A Theoretical Basis for Green Growth

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Abstract

This paper suggests a theoretical model of inclusive green growth. Paper analyses development mechanism through which natural resource capital regenerates (or at least non-degrade) and contributes to economic growth. Climate change is a threat to save natural resources which is a crucial productive capital in the economy and also challenges economic development in the 21st century. New development strategy is the inclusive green growth that leads towards sustainable development. This paper suggests policy inputs regarding regeneration of natural resource and its preservation in term of water shed development, flood control or development of ecosystem services through creation of jobs in the channel of productive consumption. Policy makers should focus on employability, regeneration and preservation of natural resource capital for sustaining livelihoods in the economy.

1. Introduction

Global climate change[1] is one of the greatest threats to human civilization in the twenty first century. The world is facing problem of resource constraint for economic growth. Desirable growth is not achievable due to depletion of natural resources, climate change and other development constraints[2] (Arrow et al (2004), Dasgupta et al (2000)). International forums (such as the UNEP, G20, World Bank, OECD, and G8 etc) advocate green growth development strategy for mitigating climate change but none provide how to achieve it. What is the development mechanism for achieving it? This paper makes an attempt to provide a theoretical model that makes green growth strategy for economic development.

Concept of green growth is immature at its early stage and improves considerably in recent time (World Bank 2012, Dinda 2013). Green growth strategy is one important emerging growth model for national development. Green growth is a precondition for sustainable development. Green growth refers to a possible growth which transforms one economy from currently prevailing situation to a sustainable economy. It promotes growth and development while reducing pollution, waste, greenhouse gas (GHG) emissions, natural resource depletions, strengthening energy efficiency, preserving biodiversity, and protecting local ecosystem. One country may adopt a green growth strategy to develop economic, social, technological, environmental, and developmental aspects within comprehensive policy measures. Green growth development strategy can

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[1] Climate change is a significant shift of climate lasting for an extended period of time.
[2] A considerable literature (World Bank (1992), Boyce (1994), Agras and Chapman (1999), Beckerman (1992), Dinda (2004, 2005), Bimonte (2002), Cole et al. (1997), Cole (2004), de Bruyn (1997), Dinda et al. (2000), Gawande et al. (2000), Grossman and Krueger (1995), Munasinghe (1999), Pasche (2002), Rothman (1998), Selden and Song (1994), Shafik (1994), Suri and Chapman (1998), Tisdell (2001)) provide evidences on the link between economic growth and environmental degradation.

be visualised as an instrumental approach to drive the economy in newly emerged *sustainability* paradigm.

The twentieth century is marked as development strategy for industrialization. Worldwide economic development initiates in the process of industrialization leading to the mass production system that is based on fossil fuel which releases GHG emissions. Over time, these accumulated GHG emissions and other wastes gradually deplete the existing environment (World Bank 1992, Coondoo and Dinda 2002). Agricultural production also leads to loss of soil and water pollution due to over use of fertilizers; depleting ground water, deforestation - all leads to change the climate which threats to human civilization and challenge to the 20th century's development strategy[3] and how to mitigate climate change. Is there any economic growth model explaining climate mitigations? How does it mitigate climate change? Or, what should be the development strategy for the developing countries for their economic growth and sustainable development to mitigate climate change? Answering such questions is essential for searching economic growth model which mitigates climate change issues. Sustainable development strategy is the vehicle lifting to newly *sustainability* paradigm.

Sustainable development is non-declining welfare state. It is a lifestyle of human society that continues for long time without major adverse consequences (Heal 2011). Climate change provides certain space and opportunity to grow with efficient products such as clean, green and climate friendly product or climate smart goods (CSG). Outputs or/and goods which have relatively less adverse impact on environment are termed as climate

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[3] Industrialization is the main focus of the development strategy, and consequence is the GHG. Carbon dioxide (CO_2) emission is one major component of GHG. CO_2 emission is the main culprit of recent global warming and climate change (Coondoo and Dinda (2002)).

friendly or smart goods (Dinda 2011). Resource-efficient growth process has definitely less impact on environment that probably ensures non-declining wellbeing of human society which is highly desirable.

