mineral products.

Fig 6d: Share of CO Emissions Across Sectors



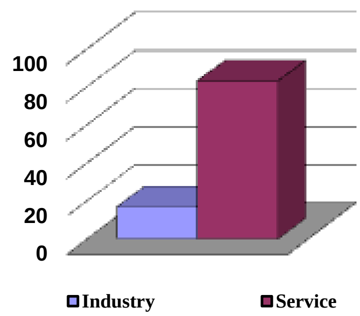
The service sector is responsible for 75.59 % of CO emissions which is the highest share while the share of agricultural sector is 15.87% and the industrial sector is emitting only 8.53%.

6.5 Non-Methane Volatile Organic Compounds NMVOC

The share of NMVOC in GHG is 0.3199 % out of which 0.054% is associated with the industrial sector, 0.266 % with the service sector and it is negligible in the agriculture sector.

The service sector emits more NMVOC than the industrial sector while the share of the agriculture sector is negligible.

Fig 6e: Share of NMVOC Emissions Across Sectors



The share of service sector is 83.13% while industrial sector is responsible for 16.86% of the emission.

6.6 Decomposition of CO2

Following fig 6.1 shows the sectoral emissions of CO2. The study applied the sectoral weight of CO2 to overall series to decompose the overall CO2 series into sectoral series:

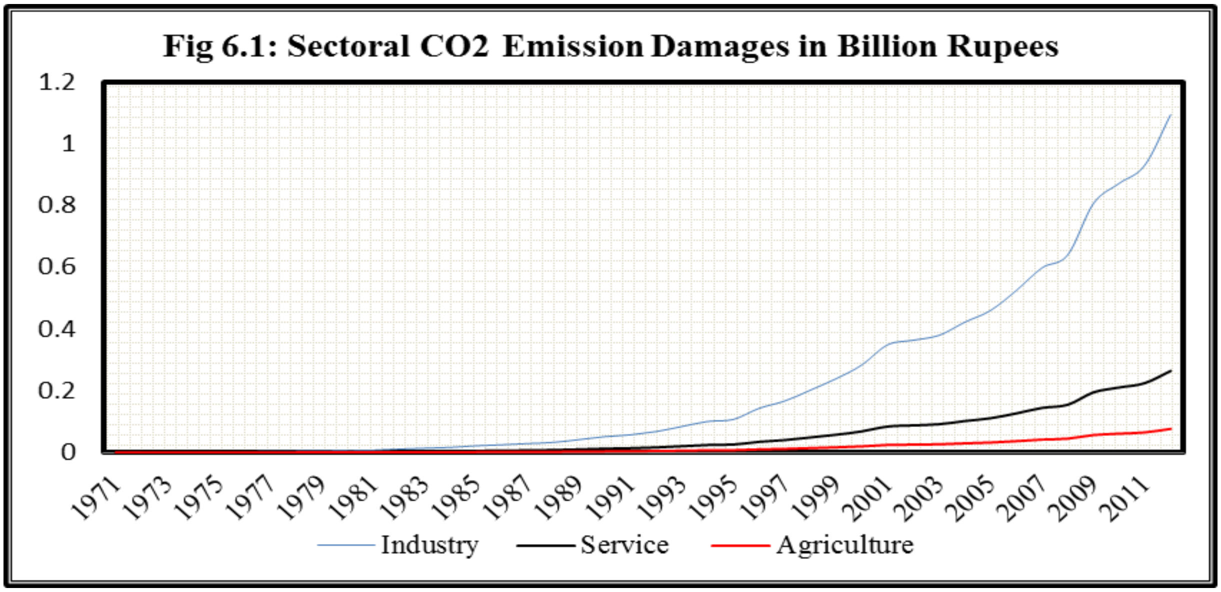


Fig 6.1 shows CO2 emission by sectors of the economy. Industrial sector emits the largest amount of CO2 fallow by service sector and the lowest by agricultural sector.

The study faces a limitation of data on sectoral particulate matters emission. The study has used the sectoral weight of the total emission as the sectoral weight for particulate matters including other emission of GHG. The study applied the weight to the costs of overall particulate matters series including other emission of GHG and decomposed into sectoral particulate matters series. Following fig 6.2 shows the sectoral particulate matter series:

Fig 6.2: Sectoral Damages from Particulate Matters and Other Emission (Billion Rupees)

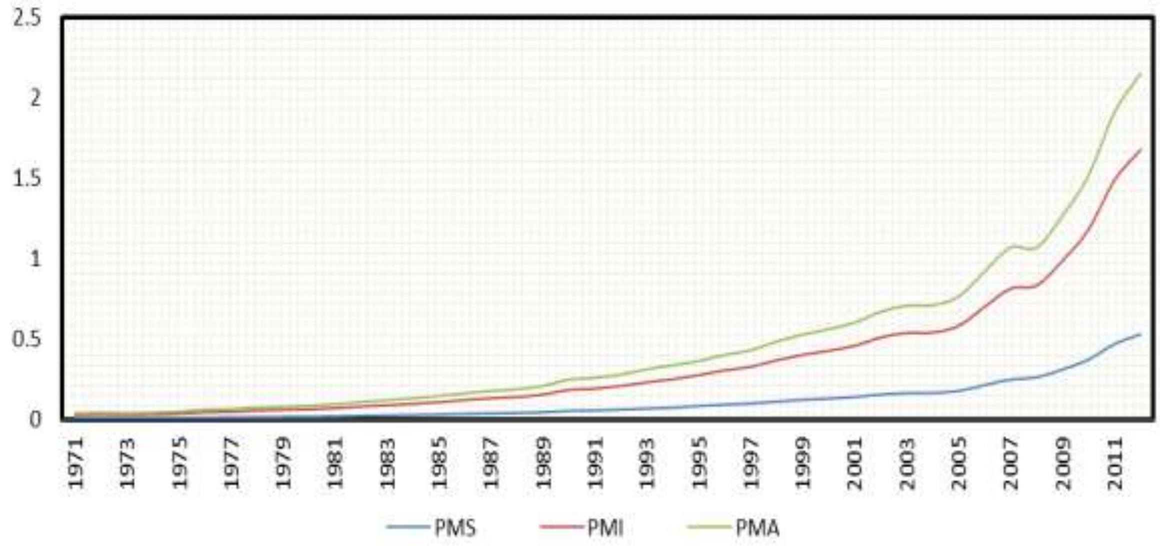


Fig 6.2 contains the air pollution costs by sectors excluding CO2. Agricultural sector air pollution costs are the highest throughout the period of analysis followed by industrial sector and the lowest by the service sector.

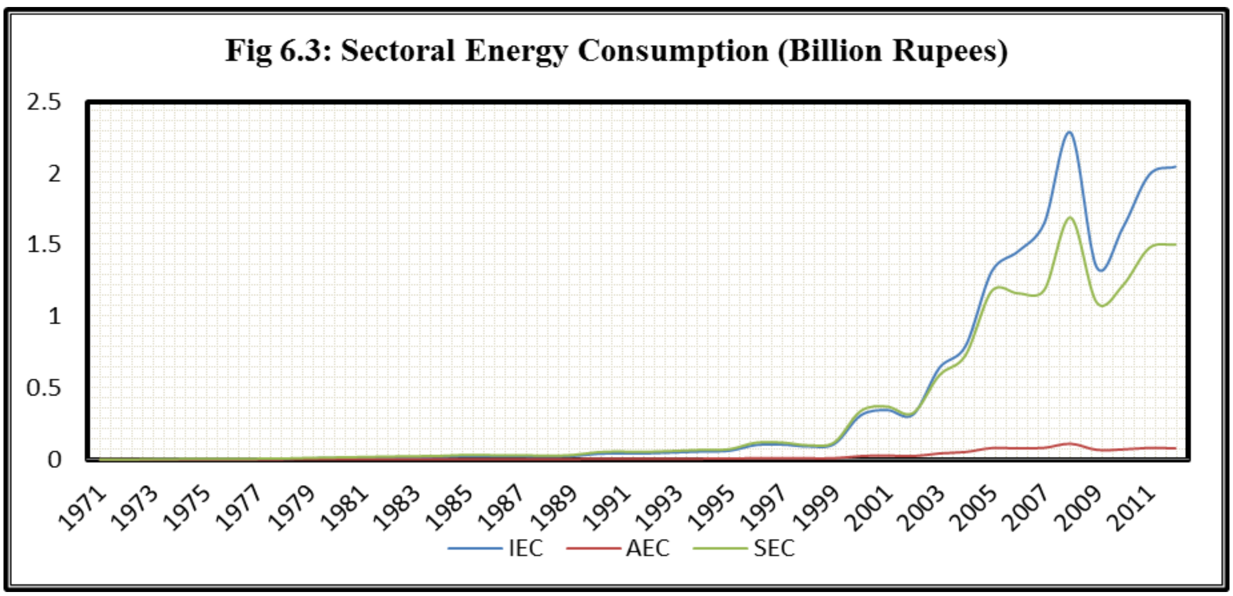
6.7 Depreciation of Physical Capital

Value added is the net output of a sector after adding up all outputs and subtracting intermediate inputs. This component of D needs not to decomposed sector wise because value-added data is available according to sector. Corresponding depreciation of physical capital has already been subtracted from each sector gross value-added; depreciation of physical capital in the agricultural sector has been subtracted from agricultural gross value-added, depreciation of physical capital in the industrial sector has also been subtracted from industrial gross value-added and similarly, depreciation of physical capital in the services sector has been subtracted from service sector gross value-added.

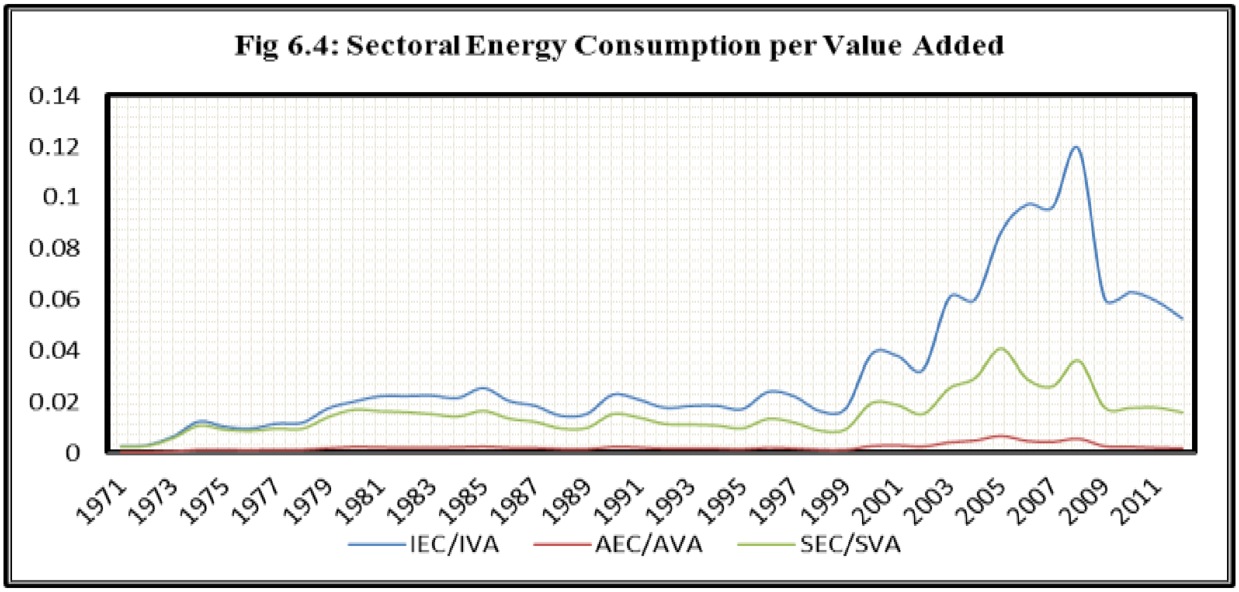
6.8 Energy Depletion

The study faced two problems in decomposing the series of energy depletion available in WDI; first the series is given for the economy as a whole while for sectoral analysis the study needs to have sector wise energy consumption, second the series is given in monetary terms while sector wise data are available in quantity terms in the environmental compendium of Pakistan's economy. The study developed weight from the data available in environmental compendium (the data are in physical units) and then the weight applied to overall series available in WDI (the data are in monetary term).

The following fig 6.3 shows energy consumption of the three sectors of the economy; service sector, agricultural sector and industrial sector:



The annual average industrial energy consumption is the highest followed by service sector and the lowest by agricultural sector. The values of energy consumption are the highest in 2008 in each sector and then sharply decline in 2009 in industrial and service sectors. And also a decline is observed in agricultural sector in the same period. From 1999 and onwards the sectoral pattern of energy consumption is significantly changed: sharp increasing trends with large dispersions especially in industrial and service sectors. . In order to analyze the energy consumption by sectors deeply, the study has to analyze energy consumption per value-added of the sectors. Following fig 6.3 shows energy consumption per value-added by the sectors:



The fig 6.4 represents energy consumption per value-added by the economy's three sectors. Energy consumption per value-added by the agricultural (AEC/AVA) sector is almost constant and close to x-axis over the period of analysis, while there are fluctuations in the rest of the two sectors' data. The behavior in the two sectors' data is similar but the industrial sector needs more energy than the service sector in order to produce one billion value-added. In the period 1979 to 1987 one billion value added in both the sectors needed more energy than in other years of the period 1971 to 1990. There is a sharp increase in the consumption of energy to produce one billion value-added from 1999 onwards by both industrial and service sectors but the industrial sector's energy consumption per value- added is higher than the service sector. The decrease in the industrial's sector energy consumption per value- added from 1983 to 1999 is due to technological improvement while the increase from 1999 to end of the analysis is due to replacement of capital for labor, in other words technology has become relatively capital intensive.

6.9 Mineral Depletion

The items covered by mineral depletion are associated with the industrial sector of the economy and do not need to be decomposed into sector, which is why these items were subtracted from the industrial value-added. The series of mineral depletion for the whole economy and the industrial sector is the same and almost plays no direct role in agriculture or service sector.

6.10 Forest Depletion

With reference to renewable resource depletion the only data available for Pakistan's economy are forest depletion while data for the other components of renewable resource depletion such as livestock, fishery etc. are unavailable. Forest depletion is associated with the economy's agriculture sector and does not need to be decomposing according to sectors. This item was subtracted from agricultural value-added. The series of forest depletion for the whole economy and for agriculture sector is the same and almost plays no direct or negligible role in the industrial or service sector.

Forests, as a renewable natural resource, play an important role in cleaning the polluted air and protecting the land from soil erosion. Pakistan had 3.28 percent area of total land under forest in 1990 which declined to 2.74 percent in 2000 and 2.47 percent in 2005 which is far below the required area specified by experts

6.11 Cost of water pollution

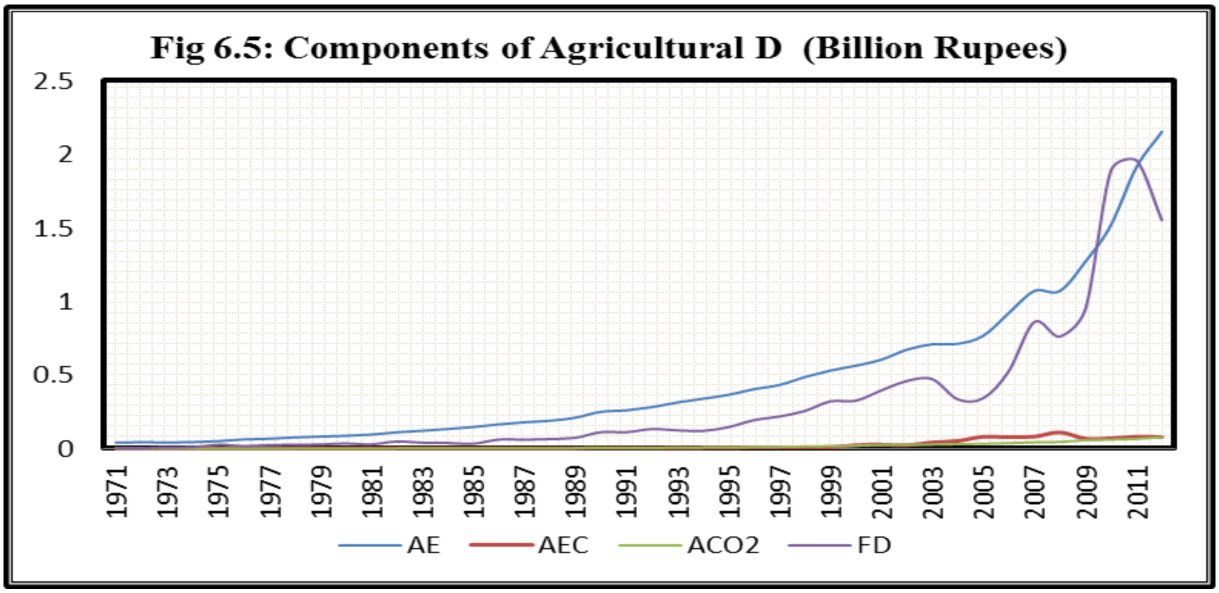
Water pollution costs are associated with only the industrial sector of the economy. Due to unavailability of data with reference to the two other sectors of economy, only industrial sector waste was used, i.e. waste emitted from chemical, clay, glass, food, metal, paper, textile, wood and other industries. The series do not need to be separated according to sectors, thus this item was subtracted from industrial value-added consumption. The series of water pollution cost for the whole economy and industrial sector is the same and almost plays no direct role in agriculture or the service sector. See chapter 4 for the graphical analysis of the data of water pollution cost.

6.12 Agricultural sector

The total area of the country is 79.61 million hectares, 27 percent is under cultivation. The agriculture sector of Pakistan economy has a vast irrigation network. According to the 'Strategic Country Environmental Assessment (2008) 40 percent of irrigated land has been affected by salinity and water logging. Farmers irrigate the farms when water is made available rather than when it is needed which results in an increasing in water logging, damage structure of the soil and causes low productivity. The consequence of low productivity is low net value-addition in the output which implies that the chance of sustainability of the sector would be reduced. Similarly, degradation of the land in the form of water-logging and lower fertility also affects the sustainability of the sector negatively. However, due to data non-availability the study does not take into account the cost of land degradation. The importance of agriculture sector to the economy can be assessed in two ways: first, it provides food to the individuals of the economy and fiber for agro-base industry; second, it provides a market for many industrial goods. It also provides the most precious foreign exchange through the export of agro-based products. These products in the textile industry obtain a large amount of its raw material from the agricultural sector of the economy. The agriculture sector is considered to be the backbone of the economy by experts and they recommend that the government should pay attention to proper facilities; such as appropriate and timely irrigation, price, the provision of seeds of better quality, encouraging provision of small loans to growers, searching for new markets for the export of fruits and vegetables, and elimination of corruption etc, under a sustainable system.

6.12.1 D-Series of Agricultural Sector

Following fig 6.5 shows components of agricultural D: AE is real cost of agricultural emission other than CO2, AEC is the real costs of agricultural energy consumption, ACO2 is the real costs of agricultural CO2 and FD is real forest depletion.



AE has the highest value of the components from 1971 to 2009, in the same period the second largest of the components is deforestation. In 2010 and 2011 the deforestation is the largest of the components and remains second largest of the components in 2012. Agricultural energy consumption and costs of agricultural CO2 are comparatively low. In most of the period AEC is greater than ACO2. The sum of the components is D of agriculture sector. Following fig 6.6 shows the D-series of agricultural sector:

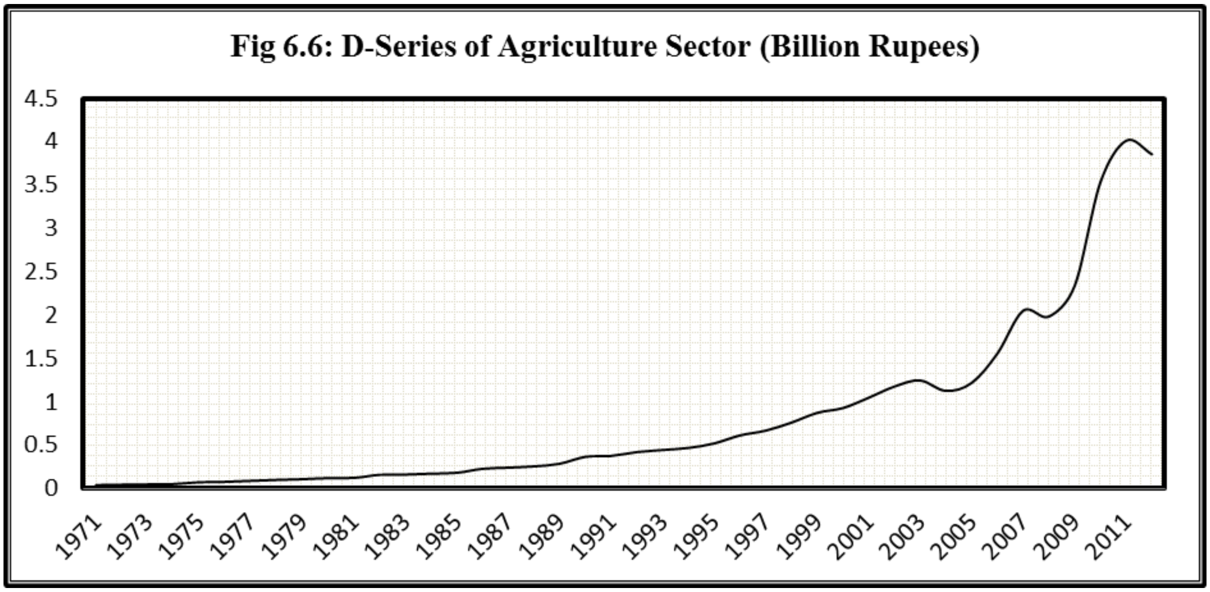
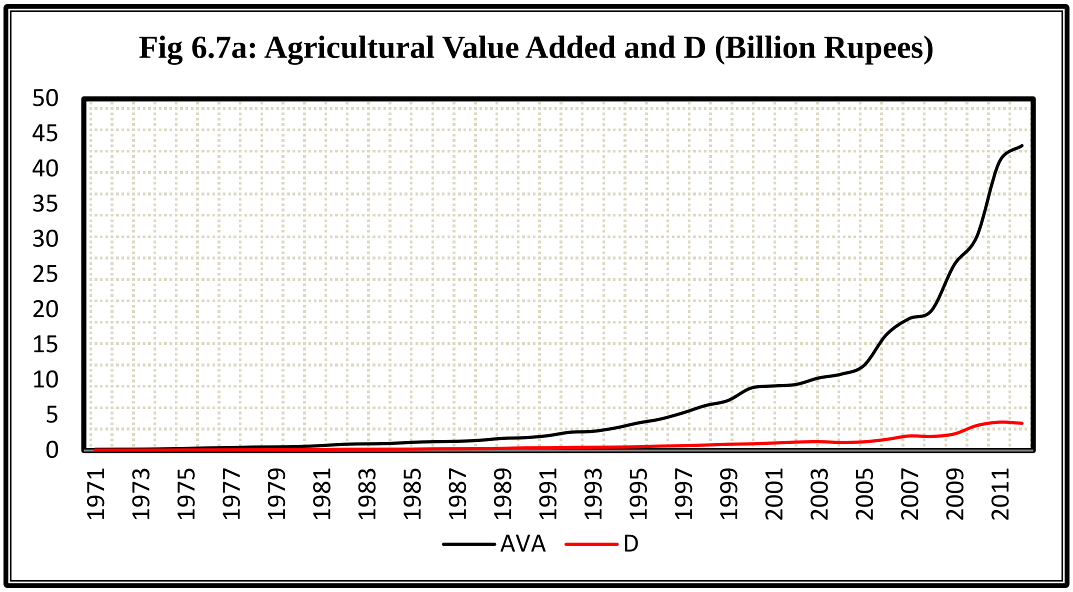


Fig 6.6: D-Series of Agriculture Sector (Billion Rupees)

The D series of agricultural sector starts from the minimum 0.0425 billion in 1971 and maintains an upward trend reached to the maximum 4.013 billion in 2011. From 1971 to 2003 there is comparatively smooth upward trend in the series, but onwards till the end, the trend is sharp increasing with comparatively large fluctuations.

