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Comparing Effects of Green Innovation and Renewable Energy on Green Economy: The Metrics of Green Economy as Nucleus of SDGs

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ABSTRACT

Green Economy (GE) is a practicable strategy for the implementation of a sustainable development paradigm that confirms a dynamic growth, which is both humanly and naturally sustainable. The objective of this research article is to analyse the effect of environment friendly variables like green innovations (GI) and Renewable Energy (GN) specifically along with some variables on GE in South Asia (SA). This research article discusses a relationship of renewable energy (GN), green jobs (GJ), natural resource scarcity (RS), green innovations and green technology (GT) on GE. To evaluate the status of the connection between the variables, a panel autoregressive distributed lagged (ARDL) bounds analysis methodology was used on 50 years (1972 – 2021) data of South Asian region. This is a panel data analysis as countries of South Asia were discussed. Findings of this study showed no influence of GI on GE as well as on sustainable development. Furthermore, linked variable Renewable Energy indicated positive effect on GE along with economic development. On the contrary, the results of green jobs, GT and resource scarcity are not in the favour of GE because of lack of knowledge, cost of production, less awareness etc. On account of these empirical findings attained, policy strategies are recommended to introduce new skylines for economically underdeveloped nations in agrarian and industrialization. Government can take steps to create opportunities through trainings for a layperson to participate in economic activities and live with a respectable employment. Awareness campaigns, degrees, diplomas, certified training programs and workshops should be organized to implement this initiative by its spirit.

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1. Introduction

We are driven to examine how renewable energy affects the green economy (GE) after merging the contributions of innovation and the evidently environmentally destructive militarism. This study addressed the significance of GE for attainment of SDGs 2030. When all countries entered the era of industrial growth, they realized that they are gaining materialistic relief but losing the health as well as environment of their nation (Ahuti, 2015). This issue should be taken on serious note to save pure life on this planet for our future generations. We need to leave healthy environment for them. Therefore, Sustainable Development Goals targeted Green Economy because natural resources are the base of life (Bina, 2013). In green economy, the center of attention is welfare of humans. It will upgrade the standard of life because it helps to attain the objectives of economic development along with the conservation of natural resources. It's environment friendly economy in all respects. In the beginning, heavy investment will be required for the transformation to green economy but in the long run, this step for transition will be proved as a milestone towards development in all aspects. China invested a huge amount for

this purpose and gained a lot in return (Yi & Liu, 2015). Developing Countries should learn from their experiences.

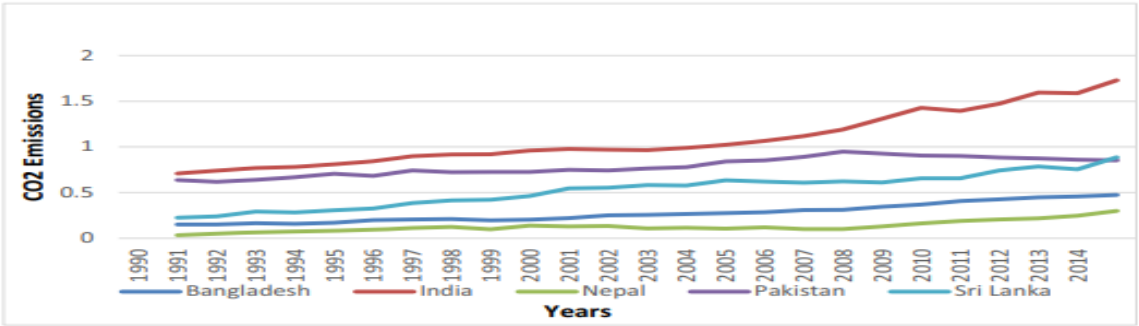
It is a global issue to save environment on priority. World economy is going through fourth revolution in industrial sector. The industrial progress negatively affected environment. The quality of life was declined due to these environmental issues (Elheddad, Benjasak, Deljavan, Alharthi, & Almabrok, 2021). Therefore, environment is a hot issue at global level. Each state worked on law to save environment. The provision of clean water, clean air and friendly environment is in the preference of every government. The green economy deals with the issues related to environment as well as poverty. The policy makers are supposed to keep in mind the two objectives on priority; one is to eradicate the poverty and the other one is safe environment (Dunn, 2010). These objectives stimulated them to plan for the transition to GE. An execution for GE specifically targets the sustainable development goals 2030.

South Asian Countries (Pakistan, India, Afghanistan, Sri Lanka, Maldives, Bangladesh, Nepal and Bhutan) are the center as regards to this research with reference to green economy. These are agro based countries and moving towards industrial growth. The importance of green technologies, Renewable Energy, green jobs, natural resource scarcity and carbon emission for transition to GE will be discussed in this study. If policy makers of South Asian Countries plan for green economy and execute according to its true spirit then they can easily come out of vicious circle of poverty (Babonea & Joia, 2012).

Despite the fact green economy deals with environment side by side GDP. Agriculture in SA is significantly impacted by climate change and its variability. According to various future growth scenarios, the IPCC forecasts a temperature rise of 0.5 – 1.2 °C for the region by 2020, 0.88 – 3.16°C by 2050, and 1.56 – 5.44 °C by 2080 (IPCC, 2007). The earth's temperature is rising as a result of climate change (IPCC, 2007, 2014). The increase in atmospheric carbon dioxide (CO_2) emissions is causing a rise in global warming. Environmental deterioration is a result of CO_2 emissions. According to the IPCC (2014), developing economies are responsible for 76.6% of global GHG emissions, which significantly contributes to the environmental degradation. Therefore, reducing emissions is becoming a major priority. In the literature, there is comparatively little discussion of the effects of globalization and financial development on environmental damage than that of environmental degradation caused by rapid economic growth (Gökmenoğlu & Taspinar, 2016).

The graphs shown below show the trends of the variables. The pattern of carbon emissions is shown in Figure 1, with India having most significant emissions in the area due to its 7% annual growth rate and reliance on energy to maintain it (World Bank, 2019). Subsequently, the quality of the regional environment has declined, while Nepal has experienced the lowest levels of carbon emissions between 1990 and 2014. Earth's temperature increased due to the increase in CO_2 emissions in the atmosphere, which also caused changes in the climatic pattern (IPCC, 2007, 2014). The trend in GDP per capita is seen in Figure 2. India, Pakistan, and Sri Lanka are the countries in the area having the greatest GDP per head growth rates. In Nepal, the GDP per head is growing at the slowest rate.