Recent urgent need is to reduce GHG emissions and prevent further damage to environment/nature and threats to social security. Urgent need of the world is to adopt *green growth* development strategy, which incorporates regeneration and/or preservation of natural resource capital that is generated in the channel through improvement of ecological services, flood control mechanism; watershed development, raising soil moisture, improvement of soil fertility, and expansion of green area etc. *Green growth* decouples economic growth from adverse environmental impacts. Green growth is achievable through *productive consumption*[4] which protects both human and natural resources in the economy.

Productive consumption is a part of consumption for reproduction of productive inputs. Productive consumption expenditure, here, assists to preserve and reproduce natural resources which ensure livelihood and life support system for human society (Dinda 2013). One can think or argue that these are defensive expenditure to stop degradation of natural resources, but here, productive consumption is different from defensive expenditure that is used to protect human and natural capital only from environmental degradation. Productive consumption, one hand, ensures sustainable consumption through regeneration of productive natural resources, and other hand, develop human capital, and create jobs. Employability creates the platform to interact individuals which

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[4]According to Steger (2002) one part of consumption is used for the development of human capital in terms of health and education that increase the labour productivity. Human capital enhancement function depends on productive consumption which is a part of expenditure that creates employment opportunity at local level and creates base for interaction among them (Dinda 2008).

may set up social norms and regulations that help to improve social capital in the form of social networks, cooperation, trust and reciprocity.

This paper emphasises on regeneration of natural resources which are crucial productive capital in the economy and makes sense to invest on it. Spending on regeneration or preservation of natural resources should be considered as investment in productive natural resources which is a part of output sacrifices current consumption for sustainable future consumption[5]. It is a part of consumption (i.e., equivalent to part of expenditure) that is used for reproduction of natural resources. For example, the government of India spends huge amount of money (Indian Rupees) every year (through budgetary allocations) on food wage bill for rural employment guarantee scheme on conservation of biodiversity, flood control and water shed development etc that are considered here productive consumption rather than simple investment on natural resource capital which has no immediate return at market price. Productive consumption has wider impact on the economy in terms of development of natural resource capital and, human and social capital[6]. Productive consumption has no concept of marketable return or dividend but guaranteed huge non-market values returns to the society in coming days. This paper deals with the issue combining the accumulation of natural resource capital along with

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[5]Productive consumption has enhancing power to regenerate productive inputs and ensure to sustain long run production and provide life support system and other economic activities.

[6] It develops certain social norms and networks that generate shared understandings, which underpin co-operation and collective action for mutual benefits like developing flood control system, and water shed management that create the base for economic prosperity. This productive consumption has duel impact on the economy in terms of creation of productive natural resources and social capital. Social capital refers to the norms and networks that enable collective action. It represents an interaction between individual and society (Alesina and Ferrara 2002), since social capital allows individual to act in certain ways, but within a collectively defined freedom (Berggren and Jordahl 2006). Interaction enables people to commit themselves to each other and repeated interactions with each other in their daily business that reduce social transactions cost (Putnam 1993). Social capital allows individuals to resolve collective problems more easily. Individuals often might be better off if they cooperate with doing their own job (Coleman 1988, 1990). Social norms and networks provide an institutional mechanism with the power to ensure collectively

human capital, which in turn depends on productive consumption (Steger 2002). This paper introduces to stress the complementarities of natural resource inputs with other (physical, human and social) inputs in the aggregate growth process. The idea is that natural resource capital creates pave the way for economic development in under developed economy and transmits social norms that support cooperation to invest in natural resources moves towards green growth.

Green growth is a development strategy to achieve *sustainable development*[7] and focuses more on economic growth and environmental quality improvement activities. *Green growth* balances harmony between economy and environment by preventing climate change (with conservation of resources and energy). Sustainable development is not followed automatically by green growth which consists of economic growth, ecological-efficiency and social development. Development for all is the objective of the policy makers and they will achieve it including all. It should be the inclusive growth approach.

