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Green NNP: Economics of Natural Resource Accounting

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ABSTRACT

The paper provides a review of some contemporary tools for integrating green concerns in national income accounting and highlights that despite having benefits from Green NNP accounting; the techniques so devised as of now for inclusion of environmental impact in national accounts suffer from various limitations. However, shadow prices of natural capital may be evaluated using these techniques selectively in different satellite accounts, so that the conventional purposes of national income accounts are not adversely impacted and broader picture of utilization (or exploitation) of natural resources is better surfaced.

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Introduction

Conventional Income accounting frameworks reflect production and consumption processes involving market (either actual or imputed), thereby failing to account for non-market activities. Such a neglect, occasioned by non-availability of empirical data or difficulty in procuring such data, renders Net National Product (hereinafter, NNP) as ineffectual for inter-temporal and inter-geographical welfare comparisons. Similar is case with non-accounting of natural resources and environmental impact due to production and consumption activities in NNP.

Three important economic functions of environment are: provision of resources for productive economic activities, sink for by-products discharged during production and consumption activities, and provision of direct utility with respect to resources like clean drinking water, pollution free air, etc.[1] Therefore, natural resources generate income and thus, their re-generation adds to welfare stock and their degeneration implies decrease in welfare. If, however, income and product accounts are not adjusted accordingly, they may represent an over-estimated or under-estimated NNP valuation. Greening of NNP refers to modifying the conventional accounting frameworks to accommodate this economic-environmental interaction.

Benefits of Green NNP:

Besides presenting a more accurate estimation of income, output and correspondingly, welfare, Green NNP would help frame better economic and environmental policies through integration of statistical data. Questions like impact of current production and consumption levels on state of environment; effect on nation's real income due to change in stock and flow of natural resources and whether such depletion costs are being offset by Government, etc. will be answered through Green NNP. United Nations (UN) in System of (Integrated) Environmental and Economic Accounts (SEEA)

[1] Sharmila Bannerjee, 'Economic Valuation of Environmental Benefits and Costs' in Rabindra N Bhattacharya (eds), *Environmental economics : an indian perspective* (1st, OUP, New Delhi 2001) 125

expounded Drivers Pressures State Impact Response (DPSIR) model: anthropogenic activities (Drivers) cause pressures on ecosystem through environment-degrading activities (like emission of wastes in environment, causing pollution, etc.) that change primordial balanced **s**tate of ecosystem (by causing depletion of natural capital more than its regenerative capacity, and leading to degradation in human welfare); and, if such environmental degradation (**i**mpact) is measured, appropriate management **r**esponses are issued to address the environmental issues (viz. environmental taxes, eco-friendly policies).[2] Therefore, DPSIR framework elaborately comprehended usefulness of Green NNP in state policy and welfare concerns.

Further, linking environment with development yields favorable outcome of 'sustainable development'. *Dasgupta* holds that such conceptualization of Sustainable development in Green NNP is 'categorically mistaken' in identifying "determinants of well-being (e.g. means of production) with the constituents of well being (e.g. health, welfare)".[3] Nevertheless, he expounds well-being function with endogenous degrees of inter-generational welfare substitutability as empirically advanced over alienated focus on welfare of future generation.[4] *Pearson*, on other hand, advances narrow definition of sustainable development as "no decrease in real consumption over time", i.e. where gross savings (say, S_T) exceed depreciation in physical (k_P), labor (k_L) and natural capital (k_N), i.e. $S_T \geq \alpha_P k_P + \alpha_L k_L + \alpha_N k_N$ (wherein α denote fraction of capital lost in that period of time).[5]

While further advent into conceptualization or measurement of Sustainable development through Green NNP is not within the scope of present study, it becomes remarkably clear that Green NNP facilitates policy measures for effectuation of Sustainable development through measurement of stock/flow of natural capital, depletion rate, resource efficiency, environmental costs of current and capital production, and mitigating/defensive expenditures.[6]

Issues Concerning Green NNP:

The current system of national income and product accounting followed by India, if sought to be integrated with environmental accounts, may cause certain difficulties and thus, present a need for paradigm shift.