Figure 1: South Asian Economies' Carbon Emissions

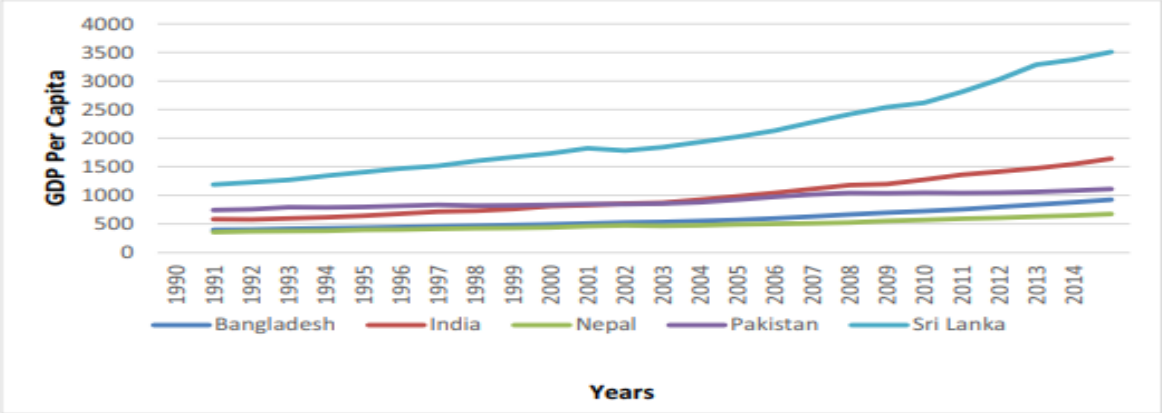


Source: (IPCC 2014)

The goal of this inquiry is to examine how GE interacts with important variables that could have a significant effect on economic expansion. In this research, green economy will be linked with green technologies, green jobs, scarcity of natural resources, Renewable Energy and green

innovations to evaluate the influence as concerned to above mentioned elements upon green economy. Several variables affected green economy positively. The influence of GI on GE along with cluster based on some above mentioned specifically selected variables in the region of South Asia was rarely discussed. Therefore, this model is the area of discussion in this article.

Figure 2: Economies In South Asia, By GDP Per Capita



Source: (IPCC 2014)

The Green Economy will give boost to the economy by implementing Green Technologies e.g., recycling, clean water, clean air, energies based on natural resources. Green Technologies make a route to social equality via green jobs, pure environment, productive resource allocation, effective use of energies and less carbon emissions. Carbon emission can be controlled through Green Technology based industries. Many researchers threw light on the importance of Green Economy but still there is room to show connection concerning carbon release and energy utilization for functional influence of GE upon Economic Growth. Green technology creates the path which leads towards the progress in green economy because it introduces innovative techniques that helps in the production of more goods with fewer natural resources and the highest quality (Eaton, 2013). Green technology intensive industries promote green economy.

An awareness campaign for SMEs in developing economies is required to guide them for the practices of green innovations (Thomas, Scandurra, & Carfora, 2022). The firms have less research in the field of green innovations therefore they don't know how to get benefit from green innovations and in the result; they damage the natural environment by adopting harmful technologies to produce the goods at low cost. On several occasions, President Obama has shed light on the prerequisite of shifting to sustainable energy resources stated, "America cannot resist this transition, we must lead it", as well as he assumed "those new energy sources to be built right here in the United States" (Brunel, 2019). These claims stimulate the economy towards green innovation industries as well as job creation in this sector that is environment friendly.

Promotion of Green Economy creates green jobs. There are three types of jobs: direct jobs, indirect jobs and induced jobs. It covers almost all respectable professions which are the indicators of boost economy. These professions are friendly to nature (Unay-Gailhard & Bojnec, 2019). Entrepreneurs and workers of this economy not only earn to achieve their individual financial goals but also contribute for SDGs. There are two categories of green jobs; direct and indirect jobs. Direct green jobs are directly linked with agricultural or natural resources. Either educated or skilled labor can be employed. Indirect green jobs are based on the supporting occupations like welders etc. The conversion to GE creates the great number of opportunities in lieu of financial boost. Green Economy is environment friendly economy. Trends of green economy reduce pollution and decrease emission of CO_2.

This environment facilitates economy with healthy work force. The potential of healthy work force is the key source to stimulate the factors of green economy. Less carbon emission techniques supports environment positively (Chen, Rojniruttikul, Kun, & Ullah, 2022). To achieve this objective, forestry should be promoted. Economy should be restructured to support green projects and to facilitate green investments. Government should ask regulating authorities to make laws to control carbon emission and make sure the implementation of such laws. Government intervention is essential to control the acts against healthy environment (Huang et al., 2022).

There's a nexus between GE and Renewable Energy. Renewable Energy often comes from green technologies e.g., solar system, wind power and hydroelectric power etc. Renewable Energy intensive economy is low-cost economy which gives more benefit (Brears, 2018).The renewable energy is sum of Renewable Energy and decreased carbon emission. The renewable energy can be effectively utilized in recycling activities. Reuse of water, wood and concrete are the examples of recycling that are in practice in many countries (Adams & Acheampong, 2019). There's a link between means scarcity and GE. The effective resource allocation and preservation of the resources are essential for promotion of green economy. The scarcity of natural resources is the problem which is faced by every country due to increase in population day by day. This scarcity can be managed by careful planning and the use of green, renewable fuels and green technologies. The renewable natural resources – as its version of a green economy (Dittrich, Giljum, Lutter, & Polzin, 2012).