Inclusive growth approach emphasizes on the broad-based policies that remove constraints to develop and create a level playing field for investment such that it can allow people to *contribute to* and *benefit from* economic growth. *Inclusive growth approach* is different from earlier *pro-poor growth* approach[8], which is interested in welfare of poor people only. Pro-poor growth approach focuses on a deprived section of the society and ignores others, whereas inclusive growth approach includes all sections of

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desirable behaviour (Bourdieu 1980, 1986). Social capital greases the wheels that allow nations to advance smoothly.

[7]Sustainable development is the development that meets the needs of the present generation without compromising the ability of the future generation to meet their needs (*Our Common Future (1987)).* The concept of 'needs', in particular the essential needs of the world's poor, to which overriding priority should be given. It leads to a secured growth engine through research and development of clean energy and green technology and creating new jobs.

[8]In the relative definition, growth is *pro-poor* if and only if the incomes of poor people grow faster than the rest of the population, i.e., inequality declines.

the society. *Inclusive growth* approach[9] is a long run perspective emphasising on increasing productive employment opportunities. This paper argues for inclusive growth focusing on (i) productive consumption (Steger 2002) which creates opportunities for the majority of poor, labour classes, and middle-class alike etc and (ii) regeneration of life support system (Cleveland (2003)) in the economy[10].

Green growth approach[11] is a newly development strategy which requires proper balancing across environmental resources and socio-economic activities that certainly drives toward *sustainable development*. Links between environment, economic and social factors are complex and nonlinear. *Inclusive green growth* has potentiality to include all for desired social development that is a pathway to achieve sustainable development. Recently, the World Bank (2012) emphasizes on inclusive green growth which argues that sustaining growth is necessary to achieve the urgent development needs of the poor. Brock and Taylor (2010) develop the Green Solow model that explains the relationship between environmental degradation and economic growth using Solow model (1956). Dasgupta and Heal (1974), Nordhaus (1974) and Solow (1974) consider exhaustible natural resource as a factor of production but reproducible natural resource is used in this paper. Smulders (1994), Bovenberger and Smulders (1996) also differ from this model in terms of regeneration mechanism through production consumption.

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[9]The analysis focuses on ways to raise the pace of growth by utilizing more parts of the labour force trapped in low-productivity activities or completely excluded from the growth process. Recently the World Bank (2012) suggests adopting inclusive growth model for sustainable development.

[10]The life support system includes all biotic & non-biotic systems which provide ecological and environmental services to all living flora and fauna in this planet. The world wide environmental degradation (World Bank 1992) makes people worried about life support system or declining the quality of environment (Dasgupta et al 2000). Natural resources and environmental services decline both in terms of quality and quantity.

[11]There is sufficient scope to develop without slow growth. Green growth is necessary, efficient and affordable (World Bank 2012).

Following Steger (2002) this study incorporates productive consumption in the growth model and adds value in literature focusing on development mechanism through which natural resource capital regenerates and contributes to economic development. Earlier economic analysis has given less emphasis on regeneration of stock of natural resources for promoting economic growth and recently, economists become more and more interested on green growth for sustainable development. This study identifies and prioritizes inclusion of natural resource constraints in economic growth process, which creates opportunities for all through productive consumption (Steger 2002) that promotes economic growth and social development[12]. This paper mainly concentrates on formation of natural resource and its preservation in the channel of productive consumption[13]. Environment or common natural resource is public goods. Everybody access it for their survival. One part of consumption expenditure should be utilized to develop or/and protect natural resources. Focusing on inclusive green growth this paper analyzes formation of natural resource capital forwarding towards sustainable economic development in the endogenous framework model. Paper will help policy makers for designing and implementing climate change related policies.