I. Defensive Expenditures:

Defensive expenditures are incurred by households, firms and government for installing precautionary measures against externalities of environmental degradation.[7] In current system of accounting, such expenditure if incurred by Households or Government is considered as purchase of final goods and services and hence accounted for in consumption and government expenditure respectively. However, if same is incurred by firms, it is considered as expenditure on intermediate goods and thus, not accounted for in NNP. *Pearson* illustrates this with example of noise pollution and equally effective defensive expenditures: first, incurred by trucking firm in installing muffler system; second, by households in installing double-glazed windows; and last, by government in erecting sound barriers.[8] Arguing that in either case, they should ideally be treated as part of expenditure on intermediate goods (cost of production) for they do not contribute to any flow of goods or services, *Pearson* identifies following problems associated with any such attempt:

(a) Difficulty in distinguishing consumption of normal goods from defensive goods. For instance, expenditure on installation of catalytic converters by auto-drivers is defensive against increased air pollution but adds to flow of goods and services (and welfare) by improving the air quality;

[2] United Nations, 'System of Environmental-Economic Accounting (SEEA)' (www.unstats.un.org 2014) <https://unstats.un.org/unsd/envaccounting/seea.asp> accessed 06 March 14

[3] Partha Dasgupta, 'Optimal development and the idea of net national product' in Ian Goldin and L.Alan Winters (eds), *The Economics of sustainable development* (1st, Cambridge University Press, Cambridge 1995) 116

[4] Ibid 115-117

[5] Charles S. Pearson, *Economics and the global environment* (1st, Cambridge University Press, Cambridge 2000) 485

[6] United Nations, 'The System of Environmental-Economic Accounts (SEEA): Measurement Framework in Support of Sustainable Development and Green Economy Policy' <https://unstats.un.org/unsd/envaccounting/Brochure.pdf> accessed 06 March 2014

[7] Gopal K Kadekodi, 'Approaches to Natural Resource Accounting in Indian Context' in Gopal K Kadekodi (eds), *Environmental economics in practice : case studies from India* (1st, OUP, New Delhi 2004)

[8] Pearson 490-491

(b) If defensive expenditures are to be considered as offsetting depletion in baseline stock of natural capital, then difficulties in measuring such (present) stock arises;

(c) If any such baseline stock is not measured, then stripping out household and government defensive expenditures occasioned by incremental environmental damage would imply fall in NNP, i.e. welfare, which may not be true. For instance, if all households install water purifiers to defend against environmental disamenity of impure water, then their welfare is increased yet NNP falls due to discounting by such expenditure; and,

(d) Mismatch between product-side and income-side of GDP would arise because, even though defensive expenditures are excluded, environmental services directly consumed (like fresh air, etc.) are not included.[9]

Kadekodi attempts to provide a theoretical solution to dilemma of defensive expenditure by demarcating defensive consumption expenditure from the portion that adds to flow of final goods or services.[10] However, *Pearson* considers the same to be practically unviable. Unless the dilemma is resolved, the problem of double counting subsists.

II. Problems In Accounting Depletion/ Degradation In Natural Capital

Measurement of sustainable income entails subtraction of depletion of natural capital from GNP. If the natural resource is commercialized and non-renewable (say, crude oil, mineral ore), changes in stock are determinable and its market price ascertainable. If the resource in question is commercialized but renewable, adjusting for changes in its stock is difficult: firstly, their prices may not be accurately ascertainable if they are under private ownership or under common property ownership; secondly, biological regenerative capacity of such resources may be uncertain and empirically unascertainable; and lastly, their salvage value (if depleted) needs to be accounted for in GDP (for instance, deforestation done to use the land for agricultural purposes).[11] Thus, accommodating regenerative capacity of such resources coupled with ascertainment of their salvage value in accordance with after-use may still reflect notionally correct picture of GDP. However, for non-monetized renewable natural capital, neither the pre-existing stock (and any corresponding change in stock or flow) can be measured nor its market-value ascertained.[12]

Approaches to Valuation of Natural Resources:

Environmental resources are *unique*, i.e. neither replicable nor regenerative (once exhausted). The uniqueness of natural amenities coupled with irreversibility of their exhaustion lends them an intrinsic value (called existence value) which is a measure of indirect benefit/utility accrued to non-user of such amenities (viz. scenic beauty, prevention of global warming, protection of endangered species and biodiversity).[13] The functional value accrued to direct user of natural capital (e.g. through provision of clean drinking water, pollution free atmosphere, forests, soil) is called actual user-value (AUV). If, however, the natural resources are currently kept idle for future potential use, their valuation is at option value. This stock of natural capital may be maintained either for one's own benefit, or for one's own descendants (*bequest value*), or for future generations, generally (*vicarious value*). Since option value is also derived for non-current use of natural resources, it may be clubbed with existence value to mean non-user value (NUV). Therefore, Total Economic Value (TEV) of natural resources is sum total of AUV and, NUV (which is, existence value plus option value).