Whenever a problem arises, it provokes us to think over it. We take a step towards research to find the solution for that particular issue. In recent decades, it was observed that human capital and environment was going to be damaged due to brown and traditional economy. It happened because the main objective of this economy is just financial development regardless of effective and sufficient use of natural resources. This problem was realized at global level because current human activities aren't in favor of environment. Therefore, it became a key target of sustainable development goals (Khoshnava et al., 2020). Therefore, almost every state is concerned as the transformation to GE from traditional economy to meet up the needs of future generation. The similarities or dissimilarities between conventional economy and GE show positive influence of GE on economic growth, environment, ecosystem, resource allocation, energy, technologies and social justice (Shabunina, Shchelkina, & Rodionov, 2017). Green Economy doesn't work in isolation. It interacts with other sectors of economy and leaves a positive impact on economic growth. According to this definition, green growth level forms:

$$GGt = MGt + GDPt - CO2,t - NFDt - NRPt$$

where GG denotes the level of green economic growth (green GDP measured in constant 2010 USD), MG denotes spending on merit goods, GDP denotes gross domestic products, CO_2 denotes the financial value of carbon dioxide, particulate emissions damage, and t denotes time, NFD denotes the financial value of forest exhaustion, NRP denotes the financial value of depleted coal, crude oil, natural gas, and other minerals. The World Bank's WDI measure these ideas, as well as our facts and figures incorporates their findings (Sohag, Husain, Hammoudeh, & Omar, 2021). In this formula, role of renewable energy and carbon emissions is significant but green innovations, green technology and green jobs are ignored. This is the research gap which has been addressed in this study. There are certain economic, social as well as ecological features in this area when formulating a collection of factors for the local GE (Hryhorak & Trushkina, 2020), however to make sure the nexus between the district and provincial growth practices. The results of this article will add advancement in the current literature as well as will be of significant concern to policymakers as well as city organizers in emerging economies.

We discovered through literature reviews that regardless of the assessment method utilized, GE has a positive influence on occupation in both developed as well as developing countries. But in some nations, like Spain, the green economy can also be harmful. Furthermore, if policy influences are taken into account, it can alter the labor market in another way. Similarly, relationship of GI, GN, GT, RS with GE varies in different regions of the world due to climate conditions, priorities of policy makers and rate of literacy. Finally, we must acknowledge that there are certain issues with the current study in this field, including a lack of studies on various nations and energy sources, a lack of acceptable theoretical justification, a lack of in-depth examination of such relationships, and so forth. We recommend that in future studies, researchers concentrate on the mechanisms by which this relationship is altered and the laws that govern such associations.

2. Literature Review

It is the need of the hour to move towards Green Economy for the welfare of our future generation. UNDP included this agenda in SDG 2030 that reflects the importance of this issue because it's highlighted on the worldwide platform. In 1989, Pearce et al. presented a report in which first time Green Economy was introduced to recommend its implementation for healthy environment and to stop exploitation of resources in developing areas at global level. In 1992,

environmental conservation along with economic growth was a common agenda of the sustainable development conference that was conducted by UN. The fragrance of GE motivated several developed countries to step in the practice of transition from traditional economy to GE. The numerous variables affect green economic growth. The role of some of the key variables will be presented in this paper (Khoshnava et al., 2020).

In a new city Samawah, the systematic investigation was conducted by using experiential based methodologies. The methods for analyzing developmental potentials using modern Geographic Information System (GIS) technologies, SWOT models and local real–world interactions had also been used. Firstly, green economy was compared with the conventional economy in all respects then SDGs, its targets and hurdles were highlighted, threats related to transformation to green economy and the attainment of SDGs were discussed. Lastly, the real picture and its capacity were described to use them to fulfill the targets in the sample city Samaawah. This study described positive impact of green economy on Samawah in renewable energy sources, employment rate, low cost of generating electricity, reduction in poverty and increase in GDP (A. H. S. Ali, 2021).

2.1. Green Technology and Green Economy

The research was conducted to answer the questions about productive capabilities in environment friendly industrial based countries. Two novel measures GCI and GCP were introduced in this study. The potential to present facts and figures related to environment, production capacity on the basis of green technology was illustrated by these measures. This research supported the production of green products by using green technology in the transition process to green economy. Green technology positively influenced green economy (Mealy & Teytelboym, 2022). The aim of this study was to shed light on two dimensions; one was based on impact of modern techniques and the other one was related to government concerns in adapting green technologies in Small and Medium Enterprises. The data was collected through questionnaire in this study by applying self – administrative approach. The purpose of this article's goal was tested using multiple regression analysis. However, a hierarchical regression was employed to test the part of intervention by the government in adapting these technologies. The results showed that government is in advocated its adoption because government had already realized its relative importance. All policy makers recommended all possible steps to align green technologies with SMEs (Kousar, Sabri, Zafar, & Akhtar, 2017). Smart manufacturing technologies are referred to as industry 4.0. In order to assess the effects of Industrial 4.0 on economic and environmental efficiency, this study uses green supply chain management as a middleman in a developing economy like Pakistan. The GSCM's mediating function helped the literature. According to the study's findings, Industry 4.0 has a favorable impact on both economic and environmental efficiency (Umar, Khan, Yusoff Yusliza, Ali, & Yu, 2022).

H_1: There is relationship between GT and GE.

2.2. Green Innovations and Green Economy

This study described the connection between GEE (green economy efficiency) along with technological innovation that positively influenced urban GE for developing economies. The data envelopment analysis game cross-efficiency model was employed to examine GE efficiency in the instance of 238 Chinese official cities from 2003 to 2017. From the perspectives of urbanization and natural resources, the spatial econometric model was used to examine a bonding and transference processes of technical innovations along with GEE. An urban progress's heterogeneity was also proposed for evaluation. The findings of this study explained that severe influence of technical innovation was substantial and could significantly develop the GEE. There were differences in the connection and mechanisms between the green economic efficiency and technological innovation. To achieve the ideal results, it was recommended to develop a green economy cluster of neighboring cities (Y. Liu & Dong, 2021). This study addressed the claim that domestic economies were stimulated by environmental policies. The regression analysis was employed. It described domestic economies had positive influence due to renewable energy policies. The foreign technologies progressed because of renewable energy policies. The results determined a rise in making of renewable energy technologies along with an increase of country's international effectiveness via exports (Brunel, 2019).

H_2: There is association between GI and GE.

2.3. Green Jobs and Green Economy

Due to change in climatic conditions and environmental issues, transition to GE is need of an hour. The GE is center of discussion at every forum. Green economy is a source of career opportunities. The trend of jobs reflects an economic framework. This research depends on the study of occupational data of Brazil for 10 years. It was quantitative research which indicated the capacity for green jobs in current economic structure. This experiential research positively explained the index of green jobs. It was also evident that transformation to green economy through green jobs is slow. However, this empirical study showed that if one region is relatively greener than the other one then it would positively affect the aligned regions (Dordmond, de Oliveira, Silva, & Swart, 2021). The utilization of renewable energy sources (RESs) in electric field is a back bone of environmentally friendly techniques and approaches the target set by European Union of carbon emission. It also controls the demand of fuel. This practice gave advantage to society socially as well as economically. Even in the current scenario of crisis, rise in investment and employment shows their levels of impact. The aim of the study was to predict a future of asset in Italy's energy sector with the application of EFA techniques and Input – Output analysis. The results of this study explained the ripple effect of RESs on economy. It strongly supported employment in green economy sector that boosts the overall economy of Italy at both ends directly and indirectly (Dell'Anna, 2021).