6.12.2 Value-added of Agriculture Sector

According to previous literature salinity and water logging are responsible for more than 21 billion rupees per year loss in agricultural output while post-harvest losses in fruits and vegetables are up by 49 billion rupees per year, and thus cause loss in agricultural value added. Fig 6.7a shows the comparison of agricultural value added and D.



In the graph given above, the AVA line represents agricultural value-added series of the economy. The D line represents D-series of the sector. D-series has already been described; the following is a description of VA series.

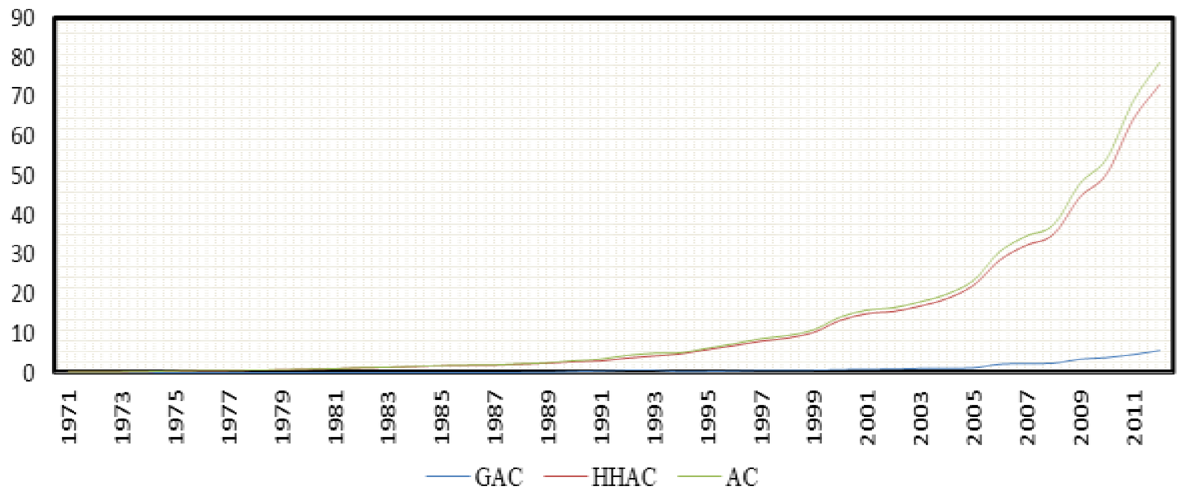
There is an upward trend in both value-added AVA and net value-added: the difference between AVA and D is net value added of the sector. The growth of net value-added in the agricultural sector in the earlier 1970s was retarded. During 1978-83 the growth rate was more than 4.6 percent while in the eighties it was around 4 percent due to favorable weather, water supply, pricing policies and the use of other inputs. The difference between the two series is increasing which is a good sign for weak wealth sustainability because D per value added is decreasing with respect to time, this implies that agricultural sector is producing a given level of output comparatively at less and less wealth damages of the economy, but in absolute figures it is still higher and needs further reduction.

Regression analysis given in the appendix to the chapter shows positive and statistically significant relationship between agricultural D and agricultural value added in long run.

6.13 Agricultural Consumption by the Economy

To estimate genuine value added of the sector, the study has to subtract the consumption of the sector from its net value added which equals to value added less D. The study estimated the consumption of the sector by the economy; the consumption of the sector by households plus by the government. The fig 6.7b below contains the sector consumption by households and government:

Fig 6.7b: Consumtion of Agriculture Sector by Household and Government (Billion Rupees)

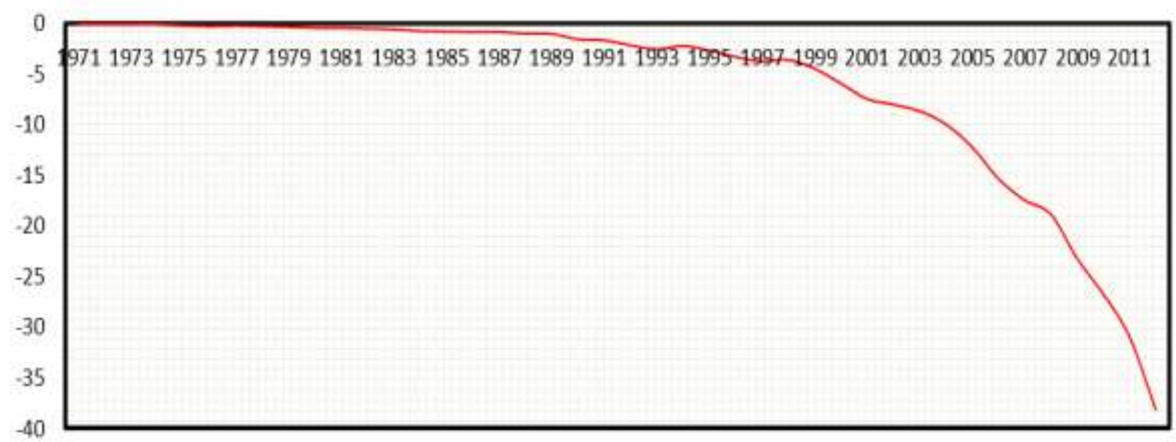


AC in the above fig shows agriculture consumption by the economy which is the sum of the consumption by household and government. GAC shows agricultural consumption by government and HHAC reflects the behavior of agricultural consumption by households.

6.14 Genuine Savings of Agriculture Sector

The study estimated genuine value added of the sector by subtracting agricultural consumption by the economy and D of the sector from value added of the sector. Then the study estimated genuine savings of the sector by adding EE with genuine value added. Following fig 6.8 shows the genuine savings of agriculture sector of the economy;

Fig 6.8: Agricultural Genuine Savings (Billion Rupees)



The fig 6.8 of genuine savings of agriculture sector reflects that the sector is not sustainable for even a single year of the analysis. Since throughout of the period of analysis values of genuine saving are negative which implies that the sector's genuine value added is not sufficient for weak sustainability of the sector. There is downward polynomial of degree five trend in fourth quadrant of the graph which implies that with respect to time agricultural sustainability is becoming more and more severe issue or the rate of agricultural wealth depletion is increasing. Therefore the sector does not fulfil the criterion for weak wealth sustainability and thus the sector is not sustainable.

6.15 Industrial Sector

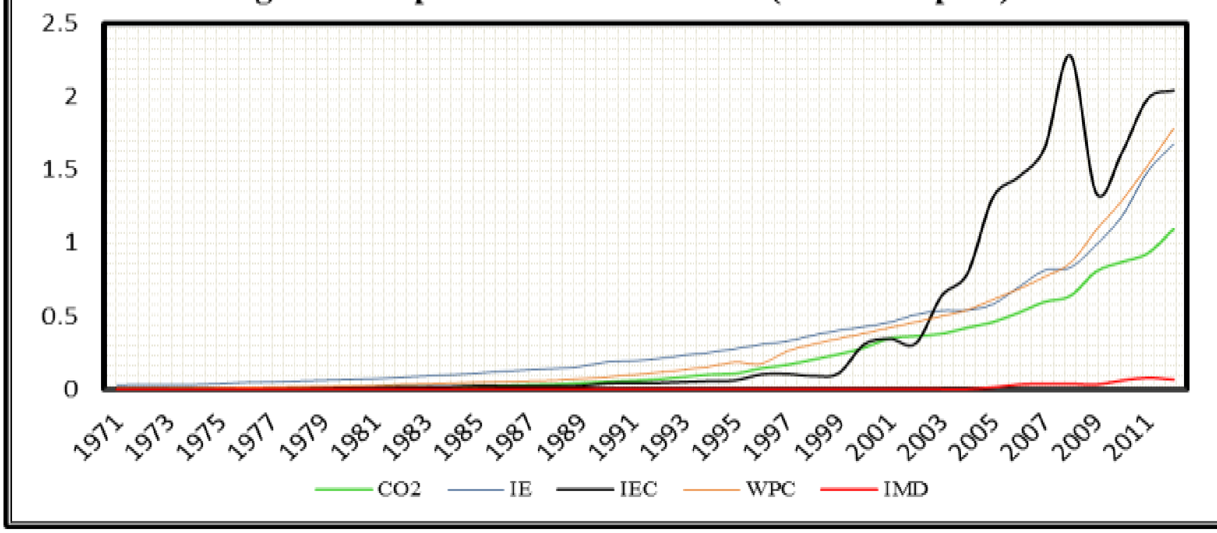
Agro-based industries discharge organic water pollutants and non-agro-based industries discharge both organic and non-organic water pollutants. Toxic and hazardous wastes are also discharged by non-agro-based industries such as metal, steel, chemical and textile industries. The textile industry discharges highly toxic chemicals and dyes while the leather industry discharges lime water and chemicals, sodium sulphides, chromium pigments and portentous.

In Karachi, the capital of Sindh, industrial wastes are discharged into the Lyari and Malir rivers and then transmitted into the Karachi Sea which has threatened the marine wealth. Punjab's Fertilizer industry at Multan discharges its pollutants into Multan canal which creates problems for irrigated land through seepage; it also generates contaminated drinking water which leads to stomach diseases. Similarly, the industrial pollutants in Punjab at Faisalabad are discharged into a long drainage channel and then transmitted to rivers Chenab and Ravi which create a problem for fertile land, and emissions from the industry namely fluorine gases etc. are responsible for eye irritation and unpleasant odor in the region. The chemical industries in Punjab at Kala Shah Kaku near Lahore discharge their wastes into river Ravi through deg Nullah. The contaminated water in the Nullah cannot be used for irrigation purposes, each year hundreds of tons of fish have been lost and a number of animals have died due to drinking the contaminated water. Besides water pollution, air pollution from the industries also creates plethora of health hazards i.e. sore throat, chronic cough, eye irritation and unconsciousness. An industrial complex in Punjab on the Lahore road near Sheikhupura discharges waste water on to open land causing land water pollution. An industrial complex in Peshawar, the capital of Khyber-Pakhtoonkhwa, discharges waste water into river Bara. Through river Kabul the wastes are transmitted into the Indus which threatens agriculture, fish life and creates problems for recreation and boating. Additionally, the emissions from the industries create many health hazards such as sore throat, chronic cough and respiratory diseases. According to Kemal et al in a report entitled, 'Sustainable Development in Pakistan with Focus on Environmental issue' there exists a trade-off between accelerated industrialization and environmental control. Therefore, accelerated industrialization with little attention to environmental issue may lead to high D and thus high national wealth depletion and low and/or negative genuine savings. Pakistan's textiles are concentrated in low value added products. Other things remaining the same low value added implies low genuine value added which further implies low and/or negative GS.

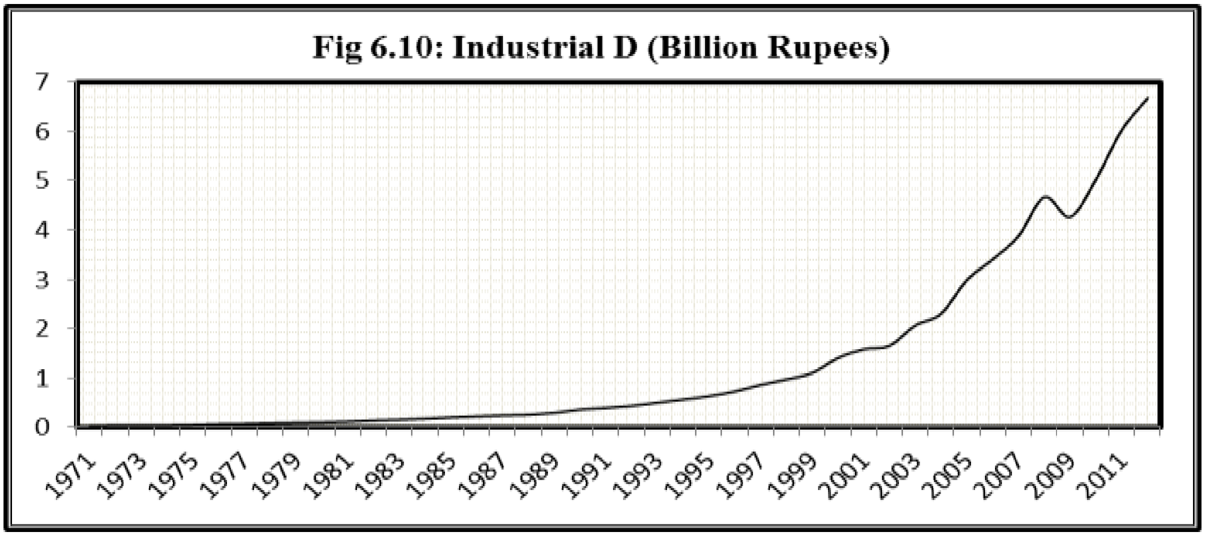
6.16 Industrial D and Its Components

The industrial D contains costs of CO2 emissions, costs of emissions other than CO2, energy consumption, water pollution cost and mineral depletion. Following Fig 6.9 shows the graph of the components of industrial D;

Fig 6.9: Components of Industrial D (Billion Rupees)



In above fig 6.9 IMD line shows the mineral depletion by industrial sector of the economy; the lowest component throughout the period of analysis. IE is the industrial emission other than CO2; the component is the largest from 1971 to 2003, but from 2003 to 2012 in most of the periods it is the third largest components. The line IEC is the industrial energy consumption; from 2003 to 2012 which is the largest component. CO2 is continuously increasing before 2003 and its third largest component but from 2003 to 2012 it is the second smallest component. WPC is water pollution costs caused by the sector and exhibits exponential trend, during the end period of analysis it is the second largest component. The sum of the components is D of the sector. Following fig 6.10 shows D of industrial sector of the economy;

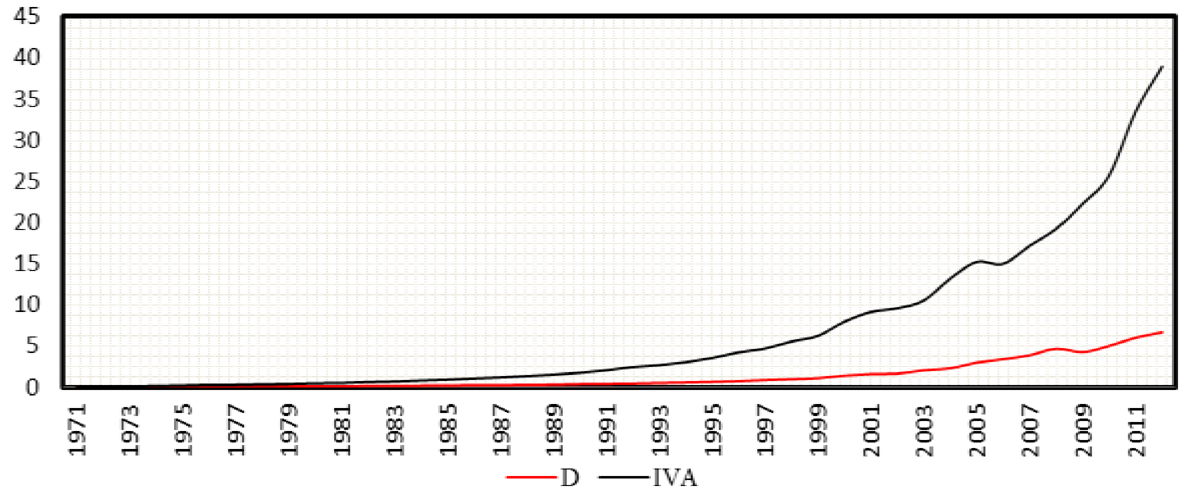


The behavior of D-series of industrial sector can be judged from the curve in graph given above. The series starts from the minimum value and ends at the maximum value, the series are growing exponentially. Initially, the trend in the series was slowly increasing till 1996 and after that it started increasing at an accelerated rate till the end. The annual average increase in the series is 1.305 billion.

6.16.1 D-series and Value Added of Industrial Sector

In Fig 6.11 the IAV curve represents industrial value-added series while D is the sum of the negative indicators of the sector, and the difference between the series is net value-addition of the sector.

Fig 6.11: D-Series and Value Added of Industrial Sector (Billion Rupees)



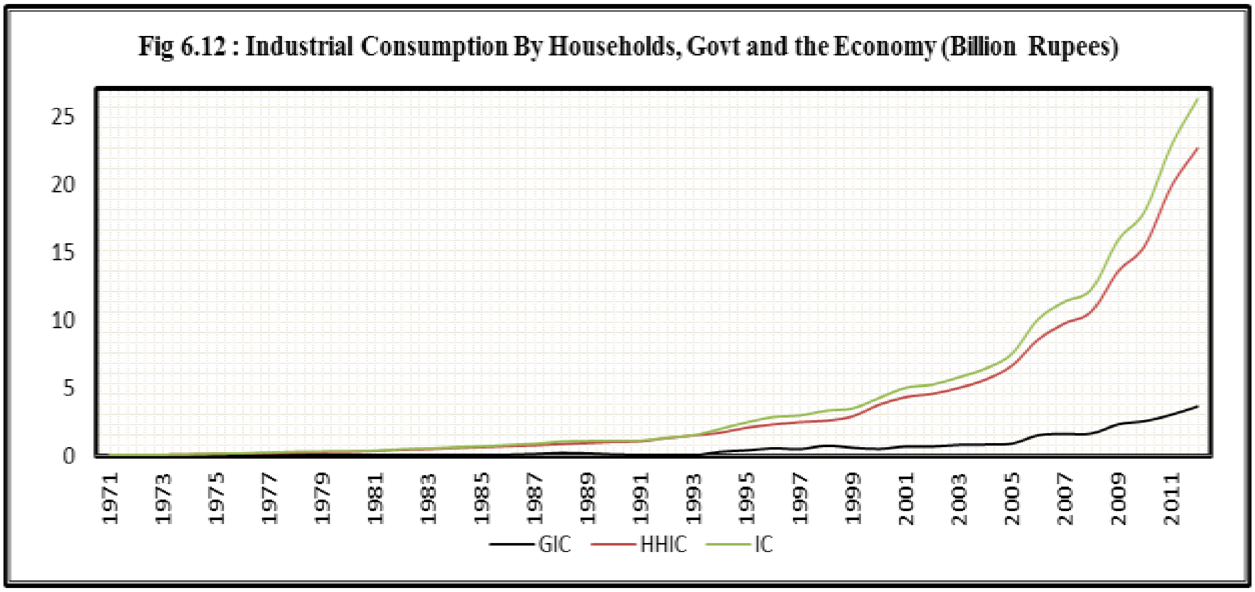
The difference between the two series is increasing which is good for the sector's sustainability, also implies that D per value added is decreasing with respect to time. With respect to time the sector' D is decreasing per for a given level of output. Therefore, the technology of the sector is becoming comparatively environmental friendly.

The econometric analysis given in the appendix to the chapter shows positive and statistically significant relationship between industrial D and industrial value added in long run. There is short run adjustment mechanism to long run path but the coefficient with one lag period is statistically not significant.

For genuine value added of the sector the study has to subtract the industrial consumption by the economy from the net value added of the sector.