Banerjee argues that AUV may be determined through actual market based valuation, anchored either on objective standard of opportunity cost framework or, subjective standard of preference theory (measurable through Travel Cost Method and Hedonic Price Theory).[14] Based on assumption that option value is occasioned by 'ignorance-based uncertainty', arising from limited knowledge about future implications of current use of environmental resources, *Banerjee* argues that no proxy-market exists for measurement of option value (and existence value). Therefore, NUV can be measured only through hypothetical market following Contingent Valuation Method.

[9] Ibid 492-493
[10] Kadekodi 354
[11] Pearson 494-496
[12] ibid
[13] Banerjee (n 1) 126-128
[14] ibid

However, since present stock of natural capital may be *conserved* for future use, fully knowing its usage and utility, *Banerjee*'s assumption behind source of option value may be refuted; in which case, such value may be ascertained through stimulated market based valuation. For simplicity however, we will proceed with *Banerjee*'s concept of TUV.

I. Objective Standard-Based Valuation:

Objective standard-based valuation relies on assessing natural resources, provision of which is desirable by society as whole (for e.g. unpolluted water and air, biodiversity) through any of following methods:

i. Dose-Response based valuation (DRV):

Valuation of shadow prices (i.e. socially optimum prices) of non-marketable goods can be achieved through this indirect approach, wherein physical or social impact (i.e. response) from systematic non-provision of such goods (i.e. dose) can be valued.[15] Stated generally, *Markandaya* devises four-step procedure to be followed in this technique:

(a) Estimation of physical damage function of the form R = f (P), where R is the response (damage) occasioned by a factor P (say, air pollution);

(b) Calculation of $\Delta R/\Delta P$ through empirical analysis

(c) Calculation of ΔP (Change in P) due to environmental policy and other factors.

(d) Calculating $V.\Delta P.(\Delta R/\Delta P) = V. \Delta R = \Delta D$ where ΔD is the damage avoided/caused by that environmental policy.[16]

This theoretical conceptualization is better illustrated by *Banerjee* through opportunity-cost (OC) model, wherein she employs the example of industrial and urban pollution (as dose) causing adverse health impact (response) by degradation in quality of air, water, waste management, etc.[17] In this scenario, the value of natural capital is indirectly discernible from costs of various illnesses contracted because of pollutants, which is in turn equal to summation of medical expenses, and, earnings foregone (OC) due to morbidity or premature death.[18]

This OC is determined by 'present value of future earnings (PV)', which is future earnings discounted by a social factor r (say) such that PV of stream of future earnings denoted by Y_0, Y_1, Y_2,… shall be summation of $Y_T/(1+r)^T$ where T is specified future time.[19] Thus, it is also called as Present Value Method (PVM).

Kadekodi argues for resources where there are costs associated with exploration, extraction, excavation, etc., such costs should be discounted from PV_0 to determine the present value of future expected return.[20] Instead of following *Markanday*'s proposition, *Kadekodi* expounds usage of PVM to determine depletion cost of natural resource in question (say, clean air) by subtraction of present value of resource stock now (say, PV_1) and that corresponding to earlier period (say, PV_0) so to determine NNP directly if GNP already known (NNP = GNP – Depreciation).[21] However, as manifest, value of discount factor r is not easily determinable.
The dose-response valuation of environmental costs is much simpler for natural resources like land, adverse resource management of which causes impact directly felt in market transactions (viz. deforestation for agriculture, timber; soil quality-degradation causing loss in productivity).[22]

Criticism: DRV is essentially beneficial when people are unaware of the adverse impacts of pollution and associated costs, or/and, where any market-based valuation is not possible (neither actual market exists nor hypothetical or experimental market situation is feasible).[23] However, DRV fails to provide any proximate nexus with valuation of natural resource (in terms of consumption expenditure), and therefore, its linkage to subjective preference based valuation is desirable.[24] For instance, farmers may not be willing to pay the increased cost for preventing soil erosion, because even with soil quality degraded to a critical extent, they may obtain same crop yield through farming techniques of crop rotation, HYV seeds, etc.