H_3: There is relationship between green jobs and green economy

2.4. Renewable Energy and Green Economy

This research explained that green infrastructure approach and economic welfare is strongly connected with energy efficiency. This is the guaranteed path towards sustainable development. In this study, ANP and ANFIS results were used to describe the efficiency and positive impact of GE indicators. The criteria of quality of the climate, energy efficiency, affordability as well as use of naturally occurring sources supported GE in the perspective of SDGs 2030 (Khoshnava et al., 2020). This study presented the case study of local level sustainability through GE in the village of Saija in Lapland. This investigation not only focused on key indicators but also non–professionals were considered as cooperative tool for the boost of green economy. The crux of this study was to support governing abilities at spatial scale. The measurement of supporting factors for transformation to green economy at spatial level led to development of green growth. The domain-based approach was employed for its framework. This investigation shed light on effective utilization of bioenergy production and biogas-based projects. The Saija transformation to a green economy was greatly aided by the agricultural and forestry sectors (Timonen, Reinikainen, Kurppa, & Riipi, 2021).

The gist of this paper was the appreciation of Russian policies in the favor of methodologies based on how well energy is performing in industry. The energy efficiency of the economy was described by scientific research techniques and specialized statistical and economic analysis of the statistics framework. The procedure included the methods of data collection, qualitative and quantitative study of the legislative structure's content, and energy efficiency. As well as, results were presented through tabular and graphical methods. The government of Russia was supporting energy-saving and energy-intensive activities since 2008 and put all its efforts for its promotion. Russia preferred self-sufficient energy techniques in all sectors to enhance environmental efficiency and low carbon economy (Matraeva, Solodukha, Erokhin, & Babenko, 2019).

H_4: There is relationship between renewable energy and green economy

2.5. Natural Resource Scarcity and Green Economy

The goal of this study was to provide information about Tanzania's implementation of the green economy. The SAGCOT (Southern Agricultural Growth Corridor of Tanzania) was established by the state as an example of an African green economy. The high growth rate of population was the cause of land conflict and lack of natural resources. The government encouraged the investment on agricultural sector, livestock, water resources, farmer's financial assistance and environment friendly production techniques. All the steps were taken for the promotion of green economy (Bergius, Benjaminsen, Maganga, & Buhaug, 2020). The water is one of the main sources of life. Life on this planet cannot be imagined without water. The sustainable future for living beings is at risk due to shortage of water. The restoration of

ecosystem is also concerned with scarcity of water. The agricultural productions, irrigation and cultivated areas rely on the supply of water. The economical use of water and rain can allow for limited capacity of green economy. The sustainable irrigation policies were recommended for better future of green development (Mazzocchi, Orsi, & Sali, 2021). The influence of green economy on US was studied in the present study. The connection between misuse of naturally occurring sources and economic growth showed that it influenced negatively on the expansion of economic development (Lane, 2019).

H_5: There is relationship between resource scarcity and green economy.

These empirical observations are supported theoretically by the "creative destruction" theory of economic innovation and the business cycle.

3. Variable Construction and Data

In order to complete this assignment, we use a number of variables, such as GDP based on GE, GI, GT, GJ, GN and RS, which are taken directly from the World Development Index (WDI) of South Asian Region for the past 50 years.

3.1. Analytical Method

To conduct this study, data is collected from WDI. This is time series analysis by taking South Asia as population. The empirical investigation is the basic Cobb-Douglas production function with constant returns and the neoclassical framework with a Hicks neutral technical process serve as the foundation for this study.

$$Yit = Ait\ Kit\alpha\ Lit\ \beta \qquad (1)$$

At stands for total factor productivity, Y_{it} stands for real per capita GDP and K_{it} represents a capital series per worker and L_{it} represents a labor force per capital unit. In the literature on macroeconomics, there are several approaches to expand this kind of production function. The researchers propose several elements that influence economic expansion, for example green innovations (Tang, Walsh, Lerner, Fitza, & Li, 2018), green technology(Lucas Jr, 1988; Mankiw, Romer, & Weil, 1992), green jobs, Renewable Energy(Grossman & Helpman, 1991; Lucas Jr, 1988; Young, 1991) and resource efficiency (Farias, 2001; Sidrauski, 1967). Thus, it is reasonable to suppose:

$$GEit = f\ (GI, GT, GJ, GN, RS) \qquad (2)$$

Whereas, GI = Green Innovations, GT = Green Technology, GJ = Green Jobs, GN = Renewable Energy, RS = Resource Scarcity. Agriculture, forestry, and fisheries value added (% of GDP) is used to calculate GE, while employment in agriculture (% of total employment) is used to calculate GJ (modeled ILO estimate), renewable energy consumption (as a percentage of the total final energy consumed), and CPIA policy as well as institutes for environment sustainability grading (1=low → 6=high), GT is measured through Agricultural raw materials exports (% of merchandise exports) and RS is measured by Adjusted savings: natural resources depletion (% of GNI). The last segment of the present study covered how the key element of GE is green innovation. Besides Green Innovations, there are a number of additional factors that could impact the GE. The last segment of this article covered how a key element of the green economy is green innovation. Additionally, to Green Innovations, there are a number of additional factors that could impact the Green Economy.

For example, Grossman and Helpman (1991); Lucas Jr (1988); Young (1991) mention that each country is negatively impacted by carbon emissions. Another significant factor influencing the green economy is the scarcity of natural resources. Most research concluded a strong and advantageous association between GE and resource scarcity(Lucas Jr, 1988; Mankiw et al., 1992). Similar to this, the discussion surrounding the influence of GN, GT, and GJ on the GE is in support of economic expansion in this field. Considering the duration, economic growth is positively and significantly impacted by all Green Economy drivers. Considering the aforementioned theoretical arguments, we specify the following econometrically estimable equation Katircioglu (2009), as follows:

$$GE_{it} = \alpha + \beta_1 GI_{it} + \beta_2 GT_{it} + \beta_3 GJ_{it} + \beta_4 \mathrm{GN}_{it} + \beta_5 \mathrm{RS}_{it} + \mu_{it} \qquad (3)$$

In the equation Eq. (2) GE, GI, GT, GJ, GE, RS represents natural log of Green Economy (GE), natural log of Green Innovations (GI), natural log of Green Technology (GT), natural log of Green Jobs (GJ), natural log of Renewable Energy (GN), natural log of Resource Scarcity (RS). Whereas, $\alpha, \beta_1, \beta_2, \beta_3, \beta_4, \beta_5, \mu_t$ are the coefficients of long-term parameters and Gaussian error term respectively.