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[12]Social capital contributes to economic growth by focusing importance of cooperation and trust within firm, market and the state. Heller (1996), Ostrom (2000) and Rose (2000) point out that social capital contributes to economic growth by facilitating collaboration between individual interests and the achieve increased output. Regions with relatively higher stocks of social capital, in terms of generalized trust and widespread civic engagement seem to achieve higher levels of growth, compared to societies with low trust and low civics. Several studies (Bertrand and Mullainathan (2000), Beugelsdijk and Smulders (2004), Bjornskov (2006), Glaeser et al. (2000), Alesina and Ferrara (2002), Dinda (2008), Knack et al. (1997), Sobel (2002), Temple and Johson (1998)) have discussed about the features of social capital and its contribution to economic growth.

[13]The productive consumption (Steger 2002) stimulates to accumulate human capital through which a base is created for cooperation, norms and regulations, and institutional formations, and thus, it helps to develop and strengthen social networks and thereby form social capital that may help to create public goods and protect it. The expenditure on health and education has positive contribution to output growth. This consumption expenditure is classified as productive consumption. Development economists (Steger (2002), Dasgupta and Marjit (2002)) recognize the possibility of productive consumption that enables the satisfaction of current needs and also increases productivity of labour.

The rest of this paper is organized as follows: Section 2 builds up a model, sub-section 2.3 discusses how productive consumption develops natural resource capital; Section 3 analyses the results derived from the model, and lastly Section 4 concludes.

2. Model

This section develops a model that analyses how productive consumption leads natural resource capital formation and/or prevents the loss of productive inputs, and improve efficiency and thereby economic growth and development. Steger (2002) defines capital as the composition of physical and human capital; here we add productive resource capital to it for wider sense of capital that is discussed later. Consider a close economy with given fixed population (i.e., growth rate of population is zero).

2.1 Welfare function

The representative household maximizes her (his) instantaneous utility (or welfare) through consumption at each moment. Using traditional utility function *U(c)*, objective of the household is

$$Max_{c} \int_{0}^{\infty} U(c)e^{-\rho t}\,dt \qquad\qquad U_c > 0, U_{cc} < 0 \qquad\qquad (2.1)$$

Where ρ (>0) is the discount rate.

2.2 Production function

The representative economic agent (household or planner) produces output, y, using composite capital, k. Under constant AK- type production technology, the intensive production[14] functional form is

$$y = f(k), \quad f' = cons \tan t > 0, \quad f'' = 0 \text{ and } f(0)=0. \tag{2.2}$$

The assumption of diminishing returns is replaced by constant returns, which is crucial for sustainable growth in long run and also a broader interpretation of capital. Steger (2002) defines capital as the composition of physical and human capital, here; natural resource capital is added to it for wider sense of capital that is discussed later.

One part of produced output is used for consumption and other part for investment. The equation of motion of the physical capital, k_p, is

$$\dot{k}_p = f(k) - c - \delta_p k_p \tag{2.3}$$

Where δ_p, the depreciation rate of physical capital and c is is consumption. Suffix t is absent in stock dynamics, for simplicity we drop suffix t from all equations in this paper.

2.3 Productive Consumption creates natural resource capital

Government should increase employment to curve down poverty in under developed economy. There is also a nexus between poverty and environment. In such situation the government can reduce poverty and hungry providing food for work/employment and engage them to protect environment and regeneration of natural resources. Wage bill is paid in terms of food, so it is actually food bill and/or we may consider it as consumption and also term it as productive consumption. One portion of national consumption expenditure is used for regeneration and restoration of natural resource capital in terms of

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[14] All variables are measured in terms of per capita. Here, we assume that population growth rate is zero.

water shed development, reforestation, regeneration of ecological services, controlling flood and preserving soil fertility etc that definitely increases life support system in the economy and improves quality of life and productivity. This type of consumption is considered (termed) as productive consumption that helps to develop natural resource capital as well as improve productivity. Productive consumption improves natural resource capital of a country/region and thereby economic development. In this context, natural resource regenerating function depends on available stock of natural resource capital (k_R) and productive consumption (c) spending for its development and preservations. Natural resource generating function is:

$$R = l(k_R, c) \tag{2.4}$$

$l_c > 0$, $l_{cc} \le 0$, $l_{k_R} > 0$, $l_{k_R k_R} < 0$, $l_{ck_R} > 0$;