[15] Anil Markandya, *The Earthscan reader in environmental economics* (1st, Earthscan, London 1992) 154
[16] ibid
[17] Banerjee (n 1) 130-131
[18] ibid
[19] Ibid 131
[20] Kadekodi 345
[21] Ibid
[22] Banerjee (n 1) 132
[23] Markandya 155
[24] ibid

Therefore, estimated decrease in welfare owing to future degraded soil-quality may not prove true in short-run.

ii. Production Function Approach

If the Marginal Cost (MC) of pollution abatement is less than the Pigouvian tax (T), imposed for enforcing environmental pollution standard, then producers will prefer to abate the pollution (say, by using silencers for preventing noise levels to reach beyond 70 Decibels, beyond which T shall be imposed).[25] However, if T<MC, then producers will prefer to continue production without any abatement and thus, pay taxes, such that MC is the OC of environmental degradation. Without going into complex details, it is relevant to note that application of this approach helps estimate environment adjusted GDP at factor cost.

II. **Subjective Presence Based Valuation**

This approach is based on behavioral model of assessment of individual's demand for natural capital. It may be classified as:

i. Travel Cost Method (TCM):

The values of improvements in natural recreational sites, or values of other sites, viz. culturally significant (like Allahabad (during Kumbh Mela), Mecca), are estimated through rigorous empirical enquiry linking demand of individual (both out-station and in-station) and attributes of the site, travel costs (which include opportunity cost of time foregone) and other socio-economic characteristics.[26] Relevant demand curve so obtained (with statistical relationship between observed no. of visits on X axis and costs of visiting on Y axis) helps identify increase in welfare of representative visitor upon quality enhancement of site (through rightward shift in demand curve), if costs are assumed to be same.[27]

Besides valuing environmental policies through impact on tourism, TCM helps identify change in welfare of people if the commodity, with nominal price-cost, for which they expended huge collection time (which forms OC), is now available to them at certain delivery cost. The statistical enquiry will yield aggregate demand curve linking OC of time expended to collect water (say) and its quantity demanded. If ratio of time costs to quantity demanded (say, P_0/Q_0) > ratio of monetary costs of delivery system to quantity demanded (say, P_1/Q_1), then introduction of delivery system will be socially advantageous.[28]

Criticism: TCM is based on assumption that consumer's willingness to pay for activity in question is independent and separable from willingness to pay for all other activities.[29] Therefore, demand estimation through TCM becomes methodologically difficult if we take into account realistic picture of trips being many-a-times multipurpose. For instance, visitor may visit several sites in one trip such that apportioning common travel costs becomes difficult. Further, TCM is useful only to ascertain AUV because it doesn't take into account the negative WTP (in situation where representative visitor doesn't go to trip due to high costs).[30]

ii. Hedonic Price Theory (HPT)

Demand for housing depends on several factors including the environmental quality. Therefore, for two identical housing amenities, consumer's demand increases with increase in quality of associated natural resources like clean air, foliage, clean drinking water, etc.[31] The Hedonic price function is obtained by joining the locus of different bid-offer equilibrium combinations of various consumers and producers corresponding to different environmental attributes, wherein the Marginal Price of that attribute is given by partial derivative of Hedonic price function w.r.t. that attribute.[32] HPT is also applicable in determining functional relationship between mortality risk associated with job and its wage (in labor markets), assuming perfect information among workers.

Criticism: Since marginal price function is locus of transaction combinations offered and accepted during equilibrium, HPT is applicable only when relevant market is in equilibrium condition characterized by MR=MC=P=MU and therefore, is fraught with idealism.[33] Being based on actual market

[25] Banerjee 133
[26] Ibid 139
[27] Markandya 150-151
[28] ibid
[29] Banerjee 139-142
[30] ibid
[31] Banerjee (n 1) 142-148
[32] Maureen L. Cropper and Wallace E. Oates, 'Measuring the benefits and costs of Pollution control' in Ulaganathan Sankar (eds), *Environmental economics* (1st, OUP, New Delhi 2001) 191-192
[33] Banerjee 148-149

transactions, HPT doesn't suffer from any hypothetical bias (manifest in CVM, below).[34] However, it suffers from shortfalls like ignoring income effect and migration among cities. People live in less desirable cities if they earn higher wages and thus, afford substantially high urban amenities; otherwise they may maximize their utility by migrating to other city.[35]

iii. Contingent Valuation Method (CVM)