3.2. Econometric Methodology

A significant amount of the research on green innovation and the green economy is reported by cointegration methods (Engle & Granger, 1987; Søren Johansen, 1991; Soren Johansen & Juselius, 1990), as we discussed in the section on literature review. We are quite concerned about the Green Innovation initiatives since the similar methodologies using the alike constructs are no longer capable of producing a novel impact; instead, they only help to multiply the quantity of conflicting outcomes over various timescales. We avoid this problem by using the Panel ARDL model. As far as we know, none of the studies for the South Asian region that are currently available used the Panel ARDL estimators to assess the connection between green innovation and the GE. Pesaran, Shin, and Smith (2001); Pesaran, Shin, and Smith (1999) presented the Panel Autoregressive Distributed Lag cointegration approach. Because of its many benefits, researchers are employing the Panel ARDL estimator. For example, Panel ARDL can be employed if all constructs are purely stationary at I(0), I(1) or I(0) & I(1) and there is no condition about all data series under study should be stationary at same order.

Pesaran (1997); Pesaran et al. (1999) emphasized that the Panel Autoregressive Distributed Lag estimators generate the appropriate factors in the case of small sample sizes, in contrast to Johansen and Juselius' cointegration method, and that the coefficients from the Panel Autoregressive Distributed Lag estimators are extremely reliable. This is especially pertinent to our circumstance because our data set has 50 annual observations. Furthermore, because there is no residual connection in the Panel ARDL paradigm, endogeneity is not as problematic. Pesaran et al. (1999) have demonstrated that even if the underlying factors are endogenous, the Panel ARDL technique can separate the dependent and explanatory variables, allowing for estimate. (Pesaran, 1997; Pesaran et al., 2001). There is the fundamental problem with a link between GI and GE because published research has yielded contradictory results of causal connection between green innovation and GE. This work therefore uses Panel ARDL modeling. Equation (3)'s Panel ARDL framework is represented by this:

$$\Delta lnGE_{it} = \alpha_0 + \sum_{j=1}^{p} \alpha_1 \, \Delta lnGE_{it-j} + \sum_{j=1}^{p} \alpha_2 \, \Delta lnGI_{it-j} + \sum_{j=1}^{p} \alpha_3 \, \Delta lnGT_{it-j} + \sum_{j=1}^{p} \alpha_4 \, \Delta lnGJ_{it-j} + \sum_{j=1}^{p} \alpha_5 \, \Delta lnCE_{it-j} + \sum_{j=1}^{p} \alpha_6 \, \Delta ln\mathrm{GN}_{it-j} + \sum_{j=1}^{p} \alpha_7 \, \Delta ln\mathrm{RS}_{it-j} + \lambda_1 GE_{it-1} + \lambda_2 GI_{it-1} + \lambda_3 GT_{it-1} + \lambda_4 GJ_{it-1} + \lambda_5 CE_{it-1} + \lambda_6 \mathrm{GN}_{it-1} + \lambda_7 \mathrm{RS}_{it-1} + \varepsilon_{it} \quad (4)$$

A statement from $\lambda_1 \rightarrow \lambda_7$ with signs of summation illustrates the short-term changes in the constructs, whereas the equation from α_1 to α_7 on R.H.S. shows the long-term relationships between constructs. While α_0 indicates the drift constant as well as ε_{it} is Gaussian white noise, respectively. Panel Autoregressive Distributed Lag bounds testing gives comprehensive data about both long-term as well as short-term dynamics subsequently a number of stages plus techniques. Using the ordinary least square (OLS) approach, the variables in Eq. (4) will be estimated in the first step, and an F-test will be performed to see whether there is a long-term association between them. In Eq. (4), null hypothesis is H_0: $\lambda_1 = \lambda_2 = \lambda_3 = \lambda_4 = \lambda_5 = \lambda_6 = \lambda_7 = 0$. This indicates that long-term relationships are nonexistent. While the alternate is H_1: $\lambda_1 \neq 0$, $\lambda_2 \neq 0$, $\lambda_3 \neq 0$, $\lambda_4 \neq 0$, $\lambda_5 \neq 0$, $\lambda_6 \neq 0$, $\lambda_7 \neq 0$.

Pesaran et al. (2001) offer upper and lower critical values, which are contrasted with the resulting F-statistics value. The null hypothesis of no cointegration will be rejected (1) if the calculated F-value is higher than the upper critical value, regardless of whether the variable is I (0) or I (1). The chosen Panel ARDL model will be used in the second stage (SBC) to estimate long-term relationships using the R2, Schwarz criterion, Hannan Quinn and Akaike Information Criterion (AIC). In third stage, the estimated error correction model is as follows:

$$\Delta GE_{it} = \beta_0 + \sum_{j=1}^{p} \delta_j \, \Delta GE_{it-j} + \sum_{j=1}^{p} \emptyset_j \, \Delta GI_{it-j} + \sum_{j=1}^{p} \omega_j \, \Delta GT_{it-j} + \sum_{j=1}^{p} \gamma_j \, \Delta GJ_{it-j} + \sum_{j=1}^{p} \theta_j \, \Delta CE_{it-j} + \sum_{j=1}^{p} \varphi_j \, \Delta \mathrm{GN}_{it-j} + \sum_{j=1}^{p} \rho_j \, \Delta \mathrm{RS}_{it-j} + \alpha \, ECM_{it-1} + U_{it} \quad (5)$$