$$\lim_{c \to \infty} l_c = \bar{l} \ \& \ \lim_{c \to \infty} l_{cc} = 0.$$

In the production process, each production generates certain pollution as a bye product. Pollution degrades environment and natural resources deplete. Let pollution is generated as a proportion of output and damages natural resource capital at the rate of ϕ ($0 \le \phi < 1$) for each unit of output. Due to pollution, natural resource damage function is $D = \phi f(k)$. The equation of motion of natural resource capital, k_R, is

$$\dot{k}_R = l(k_R, c) - \phi f(k) - \delta_R k_R \tag{2.5}$$

Where, $l(k_R, c)$ is regeneration function of natural resource, $\phi f(k)$ is the damage function due to (output) production that extracts resources, and also generates pollution and waste in the production process, and δ_R (>0) is the natural depreciation rate.

Physical capital[15], k_p, is used to produce consumption goods and its accumulation requires, at least one part, the renunciation of consumption, while natural resource capital, k_R, results from productive consumption (similar to human capital enhancement function of Steger (2002)).

2.4 Composite capital

The whole stock of composite capital is defined as $k = k_p^{\alpha} k_R^{1-\alpha}$, 0<α<1. The equation of the motion of stock of composite capital, k, can be written as:

$$\dot{k} = \eta_1 \dot{k}_p + \eta_2 \dot{k}_R \tag{2.6}$$

Where $\eta_1 = \dfrac{\alpha k}{k_p}$, and $\eta_2 = \dfrac{(1-\alpha)k}{k_R}$.

Substituting eq.(2.3) and (2.5) in eq(2.6), it can be written as

$$\dot{k} = (\eta_1 - \eta_2 \phi) f(k) - \psi(c, k_R) - \delta k \tag{2.7}$$

Here $\psi(c, k_R) = \eta_1 c - \eta_2 l(k_R, c)$ is the Net Consumption, and $\delta = \alpha \delta_p + (1-\alpha)\delta_R$.

The coefficient of production function in equation (2.7) is different from standard dynamic equation of stock of capital and it is net share of output contributing capital formation. Eq (2.7) contains one additional term viz., net consumption $\psi(c, k_R)$, which includes productive consumption through renewable resource function $l(k_R, c)$. So, productive consumption creates and preserves natural resource capital, which has two fold impacts on the economy – directly develops natural resource capital and indirectly

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[15] In this context, k_p could be equally interpreted as physical and human capital that requires the renunciation of consumption for its accumulation (Steger 2002).

creates social capital that helps to reduce conflicts and creates the pace for sustainable development.

2.5 Optimization

The traditional objective of the household (eq. (2.1)) is

$$Max \quad W = \int_0^\infty U(c)e^{-\rho t} dt$$

Subject to the constraint (eq. (2.7))

$$\dot{k} = (\eta_1 - \eta_2\phi)f(k) - \psi(c, k_R) - \delta k$$

The Hamiltonian function is

$$H = U(c) + \lambda\{(\eta_1 - \eta_2\phi)f(k) - \psi(c, k_R) - \delta k\} \tag{2.8}$$

Where $\delta = (\alpha\delta_p + (1-\alpha)\delta_R) > 0$, $(\eta_1 - \eta_2\phi) \neq 0$, $\lambda > 0$, $k_p(0) > 1$, and $k_R(0) > 1$.

3 Results

F.O.C of this solution is

$$u_c = \lambda\psi_c \tag{3.1}$$

Where λ is the shadow price of composite capital, k, and $\psi_c(c, k_R) = \eta_1 - \eta_2 l_c(c, k_R)$. The eq. (3.1) implies that along the optimal trajectory the marginal utility of consumption equals to marginal net cost of consumption in utility measured units. Along long run equilibrium path marginal utility is exactly equal to its price (or cost measured in utility units).