In CVM, individuals are required to value their maximum willingness to pay (WTP) for an increase in natural capital or, minimum willingness to accept (WTA) compensation associated with cost of decrease in natural capital, contingent upon a hypothetical constructed market.[36] *Banerjee* postulates five-fold empirical enquiry exercise for determination of aggregate total value curve for particular natural capital:

(a) Setting up the Hypothetical Market with incidents of description of commodity to be valued (its quality, utility derivable and cost-price), method of payment (whether general taxation or bidding) and institutional context (viz. social, economic factors),

(b) Obtaining the bid either through dichotomous-choice based 'closed ended referendum' (which helps determine whether price suggested to respondent was $\geq$ or $\leq$ max. WTP) or open-ended referendum (wherein exact information about maximum WTP is obtained either through stimulated bidding, or choice among range of values suited to socio-economic condition of respondent or an open ended question),

(c) Estimation of average WTP/WTA after obtaining mean or median value of WTP from values determined from step (b),

(d) Estimation of bid curves representing total WTP across series of quantity of natural capital demanded (which functionally depends on income, socio-demographic conditions and environmental quality), and,

(e) Aggregation of data to find average population WTP from individual average WTP * N (where N is total population).[37]

Criticism: CVM suffers from several potential biases, like hypothetical bias (hypothetical choices are not based on any budget constraint) and strategic bias (if respondent presumes that amount of money would be collected from him, he would strategically understate WTP and vice-versa).[38] However, while hypothetical bias may be removed through identifying a budget constraint, strategic bias may be removed by using dichotomous-choice based 'closed ended referendum' bidding style.

III. El-Serafy's User-Cost Method (UCM)

Unlike previous techniques that aim at valuation of natural capital, UCM directly adjusts national accounts for depletion of natural resources. *Serafy* divides net receipts (R = gross sale receipts – intermediate costs like extraction, excavation) into two components, X (which represents true income) and (R – X) (which represents user-cost or capital consumption allowance).[39] "R – X is that component which if reinvested at interest rate r would accumulate to an amount sufficient to generate a constant income of X in perpetuity. With constant net receipts of R over T years (the lifetime of the resource = ratio of current extraction rate to total reserves) the ratio of true income X to net receipt R is, $X/R = 1 - [1 / (1+r)^T]$."[40] Thus, R, r and T, being exogenously determined, yield X. From X, (R – X) is obtained. (R – X) is then subtracted from GNP to calculate 'Green NNP'.

Criticism: Despite being theoretically correct, UCM is fraught with several controversies that render it an unsustainable measure of Green GNP in certain circumstances. As highlighted by *Pearson*:

(a) Instead of measuring market value of natural resources, it aims to measure its true income potential;

(b) R depends on price and extraction costs which are demand elastic and thus, changes in market;

[34] ibid
[35] Cropper and Oates 193-194
[36] Markandya 146
[37] Banerjee 151-155
[38] Ibid 157-158
[39] Pearson 497
[40] Ibid 497-498

(c) Technological changes may increase the lifetime of resource T;

(d) It is based on underlying assumption that natural resource is convertible into monetary asset at a constant rate of return (so to exogenously determine R). However, many natural resources are not commercialized and thus, cannot be converted to physical asset without corresponding decrease in their existence value;

(e) While UCM is useful in context of non-renewable resources, it cannot be feasibly extended to renewable resources because their total reserves cannot be identified as stock concept due to constant biological regeneration. However, if the regeneration rate is well-defined, it can be so applied. Nevertheless, if such resources are subject to 'open access', determination of T becomes further difficult due to uncertainty in total excavation rate.[41]

Conclusion:

The work highlights that despite having benefits from Green NNP accounting; the techniques so devised as of now for inclusion of environmental impact in national accounts suffer from various limitations. However, shadow prices of natural capital may be evaluated using these techniques selectively in different satellite accounts, so that the conventional purposes of national income accounts are not adversely impacted and broader picture of utilization (or exploitation) of natural resources is better surfaced.

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[41] Pearson 496-499