The error correction model's output shows how soon long-term equilibrium is restored after a short-term shock. To show how well the model fits the data, several diagnostic tests are utilized. The chosen model is subjected to these tests, which look at heteroscedasticity, functional form, normalcy, and serial correlation. Moreover, Pesaran (1997) endorse with Brown and Korringa (1975) a test of stability to ascertain whether regression coefficient is stable. This method is also known as CUSUMSQ (cumulative sum of squares) and CUSUM (cumulative). In comparison to the break points, The CUSUM and CUSUMSQ values have been updated recursively. If the plots of the CUSUM and CUSUMSQ statistics remain inside the crucial confines of the 5% threshold of significance, the null hypothesis of all stable coefficients in the provided regression cannot be rejected. The first generation of models has been constructed to analyze the characteristics of panel-based unit root tests under the presumption that data is independently as well as identically distributed (i.d.) among people. The first unit root tests were developed by (Breitung, 1997; Levin, Lin, & Chu, 2002). The univariate regression that forms the foundation of this particular panel unit root test is as follows:

$$\Delta y_{it} = \rho_i y_{it-1} + Z_{it}\,\gamma + \mu_{it} \qquad (6)$$

where i = 1, 2,..., N denotes the individual and t = 1, 2,..., T is the number of time series observations, its z_{it} is the deterministic component and its μ_{it} is a stationary process. z_{it} can be zero, one, the fixed effects (μ_i), or fixed effect as well as a time trend (t). The null hypothesis is:

$$\rho_i = 0 \;\forall\; i \qquad (7)$$

A degree of heterogeneity taken into account by the alternative hypothesis is the fundamental distinction between the proposed tests. On panel unit root testing, (Levin et al., 2002) and (LLC afterward) present some fresh findings. They generalize Quah's model to account for individual heterogeneity in deterministic effects (constant and/or linear time trend) as well as heterogeneous serial correlation structure of the error terms under the premise of homogeneous first-order autoregressive parameters. They presumptively believe that T increases more quickly than N, so that N/T is zero because both N and T approach to infinity. Thus, referring to model (7), LLC assume homogeneous autoregressive coefficients between individual, i.e., $\rho_i = \rho$ for all I, and test the null hypothesis H_0: $\rho_i = \rho = 0$ against the alternative H_a: $\rho_i = \rho < 0$ for all i. Instead of doing a separate unit root test for each person, this process imposes a cross-equation limitation on the first-order partial autocorrelation coefficients under the null. The following structures may be used to describe the LLC analysis:

$$\Delta Y_{it} = \rho Y_{it-1} + \alpha_{0i} + \alpha_{1i} t + \mu_{it}\,, i = 1,2,\ldots\ldots,N\,, t = 1,2,\ldots.,T \qquad (8)$$

where the time trend ($\alpha_{1i} t$) and individual effects are merged. It should be highlighted that the deterministic components are a significant source of heterogeneity in this model because the coefficient of the lagged dependent variable is only allowed to be homogeneous across all units in the panel. In order to follow a stationary invertible ARMA process for each individual μ_{it} is expected to be independently distributed among individuals.

$$\mu_{it} = \sum_{j=1}^{\infty} \emptyset_{ij}\, \mu_{it-j} \;\in_{it} \qquad (9)$$

The weak convergence in the unit root tests proposed by Phillips (1987) and Phillips-Perron is claimed to be ensured by the finite-moment criteria (Phillips & Perron, 1988). (Im, Pesaran, & Shin, 2003) ensuing that, Following that, IPS suggests a new, more flexible, and computationally simple unit root testing approach for panels (known as the T-bar statistic) that considers both stationary and non-stationary series at the same time. When a cross-sectional unit's error term μ is serially correlated, maybe with different serial correlation patterns, IPS takes the mean of the ADF statistics produced for that cross-sectional unit rather than combining the data.

$$\Delta y_{it} = \alpha_{0i} + p_i y_{it-1} + \sum_{j=1}^{pi} \propto ij\, \Delta y_{it-1} + \in_{it} \qquad (10)$$

Where, as usual, i = 1, 2..., N, t = 1, 2..., T. The null hypothesis is: $H_0 : \rho_i = 0 \;for\; all\; i$.

$$H_a : \begin{cases} Pi < 0\, for\, i = 1,\ldots\ldots..N_1 \\ Pi = 0\, for\, i = N_1 + 1,..N \end{cases} \quad \text{with } 0 < N_1 \leq N$$

It enables unit roots for certain (but not all) individual series. The t-bar statistic for the null is defined by IPS as a simple average of the individual ADF statistics, t_{iT}, and is computed separately for each of the N cross-section units.

$$= \frac{1}{N} \sum_{i=1}^{N} T\, it \qquad (11)$$

4. Empirical Results

One of its key benefits of Panel Auto Regressive Distributed Lag estimators is indicated that they can be utilized without accounting for data series that are either I (0), I(1) or frictionally co-integrated. Moreover, Ouattara (2004) presents evidence, Panel Auto Regressive Distributed Lag estimators produced using the I (2) technique or later may not be appropriate for some data sets as Pesaran et al. (2001) was clear that for the Panel Auto Regressive Distributed Lag bounds checks to be accurate I (1), the variables had to be integrated to order I (0). Testing for stationarity is still mandatory. In order to determine stationary nature of data series, we employ the IPS (Im, Pesaran, and Shin W-stat) estimators. The outcomes of the IPS tests are shown in Table 1. Some of the data series is obviously integrated with I (0) or I (1), as shown by IPS results. The fact is that none of the data set is I (2) or above should be noted. It is appropriate for us to employ the Panel ARDL estimators in light of this. We may use Panel Auto Regressive Distributed Lag bounds testing techniques to assess long-term association between GE and GI, GT, GJ, GN, and RS since the unit root test demonstrates that none of the series are stationary at I (2).

Table 1: Panel Unit Root Test

	Im, Pesaran and Shin W-stat (IPS)				Levin, Lin & Chu t* (LLC)			
Variable	**I (0)**		**I (1)**		**I (0)**		**I (1)**	
GE	-	3.315 *	-	8.067	-	4.003 *	-	8.039
GI	-	2.295	-	3.348 *	-	3.002 *	-	5.059
GJ	-	2.148 *	-	2.499	-	5. 057 *	-	2.589
RE	-	3.003 *	-	8.128	-	3.017 *	-	8.128
GN	-	2.157 *	-	3.001	-	5.134 *	-	3.075
GT	-	2.338 *	-	7.005	-	2.377 *	-	10.589

* Indicates stationarity at 5% level of significance.