6.16.2 Consumption of Industrial Sector by the Economy

The study estimated the household consumption of industrial sector and government consumption of the sector. The sum of the two is consumption of the industrial sector by the economy. Fig 6.12 below contains the graphs of the consumption of the sector by household, government and the economy;

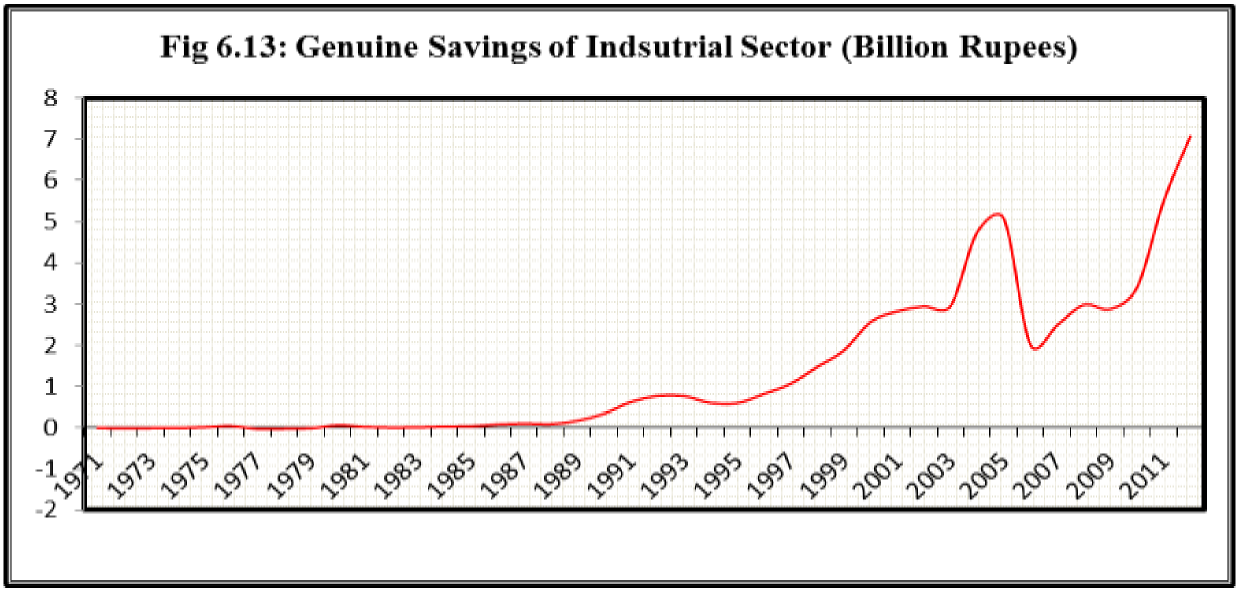


IC in fig 5.12 is industrial consumption by the economy. HHIC is the line reflecting the behavior of household industrial consumption. Similarly GIC line reflects the behavior of government industrial consumption. The three series exhibit increasing trends. With respect to time the consumption demand for industrial products by the economy is almost growing exponentially.

The difference between net value added of the sector and consumption of the sector is genuine value added. Genuine value added plus education expenditure are genuine savings of the sector. Let us estimate the genuine savings of the sector.

6.16.3 Genuine Savings of Industrial Sector

The study estimated GS of the industrial sector by subtracting D and consumption of the sector from its value added and then added education expenditure. Fig 6.13 below shows behavior of GS of industrial sector;



The graph given above shows that industrial sector had a mixed trend between 1971 and 1982. In some years it was sustainable while in other years it was not. After 1983 it was sustainable and increasing but showed some fluctuations. The industrial sector had more fluctuations between 2003 and 2012. A sharp decrease was seen in 2006 to 2008 while a sharp increase was seen in years 1995 to 2002. GS of the sector is negative from 1971 to 1972 and then 1977 and 1978. GS is positive in the rest of the years. Overall the sector is fulfilling the criterion of weak wealth sustainability. The causes of negative GS of the sector could be 1971 war between India and Pakistan and nationalization policy of the government.

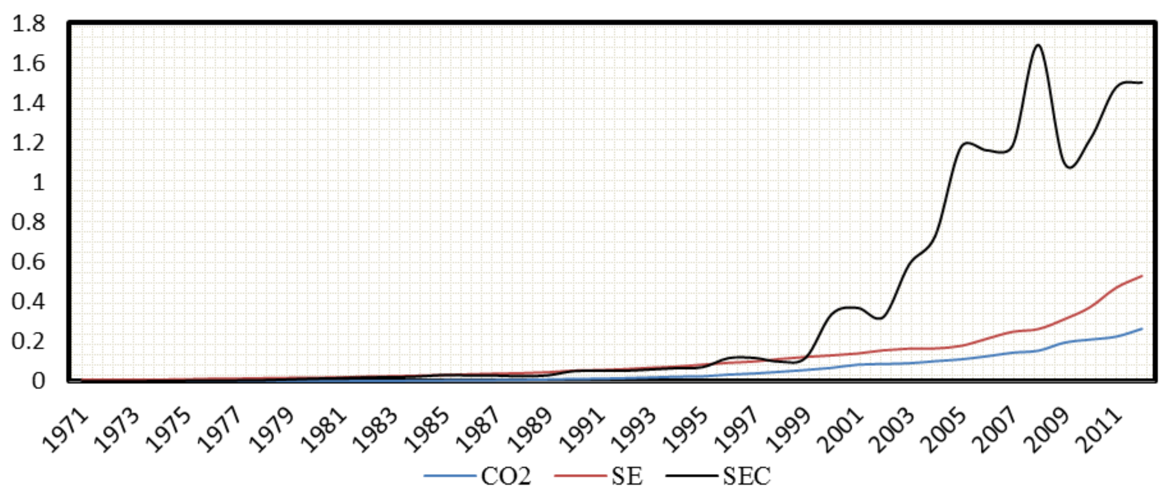
6.17 Service Sector

This sector of an economy that produces services rather than goods is called service sector of an economy, the services include finance, wholesale and retail trades, communication, transportation, education and health. The service sector also includes all professional services such as engineering and medicine, all consumer and government services, housekeeping, psychotherapy, plan preparation, guided tours, nursing and teaching etc. are also included in the sector. The sector also includes transportation, distribution and sale of goods from producer to consumers as may happen in wholesaling and retailing. It may also include provision of services such as tourism or entertainment, where the goods may be transformed in the process of providing the services such as in the hospitality sector. There may not even be any goods involved, people and services to people might involve interaction with one another rather than transforming physical goods. In technical language we may define the Service sector as the sector which includes human capital, social capital, skills, know-how and the services provided by transport and communication. It also includes governance. Nevertheless, this study focuses on the transport section of the sector.

6.17.1 D of Service Sector and Its Components

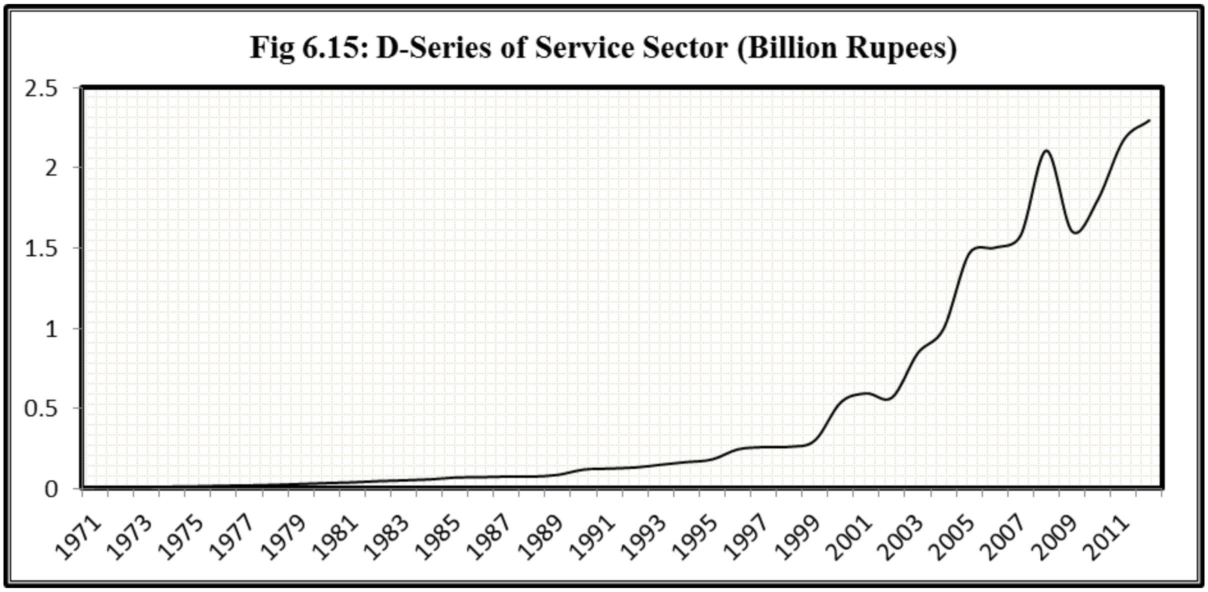
D of service sector includes CO2 emission, emission other than CO2 and energy consumption. Fig 6.14 shows behavior of the components of D of the service sector;

Fig 6.14: Components of D of Service Sector (Billion Rupees)



CO2 emission is the smallest component of the sector. SE line represents the behavior of the emissions other than CO2 from 1999 to 2012 and is the second largest component of the D. SEC is the energy consumption of the sector. From 1999 to 2012 SEC and is the largest component of the D. It is a sharply increasing from 1999 to 2008. In 2009 sharp decreases was observed and again an increase was observed in 2010. In the same period the energy prices in international market faced large fluctuations.

The sum of the components is D of the sector. Following fig 6.15 shows the behavior of D of the service sector;

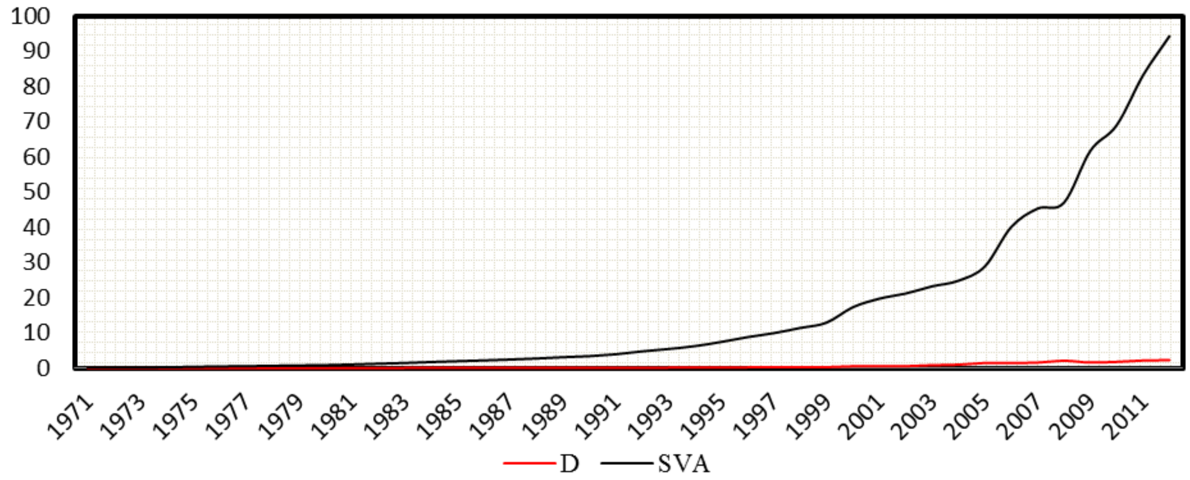


The above fig represents the behavior of service sector D. since the energy consumption is the dominant component of the D therefore, the behavior of D and energy consumption of the sector are similar. From 1971 to 1999 there is comparatively smooth and slight increasing trend in the D but there is a sharply increasing trend from 1999 to 2008. In 2009 sharp decrease was observed and again an increase was observed in 2010 to 2012. The difference between D and value added of the sector is net value added. Let us compare the D and value added of the sector.

6.17.2 D and Value Added of Service Sector

In fig 6.16a the value added of service sector is increasing exponentially with respect to time which is a positive sign for weak wealth sustainability. D series of the sector is close to x-axis implying low values of the D which is also a positive sign for the sustainability.

Fig 6.16a: D-Series and Value Added of Service Sector (Billion Rupees)

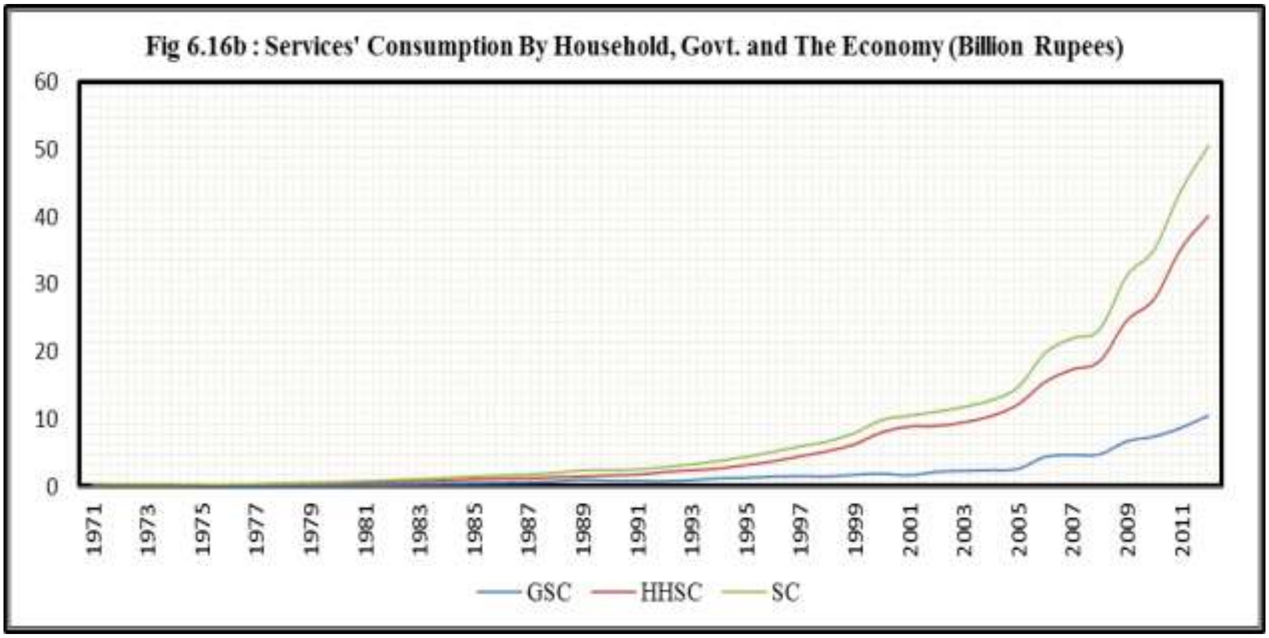


The difference between D and service sector value added SVA is increasing implying that net value added is also increasing exponentially with respect to time which is also a positive sign for weak wealth sustainability. But genuine value added depends on the consumption of the sector. Let us estimate consumption and genuine value added of the sector.

The econometric relationship between service sector D and its value added given in the appendix to the chapter is positive and statistically significant in the long run. The error correction term is insignificant at 5% level of significance but significant at 10% but the short run coefficients are statistically insignificant.

6.17.3 Consumption of Service Sector

The study estimated the household consumption of service sector and government consumption of the sector. The sum of the two is consumption of the service sector by the economy. Fig 6.16b below contains the graphs of the consumption of the sector by household, government and the economy;

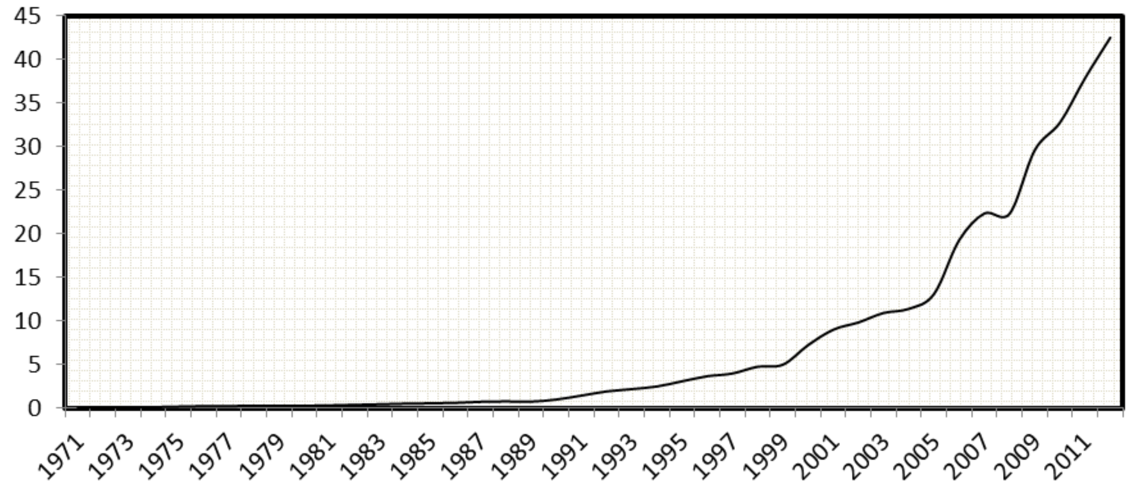


SC in fig 5.12 is services consumption by the economy. HHSC is the line reflecting the behavior of household services consumption. Similarly GSC line reflects the behavior of government services consumption. The three series exhibit increasing trends. With respect to time the consumption demand for services by the economy is growing exponentially. The difference between consumption and net value added expenditure of the sector is called genuine value added of the sector. Genuine value added plus education expenditure is GS of the sector.

6.17.4 Genuine Savings of the Service Sector

The study estimated GS of the service sector by subtracting D and consumption of the sector from its value added and then added education expenditure. Fig 6.17 below shows behavior of GS of service sector;

Fig 6.17: Genuine Savings of Service Sector (Billion Rupees)



GS of service sector of the economy has positive values throughout the period of the analysis. Therefore the service sector verifies the criterion for weak wealth sustainability throughout the period of the analysis. The series is growing exponentially implying big contribution of the sector to the economy's wealth creation, with respect to time the contribution of the sector is increasing. Therefore, the service sector of the economy is sustainable.

Chapter # 7: Conclusion

The study analyzed the weak wealth sustainability of Pakistan's economy overall and by sectors through genuine savings and value-added approaches. The unique feature of the study is sectoral sustainability analysis along with the analysis of overall economy. The basic focus of the study is savings and value-added. Therefore, savings and savings function of the economy as a whole have been analyzed in the study. The D-functions by sectors and overall have also been analyzed. The main conclusions of the study are as following:

7.1 Conclusions of the Overall Analysis

On average the economy's wealth is sustainable including net transfer in the definition of savings. From 1971 to 1977 GS is negative implying weak wealth depletion because of 1971 war between India and Pakistan, and nationalization policy since in the same period industrial sector had negative GS. In 2008 the GS is also negative due to financial crisis and fluctuations in energy prices in international market. For rest of the years the GS estimates are positive and imply weak wealth sustainability.

With respect to time the technology of the economy is becoming comparatively environmental friendly since pollutions per unit of GDP is decreasing throughout the period of analysis and also per unit of GDP it is causing less and less D, implying increase in genuine value added at constant consumption. Although the behavior of components of D is different with respect to time but on average the pollution costs is the highest followed by depreciation of produce capital and the lowest is natural resource depletion. GS behavior is comparatively more sensitive to energy depletion since 1999 onwards. The behavior of D is explained by output positively in long run but not in short run. This implies that D has no optimizing behavior over the period of analysis.

Income of the economy positively affects savings in short run as well as in long run. It implies, an increase in income leads to increase in the chances of weak wealth sustainability to hold. Dependency ratio affects the savings negatively in short run as well as in long run; increase in dependency ratio reduces the wealth accumulation. Inflation also affects the savings negatively both in short run and long run. Increase in inflation increases the opportunity cost of holding money and thus reduces the purchasing power. In order to avoid the reduction in purchasing power of money the individuals shift to higher consumption in period of high inflation. The real interest rate also becomes negative resulting in lower savings. Therefore high inflation reduces the wealth accumulation in the economy. Real interest rate affects savings negatively in long run but there is no short run causality from real interest to savings. In the long run the income effect of real interest rate is dominant over the substitution effect because of the negative relationship. Increase in real interest rate reduces the wealth accumulation in long run. Wealth accumulation of the economy is positively affected by the net foreign transfers both in short run and long run; thus the complementary hypothesis is valid in the economy.

7.2 Conclusion of Sectoral Analysis

Although agricultural sector is producing per value added at lower D with respect to time which implies that the technology of the sector is becoming comparatively environmental friendly but the relationship between sector D and its value added is positive in long run and there is no short run causality. GS of the sector is negative throughout the period of analysis. Therefore, agricultural sector’s contribution to national wealth is negative and this sector is not fulfilling the criteria of weak wealth sustainability.

D per value added of industrial sector is also decreasing with respect to time which is a good sign for weak wealth sustainability but it is higher than that of agricultural sector. The relationship between industrial D and its value added is positive in long run but no causality in short run. GS of the sector is negative from 1971 to 1972 and then 1977 and 1978 and positive in the rest of the years. On average the sector is sustainable and contribution of the sector in national wealth is positive over the period of analysis.

Similarly, D per value added is decreasing with respect to time and is the lowest of the sectors which is a good sign for weak wealth sustainability of the economy. GS of the sector is positive through the period of analysis. Therefore the sector is sustainable and contribution of the sector in national wealth is positive.

7.2.1 Policy Recommendations for Agricultural Sector

As mentioned above only agriculture sector is not sustainable. Agriculture sector is considered to be the backbone of Pakistan's economy but it was not sustainable for even a single year during the period of analysis. Therefore, it is imperative to devise a policy for this sector in order to render it sustainable. There is a need to increase water supply and overcome the problem of salinity and water logging by installing more tube wells in the area, in order to decrease the level of underground water.

All the inputs of agriculture sector including physical features of soil, surface and underground water, Chemical fertilizers should be used in such a way that minimize D and maximize the value added, in other words genuine value added of the sector should be maximized. Technological progress and technical efficiency should be considered in such a way that maximizes genuine value added of the sector. In another words, more (R&D) is required for technological progress to increase productivity (value added) and improve environment (D) while the adopted technology should be used optimally in combination with quality inputs in order to increase the genuine value added of the sector.

7.2.2 General Recommendations and Areas for Future Research

The following are a few measures which should be followed in order to avoid recurrence of health hazards but the following recommendations need further research based on their cost-benefit analysis.

- The environment provided to the workers by the factory should be strictly monitored by the government to ensure proper ventilation, lighting, adequate health facilities and sanitary conditions in order to maintain workers' health and efficiency and thus increase in the genuine value added.
- The external diseconomies should be internalized by imposing taxes in order to discourage the negative externalities to reduce D and thus increasing the genuine value added.
- Environmental friendly technology should be promoted in order to reduce air and water pollution to reduce D and thus increasing the genuine value added.
- An alternative should be adopted to river pollution in order to save the damages to agriculture and human health.

7.3 Limitations of the Study

The study faced certain limitations during analysis; following are the limitations faced by the study:

- The analysis required investment in human capital; but the study found no data of investment in human capital by sectors. The overall series of human capital proxies for EE have been decomposed into sectors' EE under the uniform assumption.