The optimal economic growth rate is

$$\frac{\dot{c}}{c} = (\sigma + \theta)^{-1}\left\{(\eta_1 - \eta_2\phi)f_k(k) - \psi_{k_R} - \frac{\psi_{ck_R}}{\psi_c}\dot{k}_R - (\rho + \delta)\right\} \tag{3.2}$$

Where $\sigma = \dfrac{-cu_{cc}}{u_c} > 0$,

$$\theta = \frac{c\psi_{cc}}{\psi_c} = \frac{-\eta_2 l_{cc} c}{\eta_1 - \eta_2 l_c}, \text{ provided } \eta_1 \neq \eta_2 l_c,$$

i.e., θ is undefined at $l_c = \dfrac{\eta_1}{\eta_2} = \dfrac{\alpha}{(1-\alpha)} \dfrac{k_R}{k_p}$,

$$\theta < 0 \text{ if } l_c > \frac{\alpha}{(1-\alpha)} \frac{k_R}{k_p} \text{ and } \theta > 0 \text{ if } l_c < \frac{\alpha}{(1-\alpha)} \frac{k_R}{k_p}$$

The term σ is inter-temporal elasticity of consumption. The second term, θ is the

elasticity of net consumption, in the first bracketed term. It is only extra term added to

traditional optimal consumption growth rate due to productive consumption. In other

words, productive consumption has significant impact on economic growth through

elasticity of net consumption (θ).

We observe that natural resource capital is an important factor that explains economic

growth. Since $-\psi_{k_R} > 0$, in eq.(3.2), economic growth rate is more than productive

consumption growth model developed by Steger (2002). This difference is created due to

incorporation of regeneration of natural resource capital. It is also reflected in third term,

$\dfrac{\psi_{ck_R}}{\psi_c} \dot{k}_R$, in the second bracket in eq. (3.2). The stock dynamics of natural resource

capital ($\dot{k}_R$) has strong and direct association with economic growth. Cross marginal net

consumption increases with natural resource capital i.e., $-\psi_{ck_R} > 0$. That means

consumption or expenditure on development of flood control system, reforestation,

watershed development, conservation of soil, and protection of biodiversity and local

ecosystem that regenerate natural resource capital, which stimulates and creates base for

sustaining economic growth. Productivity of natural resource capital improves due to productive consumption, and thereby it has definite returns or/and incentives to grow natural resource capital through widening productive consumption and it also generates social capital through social awareness and social network.

4. Conclusion

This paper suggests a green growth model. Development mechanism, in the channel of productive consumption, generates natural resource capital and stimulates economic growth in consequent years. Productive consumption is effective and essential in LDC to overcome the bottlenecks and stimulate for accelerating economic growth through incremental productive consumption the natural resource capital that influences economic growth rate through formation of natural resource stocks and elasticity of productive consumption.

Productive consumption could be a prime policy for development of underdeveloped countries if it truly enhances human capital of that country and develops institutions to regulate and control activities for social benefits. This paper suggests few policies for green growth and sustainable development. Policy makers might focus on the building of social capital in the channel of natural resource capital formation through productive consumption that improves economic prosperity of distressed communities, and economic inclusion of deprived, disadvantaged and marginalised individuals. Productive consumption might build a new level of social trust that acts as collateral and solve collectively the problems of common and/or poor people (Dowla 2006). In less developed economies, productive consumption should be a crucial policy for

development of human (health and knowledge) capital that generates social norms, regulations and cooperation, and builds up social networks that helps to create and concretize social capital. Formation of social capital is a necessary precondition to develop and build up infrastructure and other public goods. Cooperative social networks can protect natural resources and environmental quality. Local natural resource development projects[16] improve (i) natural resource base (stock of resource capital), (ii) improve the employability and employment opportunity of the participants (due to policy of employment guarantee programme), (iii) raising well-being of the vast majority of the society.

This model is based on assumptions. So, this study has several limitations that indicate future research direction - social capital formation and its role in natural resource protection are not discussed in this model; better prediction of the model needs more data and application of innovative research methodology. Our next research agenda is in this direction.

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[16] Community development programs should be the prime policy to develop face-to-face interaction among individuals and creates a setting of norms for the development of trust among themselves (Dowla 2006, Sabatini 2006).

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