4.1. Short Run Estimation

In Table 2, the value of the ECM is -0.761, which suggests that any deviation from the equilibrium is adjusted with 76.1% speed of adjustment. This result suggests that the long-term effects of the variables we chose are more significant for green growth. The computation of the ECM coefficient is a significant result of the short run dynamics. The confirmed co-integrating connections between constructs are confirmed by error correction coefficients, ECM, which is correct in sign and significant. Following a short-term shock, the coefficient of ECM depicts how quickly the long-run equilibrium is restored. For instance, the ECM coefficient is 0.761. This means that in the current year, roughly 76.1% of the disequilibria caused by the shock will have returned to the long-term equilibrium. According to the GI coefficient, which is 0.875, the rise in GI revenues of 1 unit will bring the rise in GE of 0.875 units over the short term. The result supports the idea that advances in incoming GI activities may result in higher levels of green growth, which is the GI-led growth hypothesis. Our study's outcomes are similar with those of contemporary empirical investigations, for example,(Tolliver, Fujii, Keeley, & Managi, 2021), (ur Rahman, 2018; Usman, Rahman, Shafique, Sadiq, & Idrees, 2023), At a 1% level of significance, the results are statistically significant. Next, we employ some crucial control variables, such as RS, GN, GT, and GJ.

Table 2: Short Run Panel ARDL Estimate

Variable	Coefficient	t-Statistic
GE(-1)*	-0.761	-1.856
GI**	0.875	0.635
GJ**	-0.346	-2.332
GN**	0.260	1.668
GT**	-0.231	-1.175
RS**	0.428	1.457
ECM	-0.761	-10.055
R-squared		0.691
F-statistic		4.362

Durbin-Watson stat	2.224
CUSUM	Stable
CUSUMSQ	Stable

According to the coefficient of RS (Resource Scarcity), a gauge of carbon emissions, an increase in the volume of RS will result in a real per-capita Green Growth (GE) of 0.428. The coefficient of *GN*, a measure of Renewable Energy, implies that a 1-unit increase in the volume of GN will lead to 0.342 rises in real per capita Green Growth (GE). With a magnitude of 0.231, we specifically discover a statistically significant negative sign. The real per capita green growth decreased by around 0.231 units as a result of the GT coefficient, which states that, every 1 unit increase in GT. However, the magnitude shows the results like the study of (Eaton, 2013). ,(S. Ali, ur Rahman, & Anser, 2020; Fatima, Jamshed, Tariq, & Rahman, 2023; S. M. Khan & Saif-ur-Rehman; S. U. Rahman, Chaudhry, Meo, Sheikh, & Idrees, 2022; Shafique; C. Shahid, Gurmani, Rehman, & Saif, 2023; Shahzadi, Ali, Ghafoor, & Rahman, 2023), in the case of South Asia. We discover a specifically negative sign with a magnitude of 0.346 that is statistically significant. A real per capita Green Growth of around 0.346 units results from a GJ coefficient of 1 unit increase. Table 2 follows with the outcomes of short term study and error correction coefficient. The short term outcomes are in line with a priori expectations and essentially identical in terms of signs to long term results. The short term estimations' magnitudes, however, are lower than their long run counterparts.

4.2. Long Run Panel ARDL Estimation

Table 3 shows finding of Panel Autoregressive Distributed Lag. The results illustrate that there is negative and substantial connection between green jobs and green economy at 5% level of significance in long run. It denotes that 1 unit rise in green jobs leads to decrease in green economy by 0.455 units. Our study's findings are consistent with current empirical research, such as In a similar line, environmental quality suffers from a short-term decrease in human capital, according to (S. T. Hassan, Baloch, Mahmood, & Zhang, 2019)’s studies from Pakistan. Government measures in Romania to promote the green economy have been erratic and ineffective. The motivation of both investors and those who will eventually hold green jobs is crucial to consider while determining the transition's conditions. These circumstances include challenges with the new activity' ability to generate a profit, rising prices for various goods and services, and a shock to consumer spending. The social and economic costs of shift to a GE cannot be ignored when we think about the long-term risks involved. The risks and sacrifices that must be made by some of the participants in this process are intolerable. So that everyone who can contribute to promoting the progress of GE is not discouraged but rather inspired to accept the new challenges and discover solutions to overcome the problems, the economic and social expenses of this transition must be spread. Governments alone may play this role by advocating for the necessary policies (S. Ali et al., 2020; Florea et al., 2021; Hafiza et al., 2022; Li et al., 2022; S. Rahman & Idrees, 2019; C. Shahid et al., 2023; Zhu, Fang, Rahman, & Khan, 2023; Zulfiqar et al., 2022).

Employment and the green economy rarely go hand in hand, despite appearances. This article examines this relationship using research on clean energy regulations in several nations. We discovered through literature reviews that GE has the favorable influence on job in both developed as well as developing nations, though outcomes may be different subject to the technique employed. But in some nations, like Spain, the green economy can also be harmful. Furthermore, if policy influences are taken into account, it can alter the labor market in another way. Finally, we must acknowledge that there are certain issues with the current study in this field, including a lack of studies on various nations and energy sources, a lack of acceptable theoretical justification, a lack of in-depth examination of such relationships, and so forth. We recommend that in future studies, academics concentrate on the methods by which this relationship is influenced and the regulations that should be put in place to control such relationships. (Bilal, Shah, Rahman, & Jehangir, 2022; Ge & Zhi, 2016; K. H. U. Hassan, Sheikh, & Rahman, 2022; Y. Khan, 2022; S. U. Rahman et al., 2022; Rehman, Ali, Idrees, Ali, & Zulfiqar, 2022; Sarwar, Ali, Bhatti, & ur Rehman, 2021).

Furthermore, we also observed that there is significant as well as positive association between Renewable Energy and GE at 5% level of significance. It means 1 unit rise in Renewable Energy leads to positive change in green economy by 0.342 units. The long-term link between GN and GE is an argumentative topic in the empirical economic research. For example, (Ahmed et

al., 2022) in the case of South Asia. According to the study's findings, South Asian economies' green economic growth is positively impacted through clean energy's creation as well as environmentally friendly innovations.

Table 3: Long Run Panel ARDL Estimates

Variable	Coefficient	t-Statistic
GI	1.149	0.544
GJ	-0.455	-1.889
GN	0.342	2.475
GT	-0.304	-0.987
RS	0.562	0.897
C	17.757	3.681

The dependent variable is the per-capita Green Growth.