- The data of produce capital depreciation have been taken from census of manufacturing industry (CMI) but the study found no data of agriculture and service sector. Therefore the study subtracted the industrial produced capital depreciation form overall series and then used the uniform assumption to get the series for agriculture and service sector.
- Overall series of CO_2 and other emissions have been decomposed into sector's emissions using the average weight developed from 1994 and 2008 data.
- The data of PM_{10} is available from 1990 onwards but the analysis requires the data from 1971. To estimate the missing observations from 1971 to 1989; the study extrapolated the exponential trend of the series backward.
- Due to data non-availability the study did not incorporate the land degradation and depletion of fishery in agricultural sector.
- Future studies can focus on sub-sectors.

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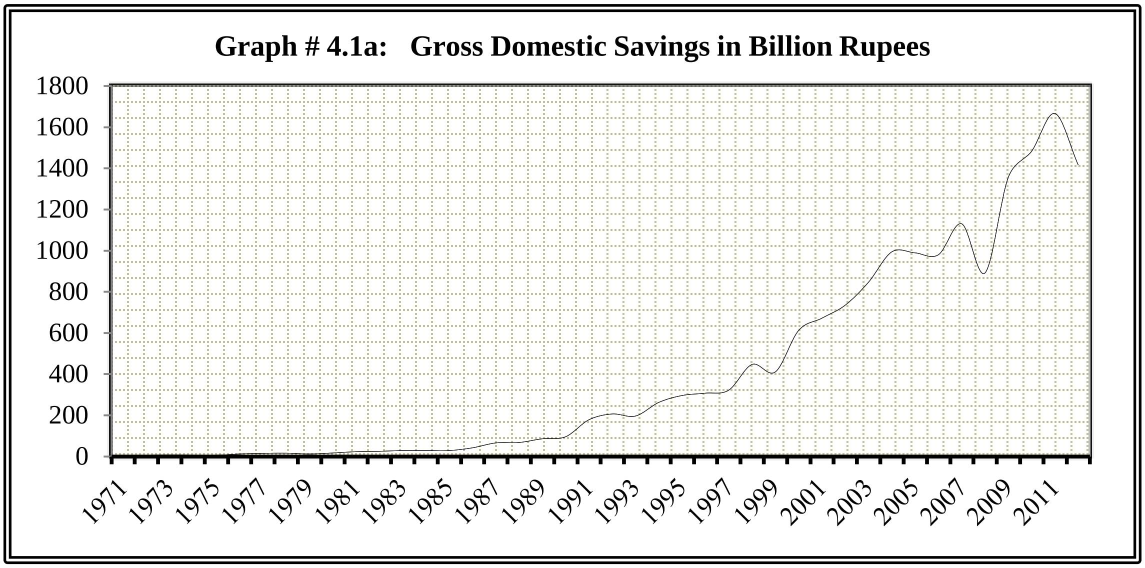
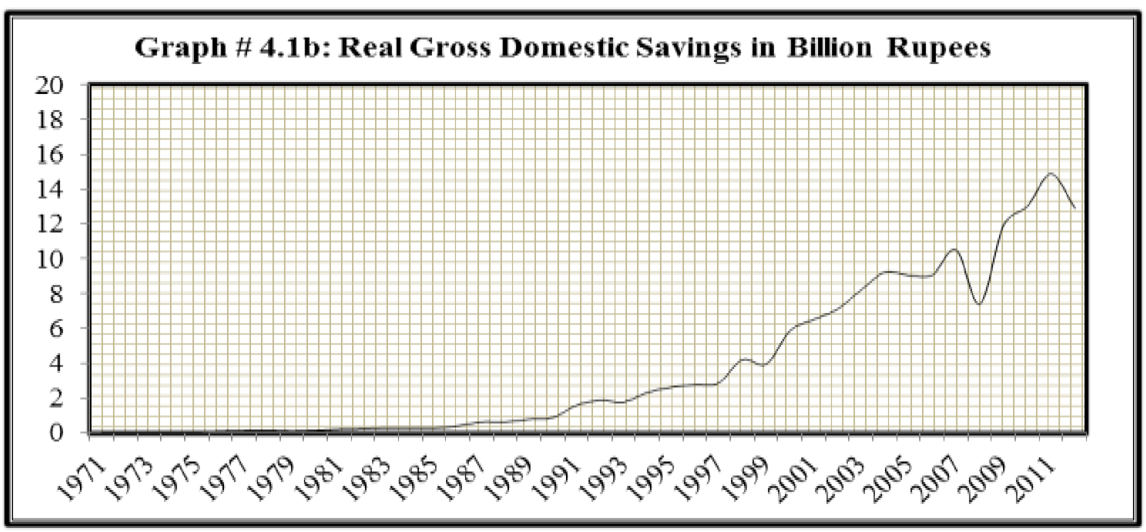
Appendix to Chapter # 4





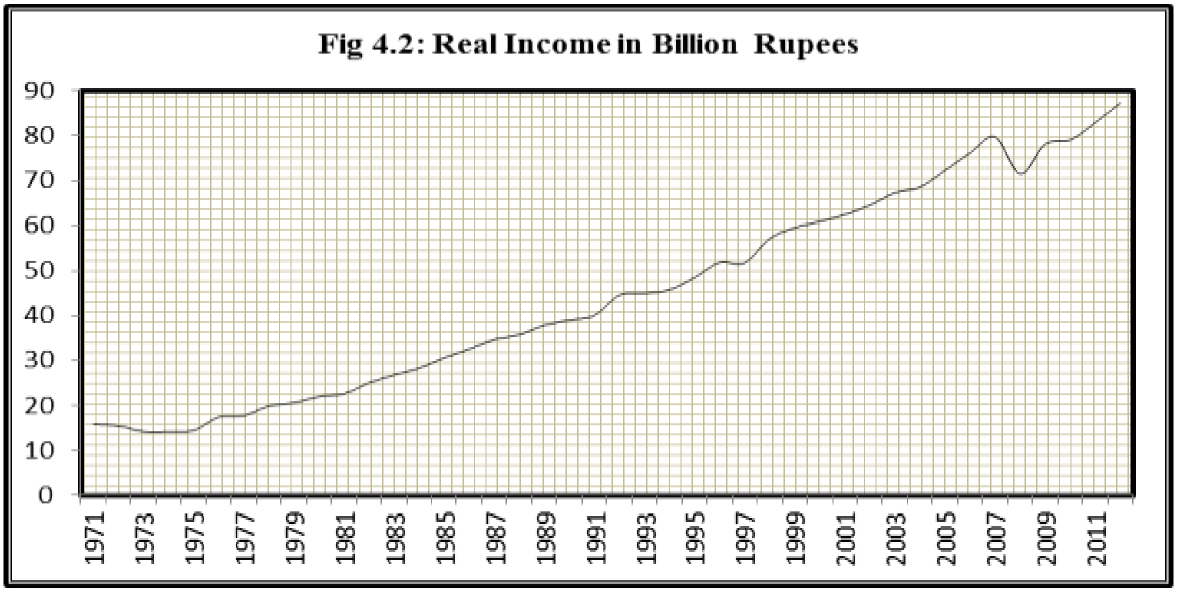


Fig 4.2: Real Income in Billion Rupees

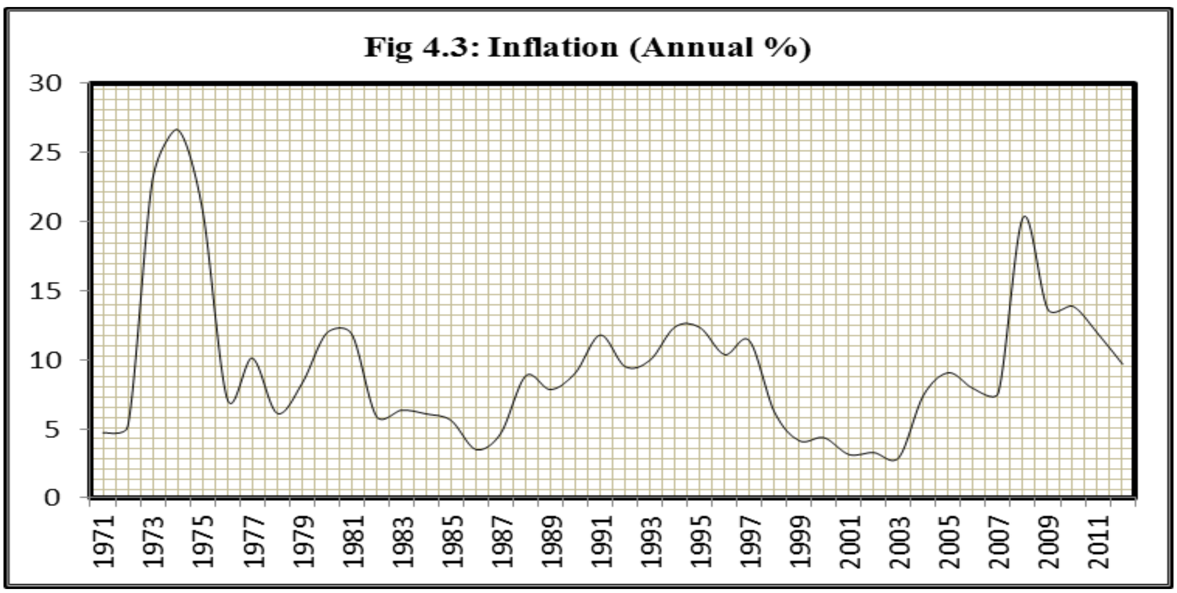


Fig 4.3: Inflation (Annual %)

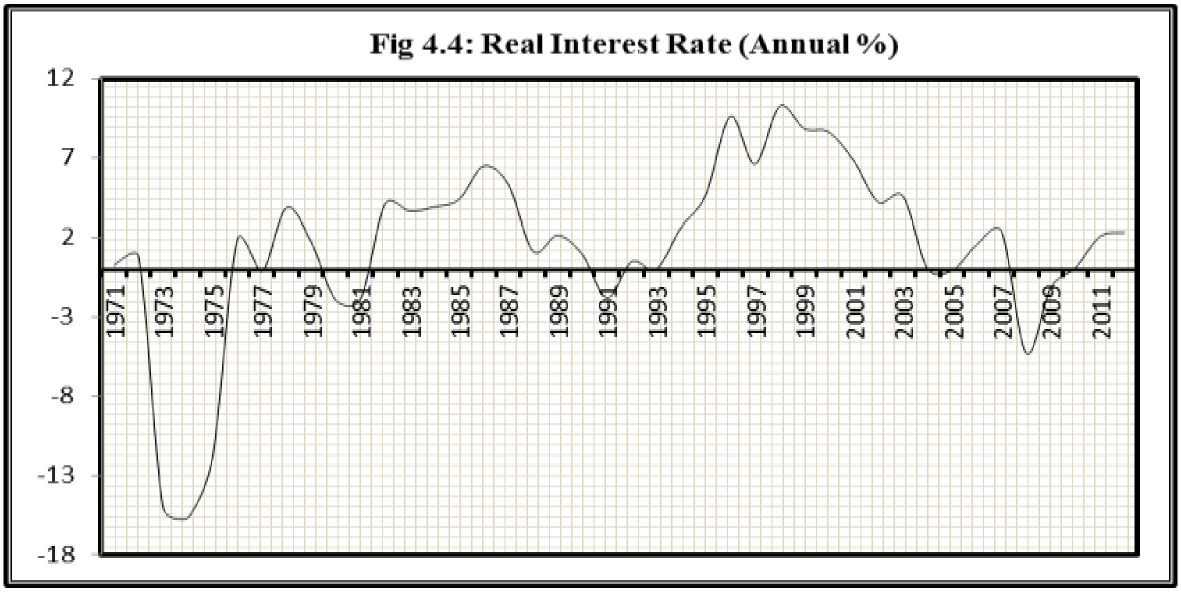


Fig 4.4: Real Interest Rate (Annual %)
12
7
2
-3
-8
-13
-18
1971
1973
1975
1977
1979
1981
1983
1985
1987
1989
1991
1993
1995
1997
1999
2001
2003
2005
2007
2009
2011

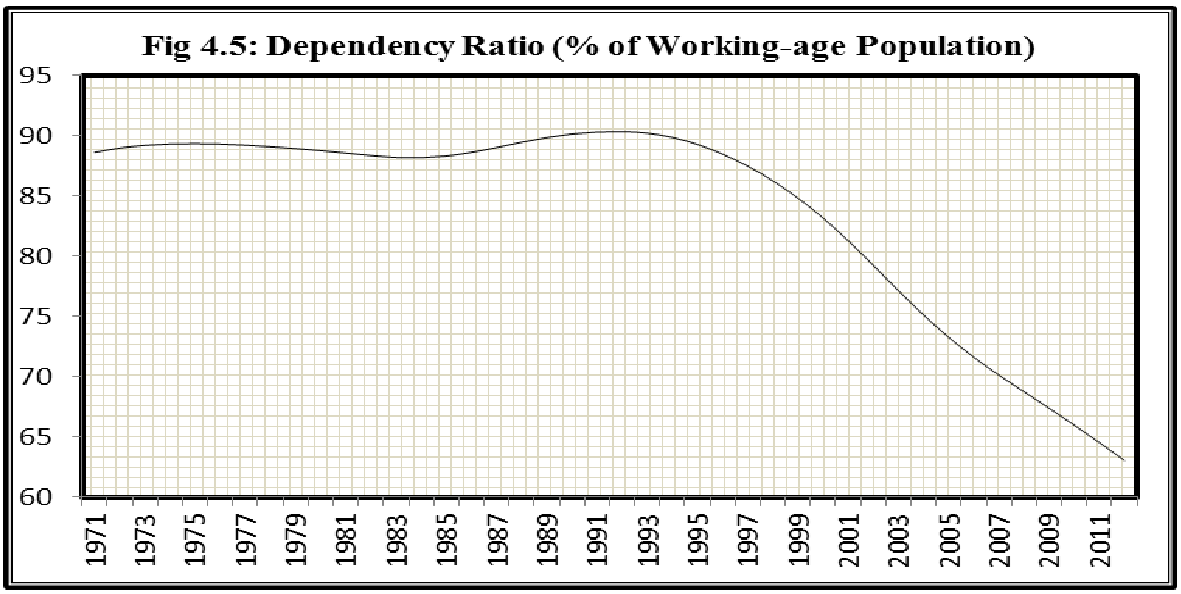


Fig 4.5: Dependency Ratio (% of Working-age Population)
95
90
85
80
75
70
65
60
1971
1973
1975
1977
1979
1981
1983
1985
1987
1989
1991
1993
1995
1997
1999
2001
2003
2005
2007
2009
2011

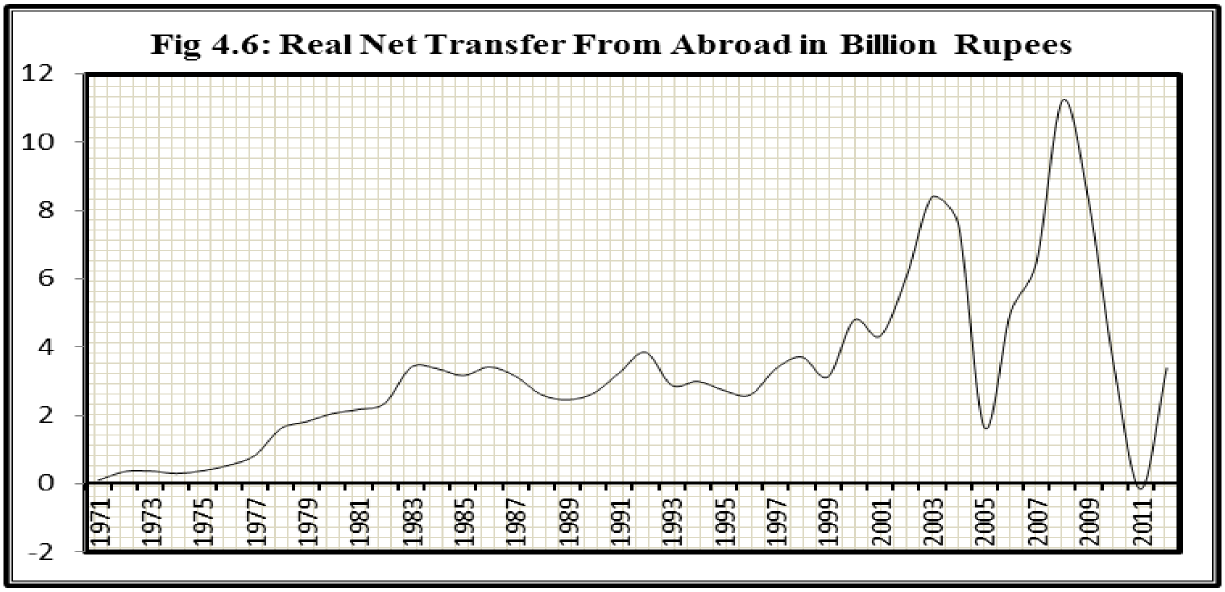


Fig 4.6: Real Net Transfer From Abroad in Billion Rupees
12
10
8
6
4
2
0
-2
1971
1973
1975
1977
1979
1981
1983
1985
1987
1989
1991
1993
1995
1997
1999
2001
2003
2005
2007
2009
2011

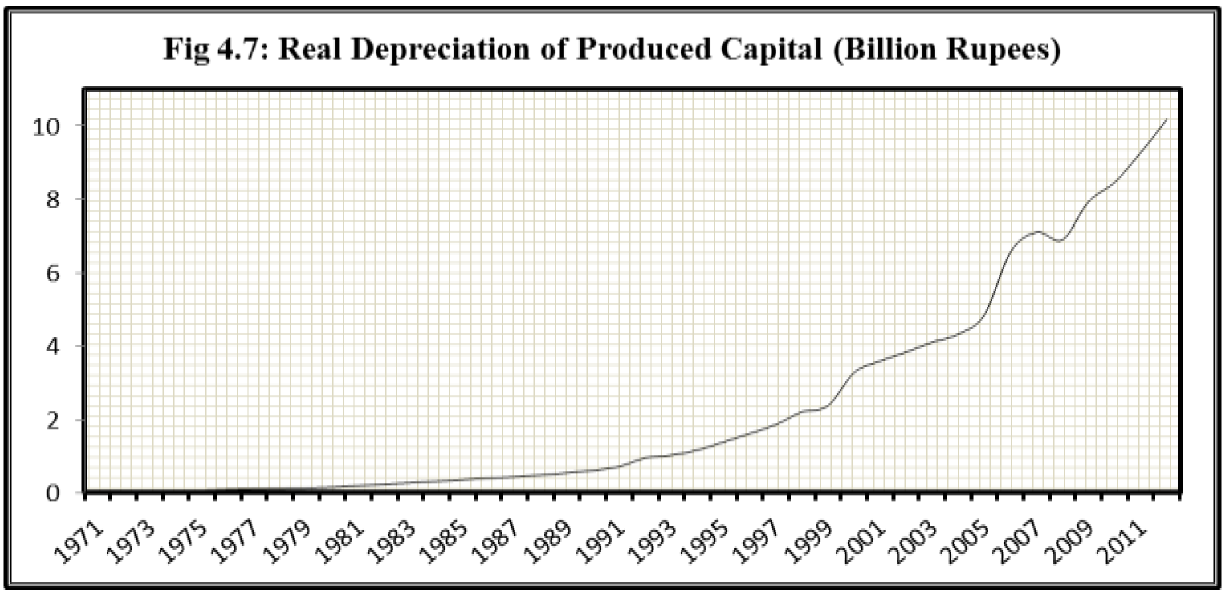


Fig 4.7: Real Depreciation of Produced Capital (Billion Rupees)
10
8
6
4
2
0
1971
1973
1975
1977
1979
1981
1983
1985
1987
1989
1991
1993
1995
1997
1999
2001
2003
2005
2007
2009
2011

Fig 4.8: Real CO2 Damages (Billion Rupees)

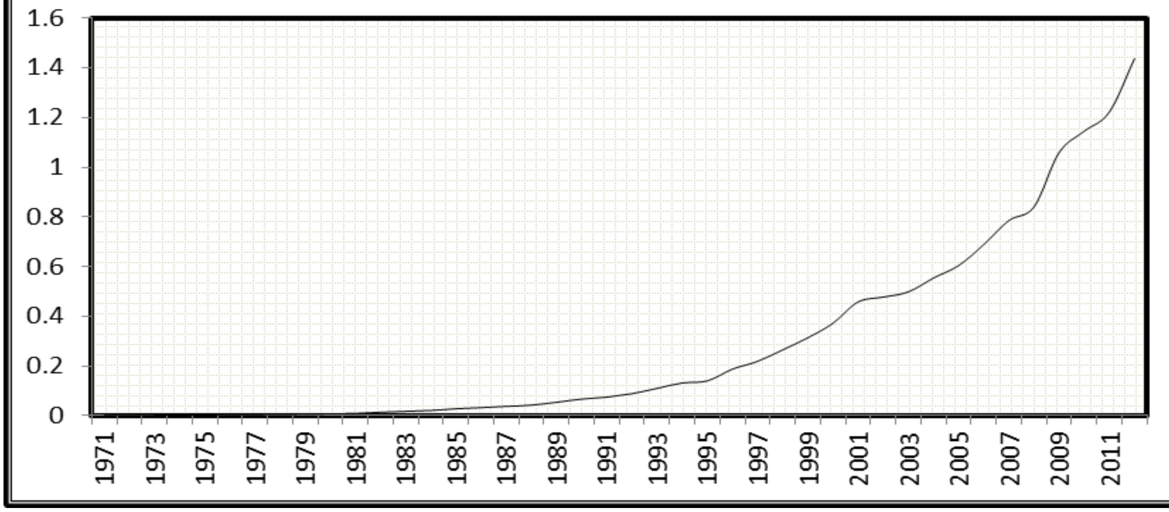
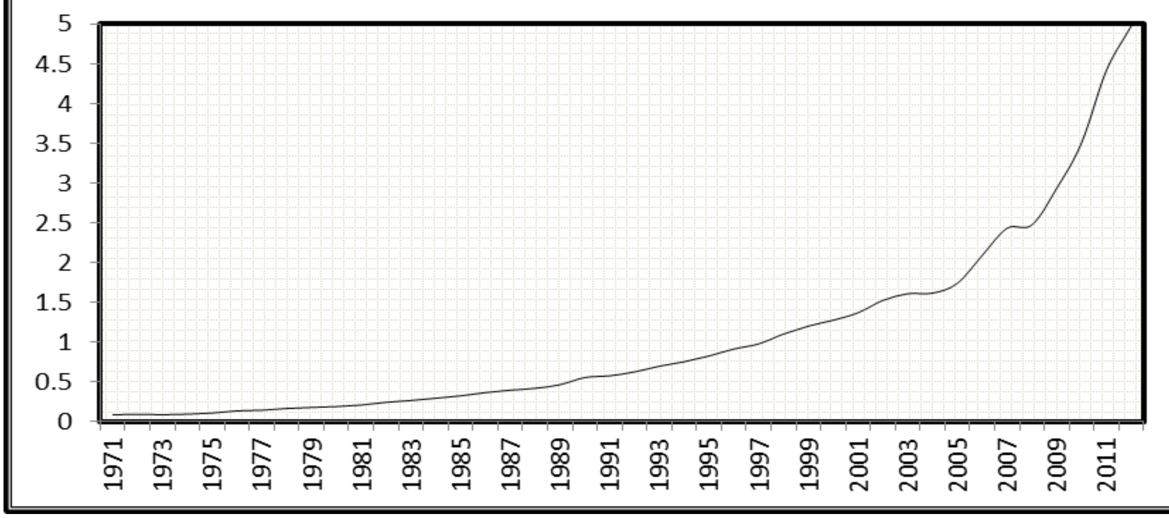


Fig 4.9: Real Particulate Emission Damages (Billion Rupees)



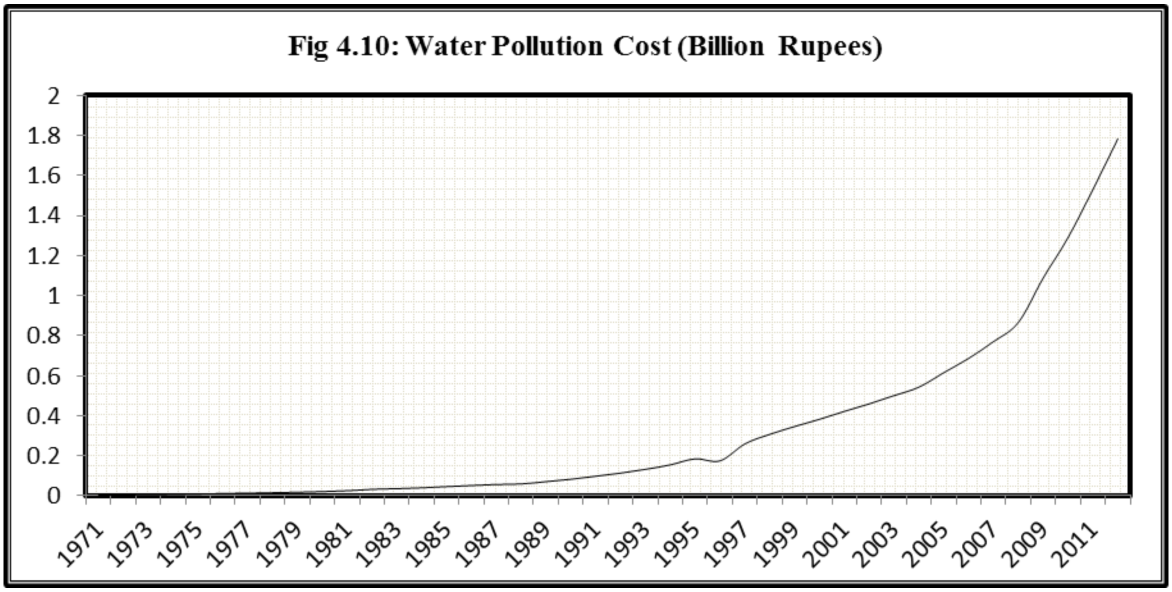


Fig 4.10: Water Pollution Cost (Billion Rupees)
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
1971
1973
1975
1977
1979
1981
1983
1985
1987
1989
1991
1993
1995
1997
1999
2001
2003
2005
2007
2009
2011

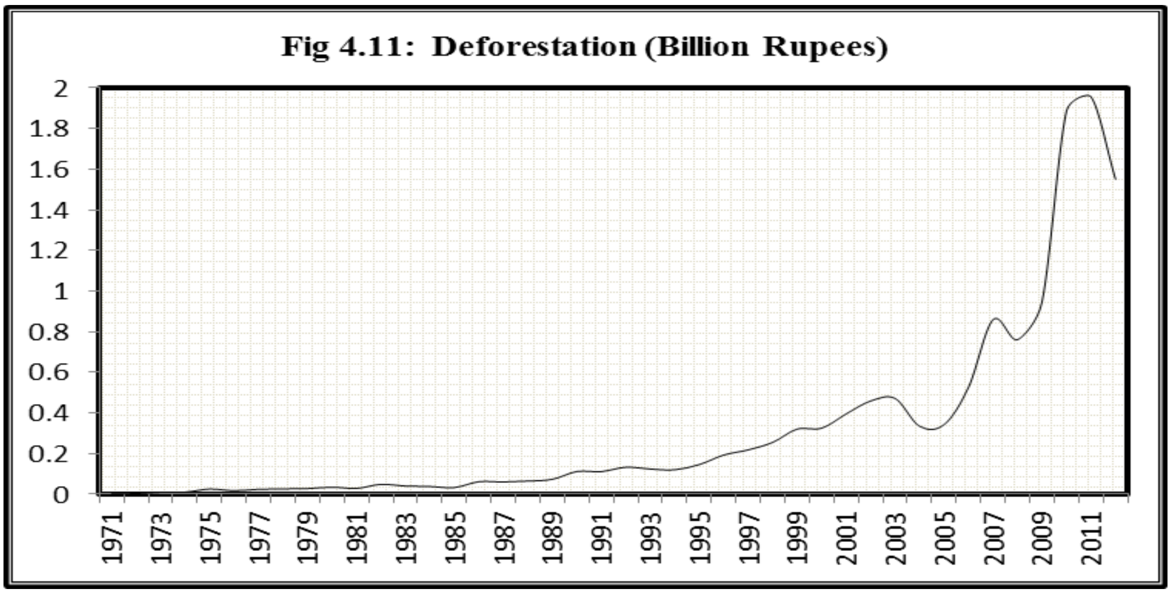


Fig 4.11: Deforestation (Billion Rupees)
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
1971
1973
1975
1977
1979
1981
1983
1985
1987
1989
1991
1993
1995
1997
1999
2001
2003
2005
2007
2009
2011

Fig 4.12: Real Energy Depletion (Billion Rupees)

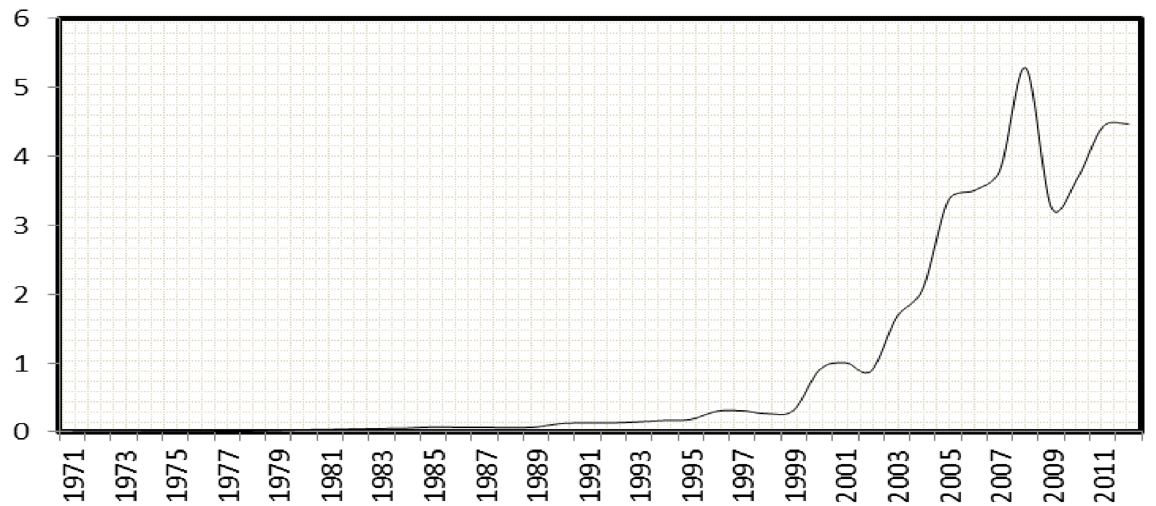
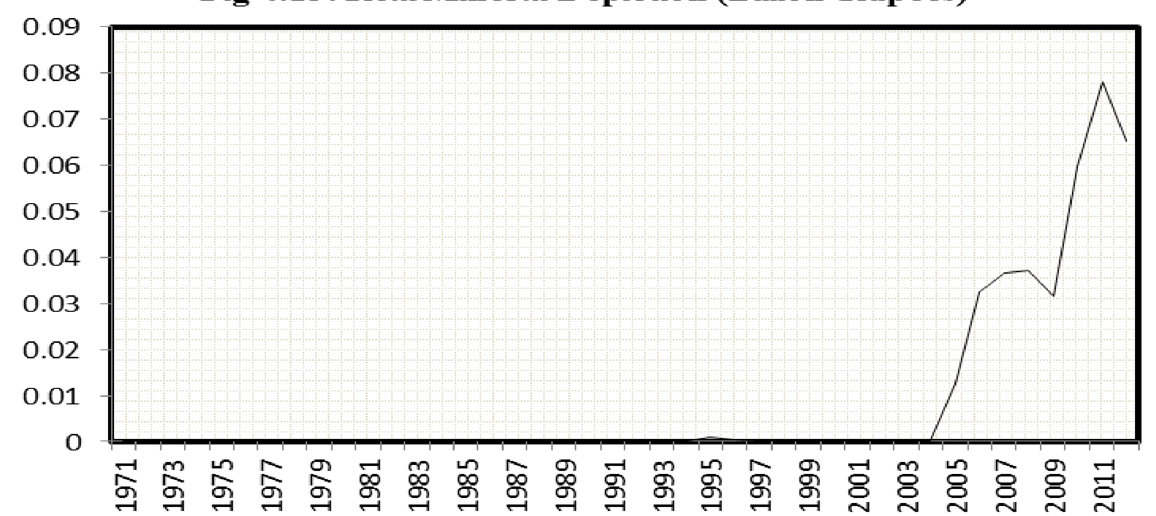


Fig 4.13: Real Mineral Depletion (Billion Rupees)



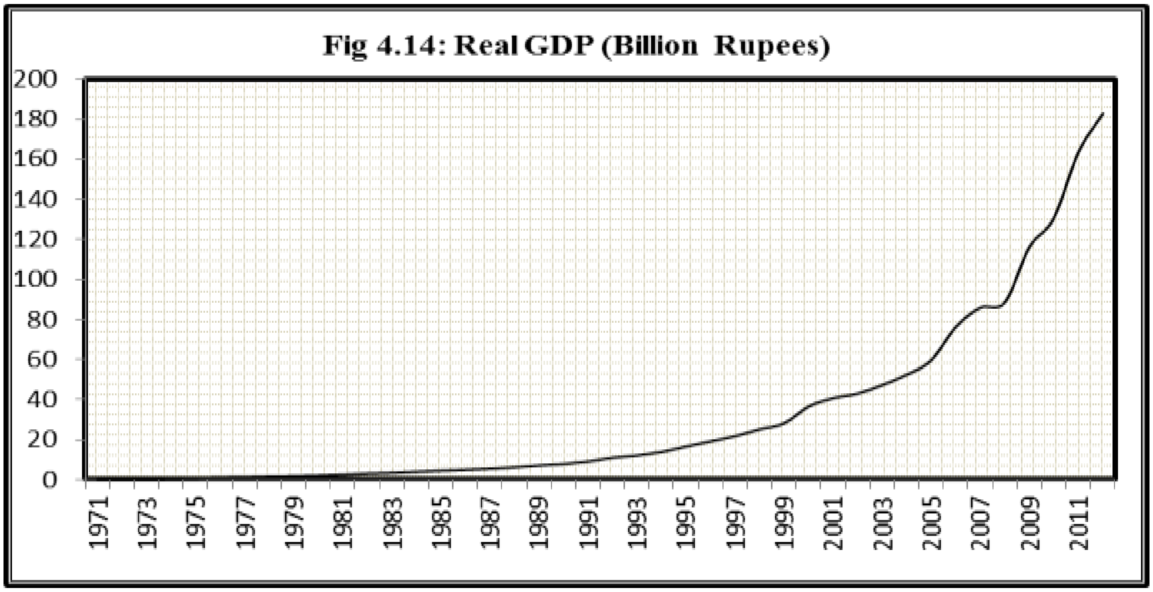


Fig 4.14: Real GDP (Billion Rupees)
200
180
160
140
120
100
80
60
40
20
0
1971
1973
1975
1977
1979
1981
1983
1985
1987
1989
1991
1993
1995
1997
1999
2001
2003
2005
2007
2009
2011

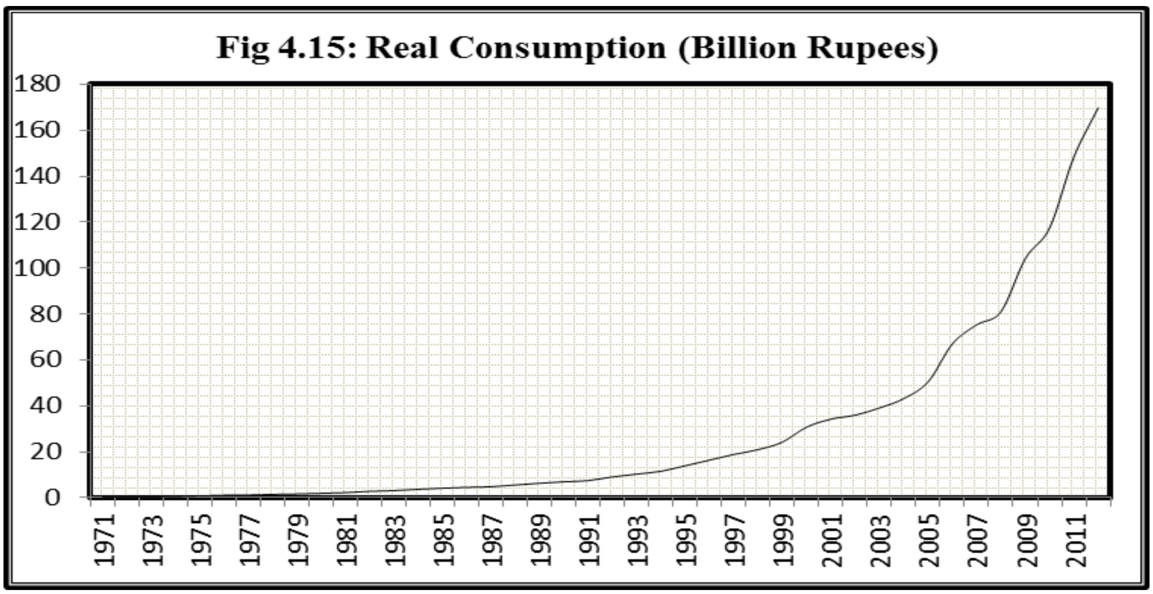


Fig 4.15: Real Consumption (Billion Rupees)
180
160
140
120
100
80
60
40
20
0
1971
1973
1975
1977
1979
1981
1983
1985
1987
1989
1991
1993
1995
1997
1999
2001
2003
2005
2007
2009
2011

Table 4.1a: Savings

Mean	403.9292
Median	186.6595
Maximum	1665.861
Minimum	4.847567
Std. Dev.	491.3217
Observations	42

Table 4.1b: Real Savings

Mean	3.693198
Median	1.684184
Maximum	14.88482
Minimum	0.04303
Std. Dev.	4.445504
Observatio	42

Table 4.2: Real Income

Mean	44.76879
Median	42.35889
Maximum	87.21944
Minimum	14.21371
Std. Dev.	22.88843
Observations	42

Table 4.3: Inflation

Mean	9.45776
Median	8.552492
Maximum	26.66303
Minimum	2.914135
Std. Dev.	5.354929
Observations	42

Table 4.4: Real Interest Rate

Mean	1.423192
Median	1.962453
Maximum	10.272
Minimum	-17.66303
Std. Dev.	5.689193
Observatio	42

Table 4.5: Dependency Ratio

Mean	83.74511
Median	88.5184
Maximum	90.33466
Minimum	63.0847
Std. Dev.	8.522473
Observations	42

Table 4.6: Real Net Transfer

Mean	3.238282
Median	3.065642
Maximum	11.23097
Minimum	-0.163491
Std. Dev.	2.426881
Observations	42

Table 4.7: Real Deprecaition of Produced Capital

Mean	2.348492
Median	0.839289
Maximum	10.18385
Minimum	0.040164
Std. Dev.	2.949528
Observations	42

Table 4.8: Real CO2 Damage

Mean	0.286854
Median	0.082091
Maximum	1.436356
Minimum	0.001489
Std. Dev.	0.387514
Observations	42

Table 4.9: Particulate Emissions Damage

Mean	1.061685
Median	0.604558
Maximum	4.977575
Minimum	0.088808
Std. Dev.	1.178797
Observations	42

Table 4.11: Real Deforestation

Mean	0.313604
Median	0.115763
Maximum	1.956899
Minimum	0.002635
Std. Dev.	0.48005
Observations	42

Table 4.12: Energy Depletion

Mean	0.976958
Median	0.132278
Maximum	5.284853
Minimum	0.000896
Std. Dev.	1.560041
Observations	42

Table 4.13: Mineral Depletion

Mean	0.008463
Median	4.95E-06
Maximum	0.078228
Minimum	0
Std. Dev.	0.019677
Observations	42

Table 4.14: Real GDP

Mean	31.9226
Median	10.0502
Maximum	182.764
Minimum	0.48207
Std. Dev.	45.6911
Observations	42

Table 4.15: Consumption

Mean	28.22946
Median	8.316764
Maximum	169.8541
Minimum	0.433935
Std. Dev.	41.51842
Observations	42

Appendix to Chapter # 5

Real Savings

The series of real savings is not stationary at level but stationary at first difference, applying ADF test of unit root, there is no unit root in the series at first difference. The maximum lag is 6 and the model includes intercept but no trend. At five percent level or even at one percent level of significance ADF value is less than the critical value; therefore, the null hypothesis of unit roots is rejected and alternate hypothesis of no unit root is accepted, the study concludes that the data are stationary at first difference and the order of integration of the series is I(1). The results of the test are given below in Table 5.1:

Table 5.1: Unit Root Test of Real Savings

Null Hypothesis: D(S) has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=6)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-8.89524	0.0000
Test critical values:	1% level	-3.60559	
	5% level	-2.93694	
	10% level	-2.60686	

*MacKinnon (1996) one-sided p-values.

Real Income

The series of real income is not stationary at level but stationary at first difference, applying ADF test of unit root, there is no unit root in the series at first difference. The maximum lag is 9 and the model includes intercept but no trend. At five percent level or even at one percent level of significance ADF value is less than the critical value; therefore, the null hypothesis of unit roots is rejected and alternate hypothesis of no unit root is accepted, the study concludes that the time series is stationary at first difference and the order of integration of the series is I(1). The results of the test are given below in the Table 5.2:

Table 5.2: Unit Root Test of Real Income			
Null Hypothesis: D(Y) has a unit root			
Exogenous: Constant			
Lag Length: 0 (Automatic - based on SIC, maxlag=9)			
		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-7.7167	0.0000
Test critical values:	1% level	-3.60559	
	5% level	-2.93694	
	10% level	-2.60686	

*MacKinnon (1996) one-sided p-values.

Inflation

The series of inflation is stationary at level. Applying ADF test of unit root, there is no unit root in the series at level. The maximum lag is 9 and the model includes intercept but no trend. At five percent level of significance, ADF value is less than the critical value; therefore, the null hypothesis of unit roots is rejected and alternate hypothesis of no unit root is accepted, the study concludes that the time series is stationary at level and the order of integration of the series is I(0). The results of the test are given below:

Table 5.3: Unit Root Test of Infaltion			
Null Hypothesis: INF has a unit root			
Exogenous: Constant			
Lag Length: 0 (Automatic - based on SIC, maxlag=9)			
		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-3.245423	0.0244
Test critical values:	1% level	-3.600987	
	5% level	-2.935001	
	10% level	-2.605836	

*MacKinnon (1996) one-sided p-values.

Real Interest Rate

The series of real interest rate is stationary at level. Applying ADF test of unit root, there is no unit root in the series at level. The maximum lag is 9 and the model includes no intercept and no trend. At five percent level of significance, ADF value is less than the critical value; therefore, the null hypothesis of unit roots is rejected and alternate hypothesis of no unit root is accepted, the study concludes that the time series is stationary at level and the order of integration of the series is I(0). The results of the test are given below:

Table 5.4: Unit Root Test of Real Interest Rate

Null Hypothesis: R has a unit root			
Exogenous: None			
Lag Length: 0 (Automatic - based on SIC, maxlag=9)			
		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-2.49821	0.0137
Test critical values:	1% level	-2.62259	
	5% level	-1.9491	
	10% level	-1.61182	

*MacKinnon (1996) one-sided p-values.

Dependency Ratio

The time series of dependency ratio is stationary at level. Applying ADF test of unit root, there is no unit root in the series at level. The maximum lag is 1 and the model includes no intercept and no trend. At five percent level of significance, ADF value is less than the critical value; therefore, the null hypothesis of unit roots is rejected and alternate hypothesis of no unit root is accepted, the study concludes that the time series is stationary at level and the order of integration of the series is I(0). The results of the test are given below:

Table 5.5: Unit Root Test of Dependency Ratio

Null Hypothesis: DR has a unit root			
Exogenous: None			
Lag Length: 1 (Automatic - based on SIC, maxlag=1)			
		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-2.401619	0.0175
Test critical values:	1% level	-2.624057	
	5% level	-1.949319	
	10% level	-1.611711	

*MacKinnon (1996) one-sided p-values.