Additionally, we found that, at the 10% level of significance, there is the significant and positive connection between resource scarcity and green economy. This implies that for every unit increase in resource scarcity, the green economy grows by 0.562 units. Recent empirical studies, like these, have found results that are consistent with those of this investigation (H. Liu, Guo, Wang, & Wang, 2022). It was discovered that the resource curse idea was accurate on a national scale; it hampered the growth of the GE primarily by impeding energy conservation and limiting environmental improvement. Regional differences in green growth were positively influenced by resource endowment in the east, negatively in the center, and not at all in the west. By encouraging less energy saving and less environmental improvement, respectively, when import and export trade volumes exceeded the threshold levels, the resource curse was made worse. To mitigate the negative effects of resource endowment on green growth, enhance the energy structure, and foster environmentally friendly technology innovation, among other goals, the Chinese government should develop more sensible frameworks for the import and export of goods.

It has been found that there is little connection between the green economy and green inventions. The findings of this research are consistent with those of latest experiential studies, for instance, (Dawood, ur Rehman, Majeed, & Idress, 2023; Hafiza et al., 2022; A. U. Shahid et al., 2022; Shahzadi et al., 2023; Tolliver et al., 2021; Younas, Idrees, & ur Rahman; Zahra, Nasir, Rahman, & Idress, 2023). Additionally, it has been noted that there is little connection between green technology and the green economy. The magnitude, however, displays the outcomes much like the (Eaton, 2013) study did for South Asia. Further evidence that all of the error-correction model's coefficients are stable comes from the fact that the CUSUMSQ as well as CUSUM statistics plots are clearly lies within the threshold limits. The preferred growth equation can be used to guide policy decisions because the variables in this equation appear to follow a consistent pattern throughout the estimating period so that the effects of changes in policy that take into account the growth equation's explanatory variables do not significantly distort the level of per capita GDP.

4.3. Parameters Stability Test

After Panel ARDL model estimation, parameters must be checked for stability. The following figures present the CUSUM and CUSUMQ tests used by Brown et al. (1975) to prove stability of the parameters. A reliable result is obtained when the parameters are stable.

Figure 3

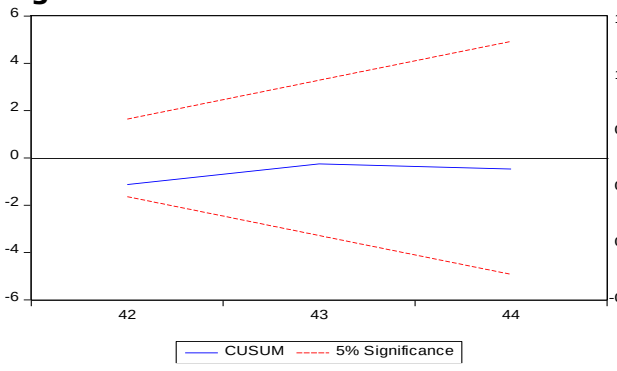
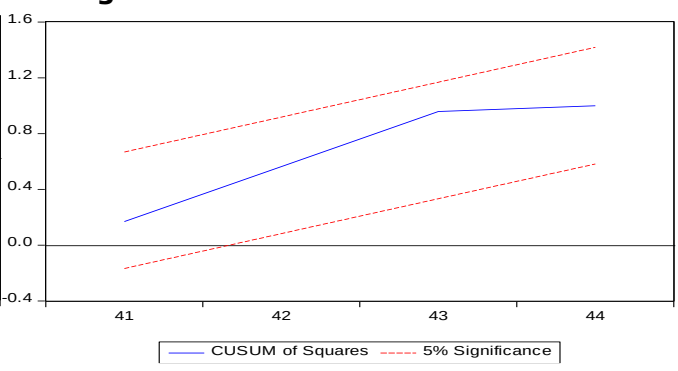


Figure 4



5. Conclusion and Policy Implications

The result describes that all variables associated with green innovations have positive impact in the long run except anti – environmental technology and jobs. Atmosphere dreadful condition is problematic for every country as well as region; it is worldwide and getting worse with every passing moment. At the end of the day, numerous elements are the source of environmental dreadful conditions together with carbon emissions and ineffective utilization of natural resources and anti – environment practices that cause the need for medical expenses. Environmentally harmful practices and the adoption of anti-environmental technologies have an impact on a nation's health costs. Green innovations and green technological practices have positive impact on economic efficiency (GDP per person or GDP expansion).

The purpose of working on this topic is to study the influence of green innovations (GI) and Renewable Energy (GN) specifically along with some variables in South Asian Region. To test the status of the linkage between the variables, a panel autoregressive distributed lagged (ARDL) bounds analysis methodology was used on 50 years (1972 – 2021) data of South Asian region. Findings of this study showed no influence of GI on GE as well as on sustainable development. Furthermore, linked variable Renewable Energy indicated positive effect on GE along with economic development. On the contrary, the results of green jobs, GT and resource scarcity are not in the favor of GE because of lack of knowledge, cost of production, less awareness etc.

The economic, social, and ecological aspects of this specific area were ensuring that there was a connection between local and regional development. They were among the crucial concerns to address the indicators for a local GE. The findings of this article will not only advance the field of study, but will also be of great interest to policymakers and urban planners in emerging markets. According to the findings of the research on capabilities as well as renewable energy sources, it is mandatory to Create the office supporting the green economy to offer information and technical guidance to service as well as industrial institutes generally for the GE, realizing the main beliefs of sustainable development, and enhancing the condition of social equity as well as human welfare in harmony with the following standards:

- Creating a strong legal foundation.
- Choose the areas where public investment and spending should be prioritized in order to green certain economic sectors.
- Cutting the budget where it is destroying natural capital.
- Modifying consumer preferences through market taxes, encouraging local communities to engage in and innovate with regards to sustainability.
- Making investments in training and capacity building to produce efficient social capitals.

Organizing technical as well as instructional workshops that help all decision-makers, targeted sectors and pertinent policy-makers implement GE processes and practices. Make a website with the following content:

- Review of environmental laws, rules, policies, procedures, and manuals.
- Outline earlier instances of the application of the idea of cleaner production and GE.
- Offering remedies for environmental issues.
- Offer technical support.

Encouraging both the public and commercial sectors to invest in renewable energy projects by offering incentives and facilities such tax breaks, financial assistance, and eased registration processes. The following policies can also be considered in the light of this study, government should announce incentives for those sectors that practice nature friendly techniques in their production process, fine should be charged for the use of anti – environmental technological practices, practice of recycling of waste water and other natural resources, vertical installation of plants and vertical use of land.

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