Real Net Foreign Capital Inflow

The time series of real net foreign capital inflow is not stationary at level but stationary at first difference, applying ADF test of unit root, there is no unit root in the series at first difference. The maximum lag is 9 and the model includes intercept but no trend. At five percent level or even at one percent level of significance ADF value is less than the critical value; therefore, the null hypothesis of unit roots is rejected and alternate hypothesis of no unit root is accepted, the study concludes that the time series is stationary at first difference and the order of integration of the series is I(1). The results of the test are given below:

Table 5.6: Unit Root Test of Real Net Foreign Capital Inflow

Null Hypothesis: D(FK) has a unit root			
Exogenous: Constant			
Lag Length: 3 (Automatic - based on SIC, maxlag=9)			
		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-6.12621	0.0000
Test critical values:	1% level	-3.62102	
	5% level	-2.94343	
	10% level	-2.61026	

*MacKinnon (1996) one-sided p-values.

Autoregressive Distributed lag Test of Co-integration

The study used E-views 8 to check the long run relationship. Since the order of integration is not same therefore, the study used ARDL approach to co-integration. Following is the procedure. The study has run the following ARDL model:

d(s) c s(-1) dr(-1) fk(-1) inf(-1) r(-1) y(-1) d(s(-1)) d(dr(-1)) d(fk(-1)) d(inf(-1)) d(r(-1)) d(y(-1)) d(s(-2)) d(dr(-2)) d(fk(-2)) d(inf(-2)) d(r(-2)) d(y(-2))……………………………… eq(5.1apx)

Following Table 5.7 are the results of eq(5.1apx):

Table 5.7: Results of Autoregrssive Distributed lag Model				
Dependent Variable: D(S)				
Method: Least Squares				
Date: 10/03/15 Time: 16:28				
Sample (adjusted): 1974 2012				
Included observations: 39 after adjustments				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	30.92701	7.89925	3.915183	0.0009
S(-1)	-1.24822	0.31933	-3.908877	0.0009
DR(-1)	-0.364965	0.088128	-4.141323	0.0005
FK(-1)	0.684453	0.133145	5.140672	0.0000
INF(-1)	-0.023324	0.055889	-0.417335	0.6809
R(-1)	-0.084769	0.050094	-1.692197	0.1061
Y(-1)	0.050838	0.035737	1.422587	0.1703
D(S(-1))	0.170191	0.317628	0.535819	0.598
D(DR(-1))	-6.850473	1.553291	-4.410295	0.0003
D(FK(-1))	-0.447059	0.093311	-4.791068	0.0001
D(INF(-1))	-0.109373	0.063543	-1.721241	0.1006
D(R(-1))	-0.07531	0.064951	-1.159491	0.2599
D(Y(-1))	-0.095776	0.101591	-0.942766	0.3571
D(S(-2))	0.136979	0.220539	0.62111	0.5415
D(DR(-2))	6.179763	1.686881	3.663425	0.0015
D(FK(-2))	-0.558036	0.067949	-8.212532	0.0000
D(INF(-2))	0.012701	0.068628	0.185071	0.855
D(R(-2))	0.06172	0.064645	0.954752	0.3511
D(Y(-2))	-0.099309	0.100223	-0.990884	0.3336
R-squared	0.933171	Mean dependent var		0.329613
Adjusted R-squared	0.873024	S.D. dependent var		1.101528
S.E. of regression	0.392515	Akaike info criterion		1.274045
Sum squared resid	3.08136	Schwarz criterion		2.084499
Log likelihood	-5.843885	Hannan-Quinn criter.		1.564829
F-statistic	15.51496	Durbin-Watson stat		1.66417
Prob(F-statistic)	0			

Then the study estimated the following model to identify the long run coefficients in the ARDL model through system of equations command in E-views:

d(s) = c(1) + c(2)*s(-1) + c(3)*dr(-1) + c(4)*fk(-1) + c(5)*inf(-1) + c(6)*r(-1) + c(7)*y(-1) + c(8)*d(s(-1)) + c(9)*d(dr(-1)) + c(10)*d(fk(-1)) + c(11)*d(inf(-1)) + c(12)*d(r(-1)) + c(13)*d(y(-1)) + c(14)*d(s(-2)) +

c(15)*d(dr(-2)) + c(16)*d(fk(-2)) + c(17)*d(inf(-2)) + c(18)*d(r(-2)) + c(19)*d(y(-2))……………………………………eq.(5.2 apx)

Following Table 5.8 shows the results of eq(5.2apx)

Table 5.8: ARDL Model

Dependent Variable: D(S)
Method: Least Squares
Date: 10/03/15 Time: 16:30
Sample (adjusted): 1974 2012
Included observations: 39 after adjustments

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	30.92701	7.89925	3.915183	0.0009
C(2)	-1.24822	0.31933	-3.908877	0.0009
C(3)	-0.364965	0.088128	-4.141323	0.0005
C(4)	0.684453	0.133145	5.140672	0
C(5)	-0.023324	0.055889	-0.417335	0.6809
C(6)	-0.084769	0.050094	-1.692197	0.1061
C(7)	0.050838	0.035737	1.422587	0.1703
C(8)	0.170191	0.317628	0.535819	0.598
C(9)	-6.850473	1.553291	-4.410295	0.0003
C(10)	-0.447059	0.093311	-4.791068	0.0001
C(11)	-0.109373	0.063543	-1.721241	0.1006
C(12)	-0.07531	0.064951	-1.159491	0.2599
C(13)	-0.095776	0.101591	-0.942766	0.3571
C(14)	0.136979	0.220539	0.62111	0.5415
C(15)	6.179763	1.686881	3.663425	0.0015
C(16)	-0.558036	0.067949	-8.212532	0
C(17)	0.012701	0.068628	0.185071	0.855
C(18)	0.06172	0.064645	0.954752	0.3511
C(19)	-0.099309	0.100223	-0.990884	0.3336

R-squared	0.933171	Mean dependent var	0.329613
Adjusted R-squared	0.873024	S.D. dependent var	1.101528
S.E. of regression	0.392515	Akaike info criterion	1.274045
Sum squared resid	3.08136	Schwarz criterion	2.084499
Log likelihood	-5.843885	Hannan-Quinn criter.	1.564829
Durbin-Watson stat	1.66417		

In the above Table 5.8, coefficients C(2), C(3), C(4), C(5), C(6), and C(7) are long run coefficients of the model. Then the study applied Wald test of coefficient restrictions to check that the long run coefficients are jointly zero. The results of the test are given below in Table 5.9:

Table 5.9: Wald Test

H0: C(2)=C(3)=C(4)=C(5)=C(6)=C(7)=0
Equation: Untitled

Test Statistic	Value	df	Probability
F-statistic	23.25283	(6, 20)	0.0000
Chi-square	139.517	6	0.0000

In the above Table 5.9, the value of F-statistic is 23.25 which the calculated value of the test. If the calculated value is greater than the upper bound of tabulated value of Pesaran et.al (2001) then null hypothesis is rejected and long run relationship among variables is exists. The tabulated values of the test- at k (the number of regressors) = 5 and 'intercept and no trend' (since the model only included intercept) - are 2.649 the lower bound, and 3.805 the upper bound. The Wald test or coefficient bound test calculated F-statistic value at 23.25 is greater than the upper bound Pesaran et al tabulated value 3.805 therefore, the study rejected the null hypothesis of 'all long run coefficients being equal to zero' and concluded that there was a long run relationship among the variables. To estimate the long run and short run coefficients the study has run the vector error correction VECM model.

Vector Error Correction Model

To run the VECM, the first step is the optimal lag selection. To select the optimal lag the study runs the vector autoregressive VAR model at default lag 1. The results of the VAR model are given below in Table 5.10:

Table 5.10: Results of VAR Model

Vector Autoregression Estimates
Date: 10/03/15 Time: 19:24
Sample (adjusted): 1972 2012
Included observations: 41 after adjustments
Standard errors in ( ) & t-statistics in [ ]

	S	Y	R	INF	FK	DR
S(-1)	0.566741	-0.31283	-0.40817	0.321324	-0.91004	-0.35596
	-0.22178	-0.514	-0.95173	-1.08573	-0.37342	-0.10318
	[2.55538]	[-0.60862]	[-0.42888]	[0.29595]	[-2.43706]	[-3.44971]
Y(-1)	0.031176	1.047925	0.085893	-0.02774	0.164895	0.015673
	-0.03132	-0.07259	-0.13441	-0.15334	-0.05274	-0.01457
	[0.99531]	[14.4358]	[0.63902]	[-0.18087]	[3.12669]	[1.07550]
R(-1)	0.044357	0.092734	1.059348	-0.36669	-0.15557	-0.039
	-0.06311	-0.14627	-0.27084	-0.30897	-0.10626	-0.02936
	[0.70280]	[0.63399]	[3.91137]	[-1.18680]	[-1.46397]	[-1.32832]
INF(-1)	0.076997	0.153113	0.515113	0.251508	-0.20628	-0.02465
	-0.05701	-0.13213	-0.24465	-0.2791	-0.09599	-0.02652
	[1.35054]	[1.15881]	[2.10547]	[0.90114]	[-2.14889]	[-0.92915]
FK(-1)	0.174937	-0.05641	-0.06434	-0.01434	0.202791	-0.10978
	-0.09707	-0.22497	-0.41655	-0.4752	-0.16344	-0.04516
	[1.80217]	[-0.25073]	[-0.15446]	[-0.03017]	[1.24079]	[-2.43091]
DR(-1)	-0.132674	-0.10938	0.027997	0.054285	-0.18418	0.912466
	-0.07682	-0.17803	-0.32964	-0.37605	-0.12934	-0.03574
	[-1.72714]	[-0.61439]	[0.08493]	[0.14435]	[-1.42406]	[25.5314]
C	10.3189	8.709933	-9.27201	3.241806	16.52215	7.965802
	-6.78504	-15.7248	-29.1163	-33.2159	-11.424	-3.15673
	[1.52083]	[0.55390]	[-0.31845]	[0.09760]	[1.44627]	[2.52344]
R-squared	0.963735	0.992772	0.598686	0.399395	0.646079	0.997883
Adj. R-squared	0.957335	0.991496	0.527866	0.293406	0.583622	0.997509
Sum sq. resids	28.89051	155.1735	532.0142	692.3749	81.8998	6.253506
S.E. equation	0.921803	2.136335	3.955689	4.512645	1.552037	0.428867
F-statistic	150.5909	778.3171	8.453604	3.768264	10.34444	2670.713
Log likelihood	-51.00027	-85.4614	-110.72	-116.121	-72.3609	-19.6277
Akaike AIC	2.829282	4.510312	5.742439	6.005896	3.871265	1.298911
Schwarz SC	3.121843	4.802873	6.035	6.298457	4.163826	1.591472
Mean dependent	3.782102	44.15106	1.451336	9.573055	3.314765	83.62611
S.D. dependent	4.462768	23.16693	5.756908	5.368416	2.405239	8.592941

Determinant resid covariance (dof adj.)	8.503611
Determinant resid covariance	2.7655
Log likelihood	-369.912
Akaike information criterion	20.09326
Schwarz criterion	21.84863

After VAR model the study applied the lag length criteria at maximum lag 2 then 3 then 4 then 5 to investigate the optimal lag. At the maximum lag length 6 the criteria became nearly singular matrix. The results of the maximum lag 2, 3, 4 and 5 are given in Table 5.11 below:

Table 5.11: VAR Lag Order Selection Criteria

Endogenous variables: S Y R INF FK DR
Exogenous variables: C
Date: 10/03/15 Time: 19:50
Sample: 1971 2012
Included observations: 40

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-629.181	NA	2500158	31.75906	32.0124	31.85066
1	-360.879	442.6994	23.06945	20.14393	21.91725	20.78511
2	-241.794	160.7639*	0.410319*	15.98971*	19.28303*	17.18047*
Lag	LogL	LR	FPE	AIC	SC	HQ
0	-611.241	NA	2249423	31.65338	31.90931	31.74521
1	-342.038	441.7685	14.74042	19.69427	21.4858	20.33705
2	-224.123	157.221	0.25286	15.49346	18.82058	16.6872
3	-101.54	125.7261*	0.004375*	11.05331*	15.91603*	12.79801*
Lag	LogL	LR	FPE	AIC	SC	HQ
0	-587.876	NA	1512719	31.25661	31.51518	31.3486
1	-327.91	424.1543	11.78952	19.46895	21.27891	20.11292
2	-216.011	147.2355	0.251437	15.47427	18.83563	16.67021
3	-96.3703	119.6408	0.004685	11.07212	15.98488	12.82004
4	13.98809	75.50835*	0.000250*	7.158522*	13.62268*	9.458419*
Lag	LogL	LR	FPE	AIC	SC	HQ
0	-565.395	NA	1044480	30.88621	31.14744	30.97831
1	-316.324	403.8991	10.68966	19.36886	21.19747	20.01353
2	-204.863	144.5978	0.212296	15.28989	18.68588	16.48714
3	-88.1314	113.5767	0.004281	10.92602	15.88939	12.67584
4	30.0246	76.64171	0.000151	6.485157	13.01591	8.787552
5	294.5636	85.79644*	1.04e-08*	-5.868304*	2.229824*	-3.013335*

* indicates lag order selected by the criterion

LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

In the above Table 5.11, all the VAR order lag selection criteria suggest the maximum lag as optimal lag such as at maximum lag 2; all the criteria suggest lag 2 as an optimal lag. Similarly at maximum lag 3; all the criteria suggest the lag 3 as an optimal lag and so on. But the study faces limitation here since the number of observations only supports the VECM at lag three and at lag 4 and above the VECM can't be run because of insufficient observations. Therefore the study used lag three as an optimal lag in estimation of VECM model.

The study has run the VECM at optimal lag 3. Results of the model are given in Table 5.12. The error correction term is negative and statistically significant. This implies that there exists the long run causality running from independent variables to dependent variable. To check the short run causality the study used Wald coefficient restrictions test over the short run coefficients of each independent variable. To check the short run causality running from real income to real savings the study tested the null hypothesis of 'no short run causality running from real income to real savings' Ho: C (5) = C(6) = C(7) = 0. Results of the test are given below in Table 5.13a. The probability of chi-square is less than 5%. Therefore the study rejected the null hypothesis and concludes that there is a short run causality running from real income to real savings. The results of short run causality running from real interest rate to real savings are given below in Table 5.13b. The null hypothesis of no short run causality Ho: C(8) = C(9) = C(10) = 0 can't be rejected since the probability of chi-square is greater than 5%. Therefore there is no short run causality running from real interest rate to real savings. Similarly, Table 5.13c shows a short run causality running from inflation to real savings. Table 5.13d and 5.13e show statistically highly significant short rum causality running from real net foreign capital inflow to real savings and from dependency ratio to real savings respectively.

Table 5.12: Vector Error Correction Estimates

Date: 10/03/15 Time: 22:42
Sample (adjusted): 1975 2012
Included observations: 38 after adjustments

Cointegrating Eq:	CointEq1	Standard Errors	t-statistics	
S(-1)	1			
Y(-1)	-0.06028	0.0137	[-4.39734]	
DR(-1)	0.32284	0.0296	[10.9001]	
INF(-1)	0.11852	0.0256	[4.62963]	
R(-1)	0.12638	0.0177	[7.14960]	
FK(-1)	-0.69607	0.1286	[-5.41278]	
C	-27.06409			
Error Correction:	**D(S)**	**Standard Errors**	**t-statistics**	**Prob.**
CointEq1 C(1)	-0.6800	0.1644	[-4.13692]	0.0006
D(S(-1)) C(2)	-0.2757	0.1197	[-2.30300]	0.0334
D(S(-2)) C(3)	-0.4342	0.1584	[-2.74140]	0.0134
D(S(-3)) C(4)	-0.2533	0.1397	[-1.81346]	0.0865
D(Y(-1)) C(5)	-0.2324	0.0785	[-2.96203]	0.0083
D(Y(-2)) C(6)	-0.1037	0.0892	[-1.16213]	0.2604
D(Y(-3)) C(7)	-0.1504	0.0820	[-1.83478]	0.0831
D(DR(-1)) C(8)	-5.9792	1.6027	[-3.73080]	0.0015
D(DR(-2)) C(9)	5.6351	3.7129	[1.51769]	0.1465
D(DR(-3)) C(10)	-0.0826	2.3277	[-0.03549]	0.9721
D(INF(-1)) C(11)	-0.1184	0.0446	[-2.65867]	0.016
D(INF(-2)) C(12)	0.0365	0.0535	[0.68123]	0.5044
D(INF(-3)) C(13)	-0.0741	0.0473	[-1.56671]	0.1346
D(R(-1)) C(14)	-0.0713	0.0432	[-1.65007]	0.1163
D(R(-2)) C(15)	0.0511	0.0486	[1.04980]	0.3077
D(R(-3)) C(16)	-0.0396	0.0489	[-0.81039]	0.4283
D(FK(-1)) C(17)	-0.3157	0.1396	[-2.26087]	0.0364
D(FK(-2)) C(18)	-0.4739	0.1084	[-4.37018]	0.0004
D(FK(-3)) C(19)	0.0824	0.1355	[0.60797]	0.5508
C C(20)	1.0571	0.3261	[3.24199]	0.0045
R-squared	0.9545	F-statistic	19.85219	
Adj. R-squared	0.9064	Log likelihood	1.146243	
Sum sq. resids	2.0946	Akaike AIC	0.992303	
S.E. equation	0.3411	Schwarz SC	1.85419	
Mean dependent	0.3386	S.D. dependent	1.114862	
Determinant resid covariance (dof adj.)		0.000173733		
Determinant resid covariance		1.96E-06		
Log likelihood		-73.83370194		
Akaike information criterion		10.51756326		
Schwarz criterion		15.94745421		

The short run causality tests are given below in Tables 5.13a, 5.13b, 5.13c, 5.13d and 5.13e:

Table 5.13a: Wald Test			
Null Hypothesis: C(5)=C(6)=C(7)=0			
Test Statistic	Value	df	Probability
F-statistic	3.41268	(3, 18)	0.0399
Chi-square	10.23804	3	0.0166

The above Table 5.13a shows short run causality running from real income to real savings.

Table 5.13b: Wald Test			
Null Hypothesis: C(8)=C(9)=C(10)=0			
Test Statistic	Value	df	Probability
F-statistic	1.870468	(3, 18)	0.1708
Chi-square	5.611405	3	0.1321

The above Table 5.13b shows no short run causality running from real interest rate to real savings.

Table 5.13c: Wald Test			
Null Hypothesis: C(11)=C(12)=C(13)=0			
Test Statistic	Value	df	Probability
F-statistic	3.335237	(3, 18)	0.0427
Chi-square	10.00571	3	0.0185

The above Table 5.13c shows short run causality running from inflation to real savings.

Table 5.13d: Wald Test			
Null Hypothesis: C(14)=C(15)=C(16)=0			
Test Statistic	Value	df	Probability
F-statistic	23.71759	(3, 18)	0.0000
Chi-square	71.15278	3	0.0000

The above Table 5.13d shows short run causality running from real net foreign capital inflow to real savings.

Table 5.13e: Wald Test			
Null Hypothesis: C(17)=C(18)=C(19)=0			
Test Statistic	Value	df	Probability
F-statistic	16.74599	(3, 18)	0.0000
Chi-square	50.23798	3	0.0000

The above Table 5.13e shows short run causality running from dependency ratio to real savings.

Diagnostic Check of the Model

The fitted VECM R-square is high: the model explains 95% variations in the dependent variable. The overall coefficients are statistically significant. In diagnostic tests, the study checks serial correlation in the model, heteroscedasticity, residual normality and coefficient instability.

Serial Correlation

The study used Breusch-Godfrey serial correlation LM test to check the serial correlation in the VECM. The study found no serial correlation in the model. The probability of observed R-square is greater than 5%. Therefore, the study cannot reject the null hypothesis of no serial correlation and concludes that there is no serial correlation in the model. The results of the test are given below in Table 5.14a:

Table 5.14a: Breusch-Godfrey Serial Correlation LM Test:			
Ho: no serial correlation			
F-statistic	0.263677	Prob. F(3,15)	0.8505
Obs*R-squared	1.903557	Prob. Chi-Square(3)	0.5927

Heteroscedasticity

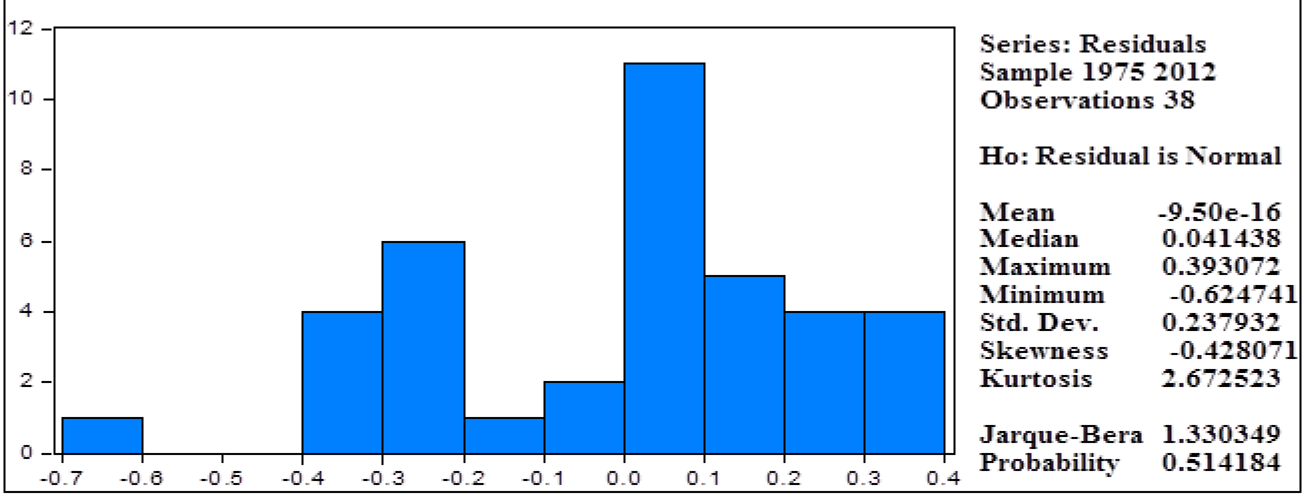
The study used Breusch-Pagan-Godfrey heteroscedasticity test to check the heteroscedasticity in the residual of the fitted VECM. The study found no heteroscedasticity in the model. The probability of observed R-square is greater than 5%. Therefore, the study cannot reject the null hypothesis of homoscedasticity and concludes that there is no heteroscedasticity in the model. The results of the test are given below in Table 5.14b:

Table 5.14b: Heteroskedasticity Test: Breusch-Pagan-Godfrey			
Ho: homoskedasticiy			
F-statistic	1.678508	Prob. F(24,13)	0.1662
Obs*R-squared	28.72896	Prob. Chi-Square(24)	0.2305
Scaled explained SS	5.390633	Prob. Chi-Square(24)	1

Residual Normality

The study used Jarque-Bera residual normality test to check normality of residuals of the fitted VECM. The study found normality in the residuals of the model. The probability of Jarque-Bera is greater than 5%. Therefore, the study cannot reject the null hypothesis of normality and concludes that residuals of the fitted model are normal. The results of the test are given below in Table 5.14c:

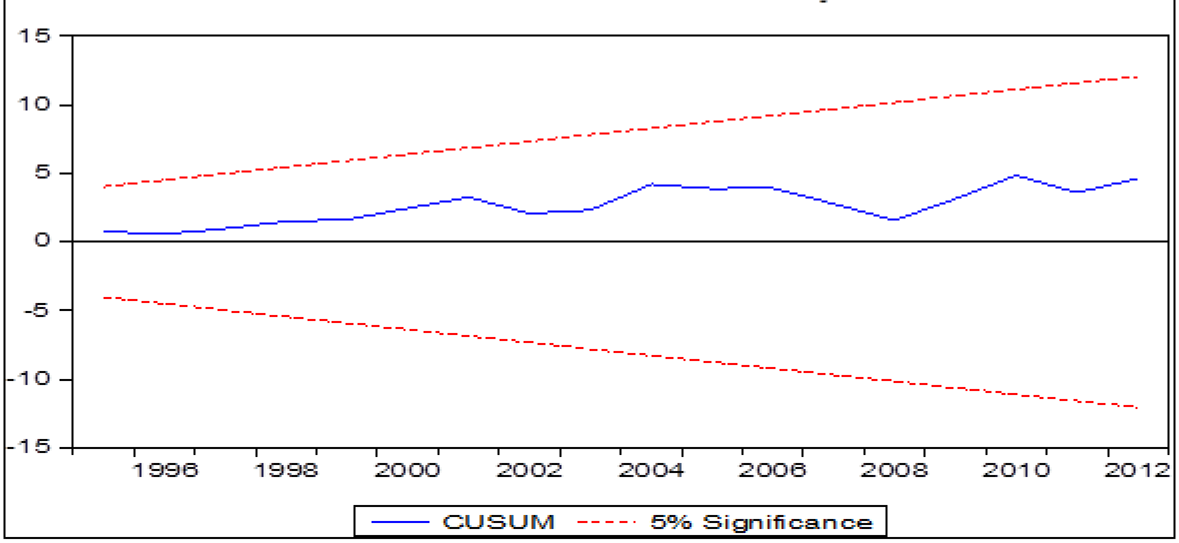
Table 5.14c: Residual Normality Test



Parameter Instability Test

The study applied CUSUM test to check instability of the estimated parameters of the VECM. In Table 5.14d dotted lines are the critical lines at 5% level of significance. The test catches parameter instability if the cumulative sum goes outside the area between the two critical lines. But in this case the cumulative sum takes place inside the area between the two critical lines. Therefore, the study concludes that there is no parameter instability problem in the model.

Table 5.14d: Parameter Insaibility Test



Below Tables 5.15 and 5.16 contain the descriptive statistic of D-series and shares of the components of the D respectively.

Table 5.15: D-series

Mean	5.313505
Median	1.886311
Maximum	24.47011
Minimum	0.138105
Std. Dev.	6.884795
Observations	42

Table 5.16: Share of the Components of D

	Depreciation	Natural Resource Depletion	Pollution
Mean	41.48302	16.07611	42.44087
Median	41.81439	13.08767	42.8969
Maximum	50.22558	35.40042	68.97382
Minimum	28.16284	2.557229	24.34477
Std. Dev.	6.232833	7.675275	11.68648
Observations	42		

D-function

D-function is the relationship between D and GDP, other thing remaining the same there is positive relationship between D and output. D depends on output and relationship is positive. Since the study analyzed the relationship with respect to time, therefore stationarity of the time series is necessary. Let us check the stationarity of the variables.

Unit Root Test of D

The time series of log D is non-stationary at level but stationary at first difference, applying ADF test of unit root, there is no unit root in the series at first difference. The maximum lag is 9 and the model includes intercept but no trend. At five percent level or even at one percent level of significance ADF value is less than the critical value; therefore, the null hypothesis of unit roots is rejected and alternate hypothesis of no unit root is accepted, the study concludes that the time series is stationary at first difference and the order of integration of the series is I(1). The results of the test are given below in Table 5.17:

Table 5.17: Unit Root Test of D

Null Hypothesis: D(LOD) has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=9)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-6.06742	0.0000
Test critical values:	1% level	-3.60559	
	5% level	-2.93694	
	10% level	-2.60686	

*MacKinnon (1996) one-sided p-values.

Unit Root Test of Gross Domestic Product

The time series of log GDP is non-stationary at level but stationary at first difference, applying ADF test of unit root, there is no unit root in the series at first difference. The maximum lag is 9 and the model includes intercept but no trend. At five percent level or even at one percent level of significance ADF value is less than the critical value; therefore, the null hypothesis of unit roots is rejected and alternate hypothesis of no unit root is accepted, the study concludes that the time series is stationary at first difference and the order of integration of the series is I(1). The results of the test are given below in Table 5.18

Table 5.18: Unit Root Test of Real Gross Domestic Product

Null Hypothesis: D(LRGDP) has a unit root			
Exogenous: Constant			
Lag Length: 0 (Automatic - based on SIC, maxlag=9)			
		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-6.19299	0.0000
Test critical values:	1% level	-3.60559	
	5% level	-2.93694	
	10% level	-2.60686	

*MacKinnon (1996) one-sided p-values.

Cointegration Test

The series log D and log GDP both are non-stationary at level but stationary at first difference. The study derived residual from OLS, regressing log-D over log-GDP, and then check the stationarity of the residual. Since the residual is stationary at level therefore, cointegration is said to be established. The results of the residual unit root test are given below in Table 5.19.

Table 5.19: Cointegration Test of Log D and Log GDP

Null Hypothesis: RESID01 has a unit root			
Exogenous: None			
Lag Length: 0 (Automatic - based on SIC, maxlag=9)			
		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-2.3978	0.0177
Test critical values:	1% level	-2.6226	
	5% level	-1.9491	
	10% level	-1.6118	

*MacKinnon (1996) one-sided p-values.

Vector Error Correction Model

Table 5.20: Vector Error Correction Estimates

Date: 11/29/15 Time: 17:05
Sample (adjusted): 1983 2012
Included observations: 30 after adjustments
Standard errors in ( ) & t-statistics in [ ]

Cointegrating Eq:	CointEq1
LOD(-1)	1
LRGDP(-1)	-0.939787
	-0.01215
	[-77.3378]
C	1.523831

Error Correction:	D(LOD)	D(LRGDP)		D(LOD)	D(LRGDP)			
CointEq1	-1.620902	0.367763	C	-0.14151	0.318706			
	-0.75772	-0.92442		-0.25274	-0.30835			
	[-2.13919]	[0.39783]		[-0.55989]	[1.03358]			
D(LOD(-1))	1.042759	-0.29192	D(LRGDP(-1	-0.80383	-0.04117	R-squared	0.773262	0.667928
	-0.54234	-0.66166		-0.50517	-0.61632	Adj. R-squared	-0.095899	-0.60501
	[1.92270]	[-0.44120]		[-1.59119]	[-0.06679]	Sum sq. resids	0.019933	0.02967
D(LOD(-2))	1.037178	-0.46074	D(LRGDP(-2	-1.23289	0.214293	S.E. equation	0.057639	0.07032
	-0.62942	-0.7679		-0.53452	-0.65212	F-statistic	0.889665	0.524712
	[1.64783]	[-0.60000]		[-2.30653]	[0.32861]	Log likelihood	67.18019	61.21434
D(LOD(-3))	1.085584	-0.31155	D(LRGDP(-3	-1.10905	0.140874	Akaike AIC	-2.878679	-2.48096
	-0.60455	-0.73756		-0.56816	-0.69316	Schwarz SC	-1.757721	-1.36
	[1.79568]	[-0.42241]		[-1.95201]	[0.20324]	Mean dependent	0.122083	0.136316
D(LOD(-4))	1.190298	-0.46082	D(LRGDP(-4	-1.48792	0.169447	S.D. dependent	0.055059	0.055506
	-0.79799	-0.97356		-0.81813	-0.99813			
	[1.49161]	[-0.47333]		[-1.81869]	[0.16976]	Determinant resid covariance (dof adj.)		5.18E-06
D(LOD(-5))	1.075665	-0.79754	D(LRGDP(-5	-0.66138	0.648854	Determinant resid covariance		2.07E-07
	-0.74564	-0.90969		-0.71831	-0.87635	Log likelihood		145.7131
	[1.44261]	[-0.87671]		[-0.92074]	[0.74040]	Akaike information criterion		-6.38087
D(LOD(-6))	1.307817	-0.08865	D(LRGDP(-6	-0.92449	0.259502	Schwarz criterion		-4.04555
	-0.82562	-1.00727		-0.69386	-0.84652			
	[1.58404]	[-0.08801]		[-1.33239]	[0.30655]			
D(LOD(-7))	0.661628	-0.43707	D(LRGDP(-7	-0.65623	0.066284			
	-0.56654	-0.69119		-0.47838	-0.58363			
	[1.16784]	[-0.63235]		[-1.37177]	[0.11357]			
D(LOD(-8))	0.85434	-0.32127	D(LRGDP(-8	-0.0187	-0.01818			
	-0.57575	-0.70243		-0.35364	-0.43145			
	[1.48386]	[-0.45738]		[-0.05289]	[-0.04213]			
D(LOD(-9))	0.423662	0.227915	D(LRGDP(-9	-0.02137	0.043876			
	-0.55295	-0.67461		-0.34207	-0.41733			
	[0.76619]	[0.33785]		[-0.06248]	[0.10513]			
D(LOD(-10))	0.94734	0.87741	D(LRGDP(-1	-0.34396	-0.63639			
	-0.51454	-0.62774		-0.39114	-0.4772			
	[1.84115]	[1.39772]		[-0.87936]	[-1.33360]			
D(LOD(-11))	0.124763	0.202032	D(LRGDP(-1	-0.00086	-0.37454			
	-0.56808	-0.69306		-0.45036	-0.54944			
	[0.21962]	[0.29151]		[-0.00192]	[-0.68168]			

Serial Correlation

The study used Breusch-Godfrey serial correlation LM test to check the serial correction in the VECM. The study found no serial correlation in the model. The probability of observed R-square is greater than 5%. Therefore, the study cannot reject the null hypothesis of no serial correlation and concludes that there is no serial correlation in the model. The results of the test are given below in Table 5.21:

Table 5.21: Breusch-Godfrey Serial Correlation LM Test:			
Ho: no serial correlation			
F-statistic	0.040587	Prob. F(2,4)	0.9606
Obs*R-squared	0.596703	Prob. Chi-Square(2)	0.742

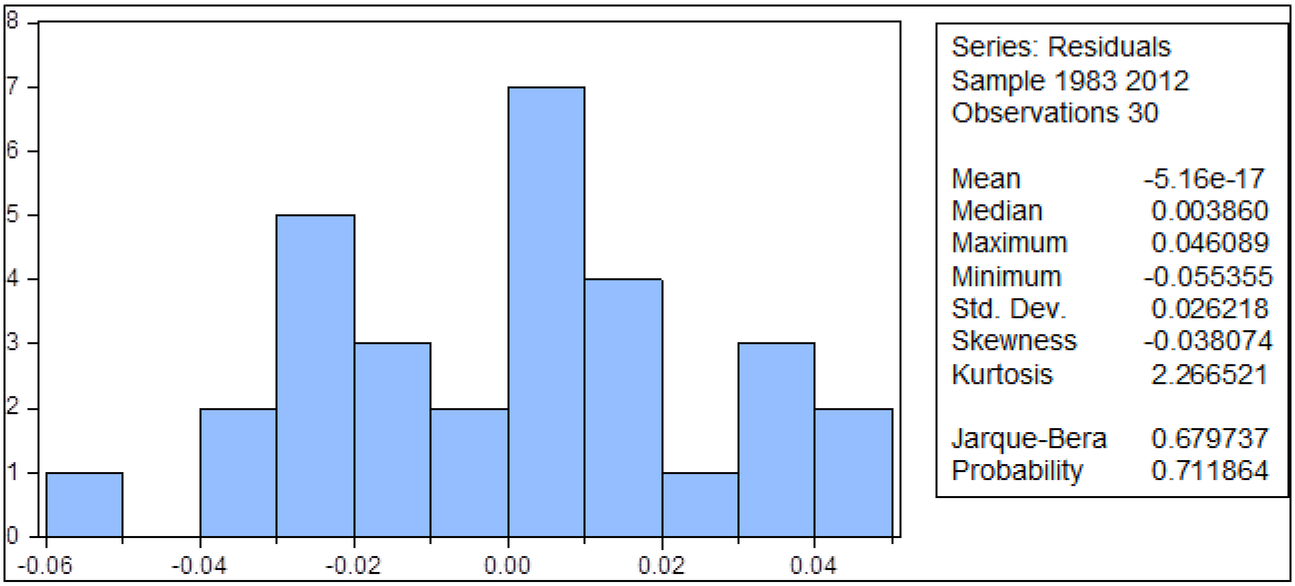
Heteroscedasticity Test

The study used Breusch-Pagan-Godfrey heteroscedasticity test to check the heteroscedasticity in the residual of the fitted VECM. The study found no heteroscedasticity in the model. The probability of observed R-square is greater than 5%. Therefore, the study cannot reject the null hypothesis of homoscedasticity and concludes that there is no heteroscedasticity in the model. The results of the test are given below in Table 5.22:

Table 5.22: Heteroskedasticity Test: Breusch-Pagan-Godfrey			
Ho: Homoscedasticity			
F-statistic	1.782062	Prob. F(24,5)	0.2714
Obs*R-squared	26.85992	Prob. Chi-Square(24	0.311
Scaled explained SS	0.680373	Prob. Chi-Square(24	1

Normality Test

The study used Jarque-Bera residual normality test to check normality of residuals of the fitted VECM. The study found normality in the residuals of the model. The probability of Jarque-Bera is greater than 5%. Therefore, the study cannot reject the null hypothesis of normality and concludes that residuals of the fitted model are normal. The results of the test are given below:



Bound tests of coefficient restriction cannot reject the null hypotheses and therefore, the tests show no short run causalities. The study concluded that there were no short run causalities.

Parameter Instability Test

The study applied CUSUM test to check instability of the estimated parameters of the VECM. In Table 5.23 dotted lines are the critical lines at 5% level of significance. The test catches parameter instability if the cumulative sum goes outside the area between the two critical lines. But in this case the cumulative sum takes place inside the area between the two critical lines. Therefore, the study concludes that there is no parameter instability problem in the model.

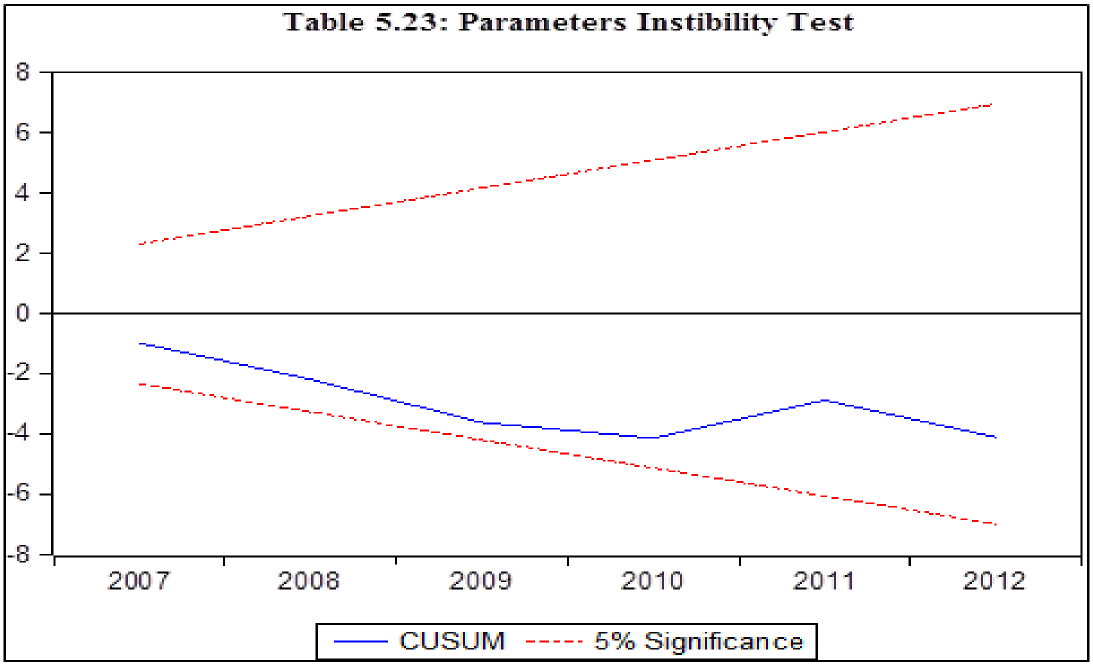


Table 5.23: Parameters Instibility Test
8
6
4
2
0
-2
-4
-6
-8
2007
2008
2009
2010
2011
2012
CUSUM
5% Significance

Appendix to Chapter # 6

The appendix contains the econometric relationship between D- series and production of each sector which is called sector D-function. Since the study uses time series model therefore, test of stationarity is necessary of each time series and if time series are not stationary at level then the cointegration test is necessary to avoid the spurious relationship among the time series. Let us first estimate the relationship between agricultural D and its production.

Agricultural D-function

Agricultural D-function is the relationship between agricultural D and agricultural output. Let us first test the stationarity of the time series.

Unit Root Test

Agricultural D

The time series of log agricultural D is not stationary at level but stationary at first difference, applying ADF test of unit root, there is no unit root in the series at first difference. The maximum lag is 9 and the model includes intercept but no trend. At five percent level or even at one percent level of significance ADF value is less than the critical value; therefore, the null hypothesis of unit roots is rejected and alternate hypothesis of no unit root is accepted, the study concludes that the time series is stationary at first difference and the order of integration of the series is I(1). The results of the test are given below in Table 6.1:

Table 6.1: Unit Root Test of Agricultural D			
Null Hypothesis: D(LAD) has a unit root			
Exogenous: Constant			
Lag Length: 1 (Automatic - based on SIC, maxlag=9)			
		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-6.54633	0.0000
Test critical values:	1% level	-3.61045	
	5% level	-2.93899	
	10% level	-2.60793	
*MacKinnon (1996) one-sided p-values.			

Agricultural Value Added

The time series of log agricultural value added is not stationary at level but stationary at first difference, applying ADF test of unit root, there is no unit root in the series at first difference. The maximum lag is 9 and the model includes intercept but no trend. At five percent level or even at one percent level of significance ADF value is less than the critical value; therefore, the null hypothesis of unit roots is rejected and alternate hypothesis of no unit root is accepted, the study concludes that the time series is stationary at first difference and the order of integration of the series is I(1). The results of the test are given below in Table 6.2:

Table 6.2: Unit Root Test of Agricultural Value Added			
Null Hypothesis: D(LAVA) has a unit root			
Exogenous: Constant			
Lag Length: 0 (Automatic - based on SIC, maxlag=9)			
		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-6.3385	0.0000
Test critical values:	1% level	-3.60559	
	5% level	-2.93694	
	10% level	-2.60686	
*MacKinnon (1996) one-sided p-values.			

The two time series log (ad) and log (ava) are not stationary at level but stationary at first difference. In order to avoid spurious relationship cointegration test is necessary. Since the order of integration of the two variables is the same therefore the study has run Johnson cointegartion test.

Optimum lag selection

All the criteria suggest lag 2 as optimum lag. Following Table 6.3 contains the results of different criteria

Table 6.3: Optimum Lag Selection

VAR Lag Order Selection Criteria
Endogenous variables: LAD LAVA
Exogenous variables: C
Date: 11/23/15 Time: 11:51
Sample: 1971 2012
Included observations: 37

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-24.95942	NA	0.014721	1.457266	1.544343	1.487965
1	86.26026	204.4038*	4.48e-05*	-4.338393*	-4.077163*	-4.246297*
2	88.50498	3.882745	4.94E-05	-4.243512	-3.808129	-4.090019
3	90.80794	3.734536	5.44E-05	-4.151781	-3.542244	-3.93689
4	92.57939	2.681112	6.21E-05	-4.031318	-3.247629	-3.755031
5	97.29126	6.622083	6.08E-05	-4.069798	-3.111955	-3.732113

* indicates lag order selected by the criterion

Cointegration Test

The series log of agricultural D and log of agricultural value added both are non-stationary at level but stationary at first difference. The study derived residual from OLS, regressing log of agricultural D over log of agricultural value added, and then check the stationarity of the residual. Since the residual is stationary at level therefore, cointegration is said to be established. The results of the residual unit root test are given below in Table 6.4.

Table 6.4: Cointegration of Agricultural D and Agricultural Value-Added

Null Hypothesis: AGRICULTURE has a unit root
Exogenous: None
Lag Length: 0 (Automatic - based on SIC, maxlag=9)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-4.733745	0.0000
Test critical values:	1% level	-2.622585	
	5% level	-1.949097	
	10% level	-1.611824	

*MacKinnon (1996) one-sided p-values.

Error Correction Model

The model shows positive and significant relationship between agricultural D and agricultural value added in long run. Although the error correction term is negative and significant but the short run coefficients are statistically insignificant. The results of the models are given below in Table 6.5:

Table 6.5: Results of Error Correction Model of Agricultural D and Agricutural Value Add		
Vector Error Correction Estimates		
Date: 11/28/15 Time: 21:15		
Sample (adjusted): 1973 2012		
Included observations: 40 after adjustments		
Standard errors in ( ) & t-statistics in [ ]		
Cointegrating Eq:	CointEq1	
LAD(-1)	1	
LAVA(-1)	-0.792977	
	-0.01191	
	[-66.5636]	
C	1.670363	
Error Correction:	D(LAD)	D(LAVA)
CointEq1	-0.561841	0.155831
	-0.20694	-0.20083
	[-2.71506]	[0.77595]
D(LAD(-1))	0.057351	-0.014147
	-0.1813	-0.17595
	[0.31633]	[-0.08040]
D(LAVA(-1))	0.330009	0.003588
	-0.19891	-0.19304
	[1.65911]	[0.01859]
C	0.057716	0.139557
	-0.02903	-0.02817
	[1.98805]	[4.95332]
R-squared	0.331017	0.023602
Adj. R-squared	0.275268	-0.057764
Sum sq. resids	0.260395	0.245247
S.E. equation	0.085048	0.082537
F-statistic	5.937668	0.290076
Log likelihood	43.93117	45.12982
Akaike AIC	-1.996559	-2.056491
Schwarz SC	-1.827671	-1.887603
Mean dependent	0.110263	0.138448
S.D. dependent	0.099902	0.080252
Determinant resid covariance (dof adj.)		3.76E-05
Determinant resid covariance		3.04E-05
Log likelihood		94.49424
Akaike information criterion		-4.224712
Schwarz criterion		-3.802492

Serial Correlation

The study used Breusch-Godfrey serial correlation LM test to check the serial correction in the VECM. The study found no serial correlation in the model. The probability of observed R-square is greater than 5%. Therefore, the study cannot reject the null hypothesis of no serial correlation and concludes that there is no serial correlation in the model. The results of the test are given below in Table 6.6:

Table 6.6: Serial Correlation Test			
Ho: no serial correclation			
Breusch-Godfrey Serial Correlation LM Test:			
F-statistic	1.598019	Prob. F(2,34)	0.2171
Obs*R-squared	3.436967	Prob. Chi-Square(2)	0.1793

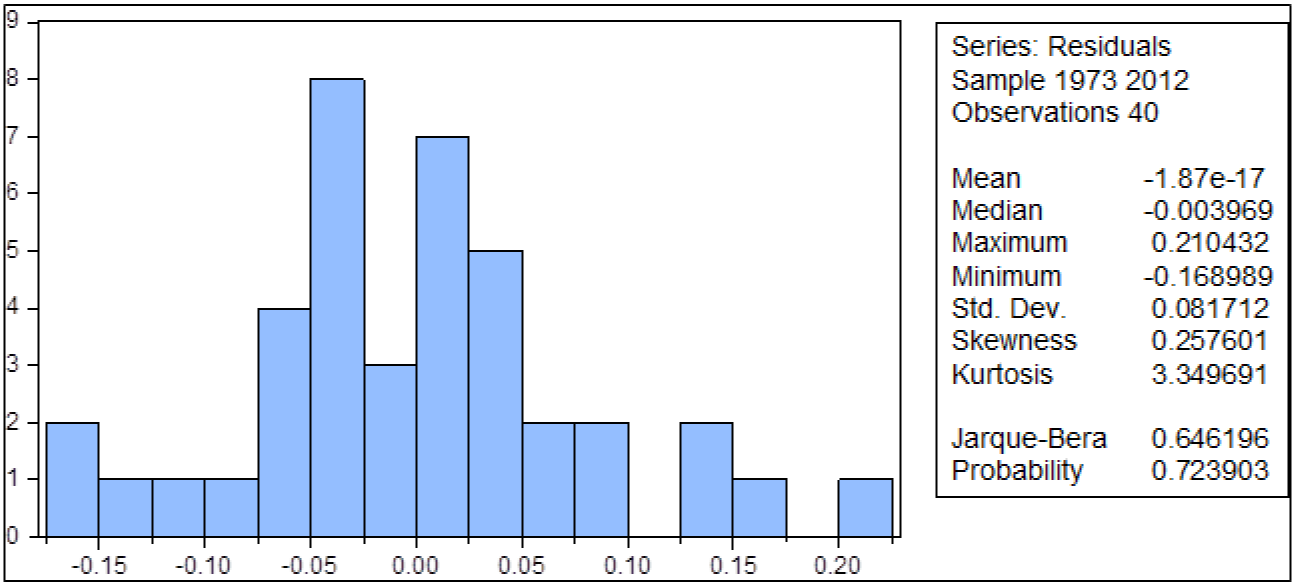
Heteroscedasticity Test

The study used Breusch-Pagan-Godfrey heteroscedasticity test to check the heteroscedasticity in the residuals of the fitted VECM. The study found no heteroscedasticity in the model. The probability of observed R-square is greater than 5%. Therefore, the study cannot reject the null hypothesis of homoscedasticity and concludes that there is no heteroscedasticity in the model. The results of the test are given below in Table 6.7:

Table 6.7: Heteroskedasticity Test: Breusch-Pagan-Godfrey			
Ho: Homoscedasticity			
F-statistic	2.651541	Prob. F(4,35)	0.0493
Obs*R-squared	9.302395	Prob. Chi-Square(4)	0.054
Scaled explained SS	8.85239	Prob. Chi-Square(4)	0.0649

Normality Test

The study used Jarque-Bera residual normality test to check normality of residuals of the fitted VECM. The study found normality in the residual of the model. The probability of Jarque-Bera is greater than 5%. Therefore, the study cannot reject the null hypothesis of normality and concludes that residuals of the fitted model are normal. The results of the test are given below:



Industrial D-function

Industrial D-function is the relationship between industrial D and industrial value added. Since it's the time series analysis; let us first check the stationarity of the variables.

Unit Root Test of Industrial D

The time series of log industrial D is non-stationary at level but stationary at first difference, applying ADF test of unit root, there is no unit root in the series at first difference. The maximum lag is 9 and the model includes intercept but no trend. At five percent level or, even at one percent level of significance ADF value is less than the critical value; therefore, the null hypothesis of unit roots is rejected and alternate hypothesis of no unit root is accepted, the study concludes that the time series is stationary at first difference and the order of integration of the series is I(1). The results of the test are given below in Table 6.8:

Table 6.8: Unit Root Test of Industrial D			
Null Hypothesis: D(LID) has a unit root			
Exogenous: Constant			
Lag Length: 0 (Automatic - based on SIC, maxlag=9)			
		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-7.366361	0.000
Test critical values:	1% level	-3.605593	
	5% level	-2.936942	
	10% level	-2.606857	

*MacKinnon (1996) one-sided p-values.

Unit Root Test of Industrial Value Added

The time series of log industrial value added is non-stationary at level but stationary at first difference, applying ADF test of unit root, there is no unit root in the series at first difference. The maximum lag is 9 and the model includes intercept but no trend. At five percent level or, even at one percent level of significance ADF value is less than the critical value; therefore, the null hypothesis of unit roots is rejected and alternate hypothesis of no unit root is accepted, the study concludes that the time series is stationary at first difference and the order of integration of the series is I(1). The results of the test are given below in Table 6.9:

Table 6.9: Unit Root Test of Industrial Value Added			
Null Hypothesis: D(LIVD) has a unit root			
Exogenous: Constant			
Lag Length: 0 (Automatic - based on SIC, maxlag=9)			
		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-5.840098	0.0000
Test critical values:	1% level	-3.605593	
	5% level	-2.936942	
	10% level	-2.606857	

*MacKinnon (1996) one-sided p-values.

Cointegration Test

The series log of industrial D and log of industrial value added both are non-stationary at level but stationary at first difference. The study derived residual from OLS, regressing log of industrial D over log of industrial value added, and then check the stationarity of the residual. Since the residual is stationary at level therefore, cointegration is said to be established. The results of the residual unit root test are given below in Table 6.10.

Table 6.10: Cointegration of Industrial D and Industrial Value-Added

Null Hypothesis: RESIDINDUSTRIAL has a unit root				
Exogenous: None				
Lag Length: 0 (Automatic - based on SIC, maxlag=9)				
		t-Statistic	Prob.*	
Augmented Dickey-Fuller test statistic		-2.326482		0.021
Test critica	1% level	-2.622585		
	5% level	-1.949097		
	10% level	-1.611824		

*MacKinnon (1996) one-sided p-values.

Error Correction Model

The model shows positive and statistically significant relationship between industrial D and industrial value added in long run. Although the error correction term is negative and significant but the short run coefficients are statistically insignificant. The results of the models are given below in Table 6.11:

Table 6.11: Results of Error Correction Model of Industrial D and Industrial Value Added

Vector Error Correction Estimates
Date: 11/28/15 Time: 22:28
Sample (adjusted): 1973 2012
Included observations: 40 after adjustments
Standard errors in ( ) & t-statistics in [ ]

Cointegrating Eq:	CointEq1		R-squared	0.204383	0.126894
LID(-1)	1		Adj. R-squared	0.138082	0.054136
LIVD(-1)	-0.96714		Sum sq. resids	0.131139	0.180122
	-0.02457		S.E. equation	0.060355	0.070735
	[-39.3699]		F-statistic	3.082642	1.744041
C	1.535001		Log likelihood	57.65006	51.30245
Error Correction:	D(LID)	D(LIVD)	Akaike AIC	-2.682503	-2.36512
CointEq1	-0.13699	0.140707	Schwarz SC	-2.513615	-2.19623
	-0.06408	-0.0751	Mean dependent	0.128528	0.14885
	[-2.13783]	[1.87365]	S.D. dependent	0.06501	0.072731
D(LID(-1))	-0.28532	-0.191455	Determinant resid covariance (dof a		1.48E-05
	-0.15788	-0.18504	Determinant resid covariance		1.20E-05
	[-1.80713]	[-1.03469]	Log likelihood		113.0584
D(LIVD(-1))	0.188657	0.216707	Akaike information criterion		-5.15292
	-0.13645	-0.15992	Schwarz criterion		-4.7307
	[1.38257]	[1.35510]			
C	0.13786	0.142036			
	-0.02527	-0.02962			
	[5.45485]	[4.79543]			

Serial Correlation

The study used Breusch-Godfrey serial correlation LM test to check the serial correction in the VECM. The study found no serial correlation in the model. The probability of observed R-square is greater than 5%. Therefore, the study cannot reject the null hypothesis of no serial correlation and concludes that there is no serial correlation in the model. The results of the test are given below in Table 6.12:

Table 6.12: Serial Correlation Test			
Ho: no serial correlation			
Breusch-Godfrey Serial Correlation LM Test:			
F-statistic	0.953942	Prob. F(2,34)	0.3953
Obs*R-squared	2.125308	Prob. Chi-Square(2)	0.3455

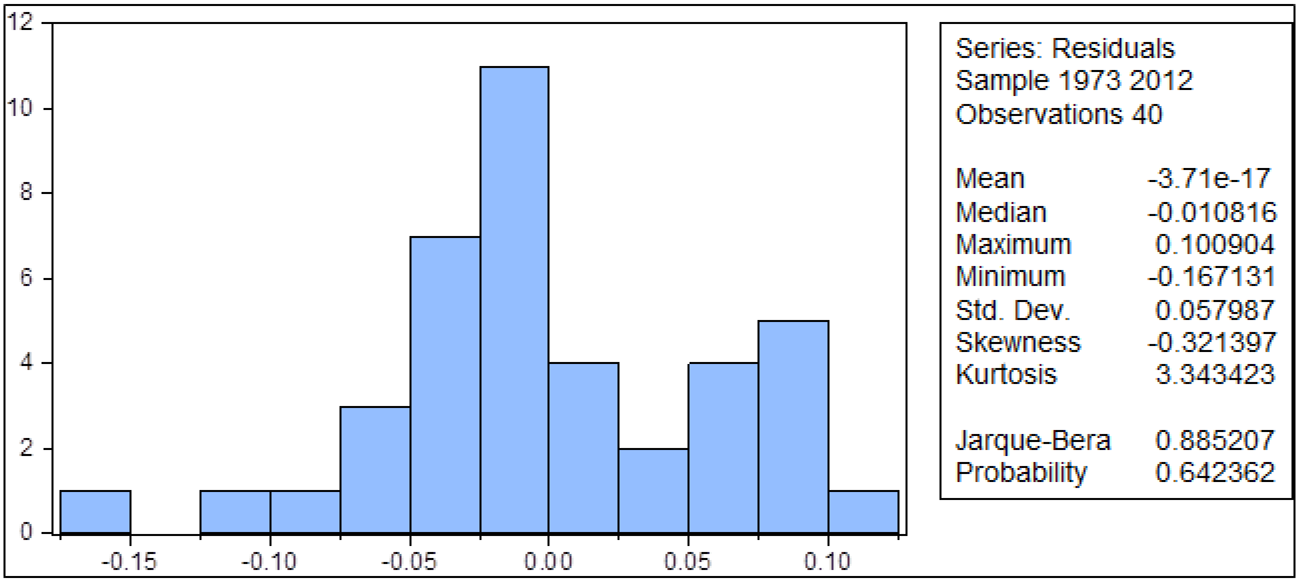
Heteroscedasticity Test

The study used Breusch-Pagan-Godfrey heteroscedasticity test to check the heteroscedasticity in the residuals of the fitted VECM. The study found no heteroscedasticity in the model. The probability of observed R-square is greater than 5%. Therefore, the study cannot reject the null hypothesis of homoscedasticity and concludes that there is no heteroscedasticity in the model. The results of the test are given below in Table 6.13:

Table 6.13: Heteroskedasticity Test: Breusch-Pagan-Godfrey			
Ho: Homoscedasticity			
F-statistic	1.973723	Prob. F(4,35)	0.1201
Obs*R-squared	7.362081	Prob. Chi-Square(4)	0.1179
Scaled explained SS	6.98725	Prob. Chi-Square(4)	0.1366

Normality Test

The study used Jarque-Bera residual normality test to check normality of residuals of the fitted VECM. The study found normality in the residuals of the model. The probability of Jarque-Bera is greater than 5%. Therefore, the study cannot reject the null hypothesis of normality and concludes that residuals of the fitted model are normal. The results of the test are given below:



D-function of Service Sector

D-function of service sector is the relationship between D of service sector and value added of the sector. To estimate the time series relationship among the variables the study has to test the stationarity of the variables. Let us check the stationarity of the time series.

Unit Root Test of D of Service Sector

The time series of log service sector D is non-stationary at level but stationary at first difference, applying ADF test of unit root, there is no unit root in the series at first difference. The maximum lag is 9 and the model includes intercept but no trend. At five percent level or, even at one percent level of significance ADF value is less than the critical value; therefore, the null hypothesis of unit roots is rejected and alternate hypothesis of no unit root is accepted, the study concludes that the time series is stationary at first difference and the order of integration of the series is I(1). The results of the test are given below in Table 6.14:

Table 6.14: Test of Unit Root of Service Sector D		
Null Hypothesis: D(LSD) has a unit root		
Exogenous: Constant		
Lag Length: 0 (Automatic - based on SIC, maxlag=9)		
	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-7.380479	0.0000
Test critic: 1% level	-3.605593	
5% level	-2.936942	
10% level	-2.606857	
*MacKinnon (1996) one-sided p-values.		

Unit Root Test of Service Sector Value Added

The time series of log service sector value added is non-stationary at level but stationary at first difference, applying ADF test of unit root, there is no unit root in the series at first difference. The maximum lag is 9 and the model includes intercept but no trend. At five percent level or, even at one percent level of significance ADF value is less than the critical value; therefore, the null hypothesis of unit roots is rejected and alternate hypothesis of no unit root is accepted, the study concludes that the time series is stationary at first difference and the order of integration of the series is I(1). The results of the test are given below in Table 6.15:

Table 6.15: Test of Unit Root of Service Sector Value Added		
Null Hypothesis: D(LSVA) has a unit root		
Exogenous: Constant		
Lag Length: 0 (Automatic - based on SIC, maxlag=9)		
	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-5.734683	0.0000
Test critic: 1% level	-3.605593	
5% level	-2.936942	
10% level	-2.606857	
*MacKinnon (1996) one-sided p-values.		

Cointegration Test

The series log of services D and log of services value added both are non-stationary at level but stationary at first difference. The study derived residual from OLS, regressing log of services D over log of services value added, and then check the stationarity of the residual. Since the residual is stationary at level therefore, cointegration is said to be established. The results of the residual unit root test are given below in Table 6.16.

Table 6.16: Cointegration of Services D and Services Value-Added

Null Hypothesis: RESIDSERVICES has a unit root
Exogenous: None
Lag Length: 0 (Automatic - based on SIC, maxlag=9)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-2.781978	0.0066
Test critical values:	1% level	-2.622585	
	5% level	-1.949097	
	10% level	-1.611824	

*MacKinnon (1996) one-sided p-values.

Error Correction Model

The model shows positive and significant relationship between agricultural D and agricultural value added in long run. Although the error correction term is negative and significant at 10% level of significance but the short run coefficients are statistically insignificant. The results of the models are given below in Table 6.17:

Table 6.17: Results of Error Correction Model of Service Sector D and Service Sector Value Added

Vector Error Correction Estimates
Date: 11/28/15 Time: 22:49
Sample (adjusted): 1973 2012
Included observations: 40 after adjustments
Standard errors in ( ) & t-statistics in [ ]

Cointegrating Eq:	CointEq1		R-squared	0.100746	0.118042
LSD(-1)	1		Adj. R-squared	0.025809	0.044545
LSVA(-1)	-0.967618		Sum sq. resids	0.682834	0.179317
	-0.04095		S.E. equation	0.137723	0.070576
	[-23.6272]		F-statistic	1.344401	1.606088
C	3.351776		Log likelihood	24.6501	51.39205
Error Correction:	D(LSD)	D(LSVA)	Akaike AIC	-1.03251	-2.3696
CointEq1	-0.19298	0.107558	Schwarz SC	-0.86362	-2.20072
	-0.11716	-0.06004	Mean dependent	0.134552	0.154402
	[-1.64719]	[1.79152]	S.D. dependent	0.139535	0.072203
D(LSD(-1))	-0.084235	0.039	Determinant resid covariance		9.20E-05
	-0.16953	-0.08688	Determinant resid covariance		7.45E-05
	[-0.49686]	[0.44890]	Log likelihood		76.57676
D(LSVA(-1))	-0.012789	0.096712	Akaike information criterion		-3.32884
	-0.30339	-0.15547	Schwarz criterion		-2.90662
	[-0.04215]	[0.62205]			
C	0.147954	0.134275			
	-0.05509	-0.02823			
	[2.68585]	[4.75661]			

Serial Correlation

The study used Breusch-Godfrey serial correlation LM test to check the serial correlation in the VECM. The study found no serial correlation in the model. The probability of observed R-square is greater than 5%. Therefore, the study cannot reject the null hypothesis of no serial correlation and concludes that there is no serial correlation in the model. The results of the test are given below in Table 6.18:

Table 6.18: Breusch-Godfrey Serial Correlation LM Test:

Ho: There is no serial correlation

F-statistic	0.729933	Prob. F(2,34)	0.4893
Obs*R-squared	1.64678	Prob. Chi-Square(2)	0.4389

Heteroscedasticity Test

The study used Breusch-Pagan-Godfrey heteroscedasticity test to check the heteroscedasticity in the residuals of the fitted VECM. The study found no heteroscedasticity in the model. The probability of observed R-square is greater than 5%. Therefore, the study cannot reject the null hypothesis of homoscedasticity and concludes that there is no heteroscedasticity in the model. The results of the test are given below in Table 6.19:

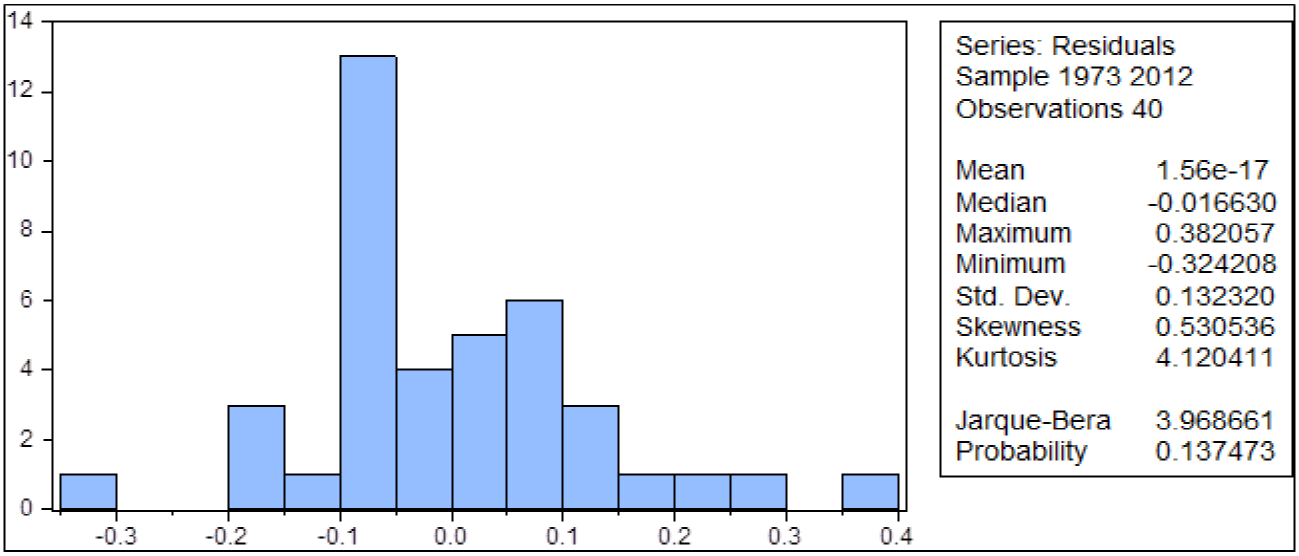
Table 6.19: Heteroskedasticity Test: Breusch-Pagan-Godfrey

Ho: Homoscedasticity

F-statistic	2.544662	Prob. F(4,35)	0.0567
Obs*R-squared	9.01191	Prob. Chi-Square(4)	0.0608
Scaled explained SS	11.38895	Prob. Chi-Square(4)	0.0225

Normality Test

The study used Jarque-Bera residual normality test to check normality of residuals of the fitted VECM. The study found normality in the residuals of the model. The probability of Jarque-Bera is greater than 5%. Therefore, the study cannot reject the null hypothesis of normality and concludes that residuals of the fitted model are normal. The results of the test are given below:



Bound tests of coefficient restriction show no short run causality and the short run coefficients are statistically insignificant.