Chapter 5

Accounting and Measuring Well-being

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Additional information is available at the end of the chapter

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Abstract

The recent literature on the measurement of sustainable income has developed in two important ways for accounting of contribution of natural resource stocks. One set of studies directly addresses the problem of measuring genuine savings or extended wealth formation including changes in human resource capital and natural capital. The second set of studies uses the extended conventional national income accounting methods for accounting of changes in natural resource stocks and environmental extensions of input-output tables. This chapter describes the methodology of measuring genuine savings for a country and reviews the estimates available for different countries. It also suggests a way forward for measuring genuine saving for India.

Keywords: genuine savings, wealth, welfare, sustainable development, natural capital, human skill capital

1. Introduction

Sustainable development of a country depends on its policies related to wealth and capital formation. It requires the measurement of wealth in broader context of including man-made physical capital, human skill capital and natural capital consisting of stocks of exhaustible and renewable resources. The wealth formation during an accounting period has to be measured as the value of changes in man-made and natural resource stocks. Recent research on green accounting was developed in the following four important ways:

i. United Nations (UN) Methodology of System of Environmental and Economic Accounting [20, 21]

ii. European Union (EU) Methodology of Extended Input–Output Tables for Accounting of Environmental Externalities [5]

iii. World Bank Methodology of Measuring Genuine Savings of Countries [8–10]

iv. Methodology of Arrow et al. [1] and the follow-up Dasgupta Committee Report [3] on Green National Accounts in India

One set of studies directly addresses the problem of measuring genuine savings or extended wealth formation including changes in human resource capital and natural capital [8–10]. Genuine savings constitute net accumulation of man-made physical capital and human skill capital and depletion of natural resource stocks. It is an indicator of sustainable income path of a country. Genuine savings of a country could be positive or negative depending if net accumulation of man-made capital is higher or lower than the value of depletion of natural resource stocks. Positive and negative genuine savings indicate, respectively, sustainable and unsustainable income paths. Available estimates of genuine savings for different countries show that some countries have negative genuine savings.

Conventional measure of savings does not consider the most of the expenditures on human skill capital formation, for example, expenditures on education, as savings in the economy. The methodology of measuring genuine savings considers education expenditures during an accounting period as part of savings in the economy. The value of depletion of exhaustible resources stocks has to be deducted from savings. The accounting principle for valuing depletion of these resources is based on the concept of weak sustainability [4, 8, 12–16]. It requires that part of net income earned from the extraction of exhaustible resources has to be reinvested in man-made capital say in creating human skill capital so that present as well as future generations share the benefits of resource extraction. Similarly, the value of degradation of renewable resource stocks has to be deducted from genuine savings. The accounting principle for valuing depletion of these resources is based on the concept of strong sustainability. It requires the measuring of environmental degradation as excess pollution or deforestation over threshold or carrying capacity levels of resource stocks and valuing it at the cost of maintaining the threshold levels or social cost of environmental degradation [20]. There are now a number of theoretical and empirical studies on measuring social cost of environmental degradation.[1]

The plan of the remaining chapter is as follows. Section 2 discusses some methodological issues in measuring genuine savings. Section 3 provides a review of estimates of genuine savings for some countries. Section 4 presents a critical assessment of genuine savings studies and lessons for India. Finally Section 5 provides conclusion.

2. Methodology

2.1. Genuine savings

Green accounting aggregates of genuine savings and sustainable income are defined in the literature on the basis of an inter-temporal optimization problem [7, 13, 14, 16, 22]. The path of

[1] See [6, 11, 17, 18].

sustainable income is derived as the one that maximizes wealth W, defined as the present value of utility or consumption given a rate of discount and the constraints on changes in man-made physical capital, human skill capital, exhaustible resource stocks and environmental resource stocks during an accounting period. The sustainable income is derived as the following current-value Hamiltonian function, which is maximized at each point in time:

$$H = C + \mu_k \frac{dK}{dt} + \mu_s \frac{dS}{dt} + \mu_n \frac{dN}{dt} + \mu_e \frac{dE}{dt} \tag{1}$$

where C is aggregate consumption and K, S, N and E are stocks of man-made physical capital, human skill capital, exhaustible resources and environmental resources and μ_k, μ_s, μ_n and μ_e are their respective shadow prices. The genuine savings G are defined as

$$G = \mu_k \frac{dK}{dt} + \mu_s \frac{dS}{dt} + \mu_n \frac{dN}{dt} + \mu_e \frac{dE}{dt} \tag{2}$$

It could be shown that (Hamilton, 1997)

$$G = rW - C \tag{3}$$

where r is the rate of discount.

Eq. (3) implies that the negative genuine savings at a point in time means that future consumption must be less than current consumption over some period on the optimal path. In other words, negative genuine savings serves as an indicator of unsustainability. The shadow prices of resource stocks in Eq. (1) are the prices required to support sustainable income path. The prices observed in the marketplace will generally differ from these shadow prices [2]. The policy distortions in a typical economy lead to over-extraction of natural resources and excess pollution emissions [10]. Under these conditions it can be shown that real-world resource rents of exhaustible resources and marginal social costs of pollution exceed their shadow prices. Efficient management of natural resources will reduce the differences in observed market prices and shadow prices and also increase genuine savings.

2.2. Measurement

Manmade capital formation ($\mu_k \frac{dK}{dt}$)

Gross national savings are measured as in conventional national income accounts of a country. Net national savings or net physical capital formation representing additions to man-made physical capital are obtained by deducting depreciation of physical capital from gross national savings.

Human skill capital formation ($\mu_s \frac{dS}{dt}$)[2]

Human skill capital is the knowledge, experience and skills embodied in a nation's population. A country augments the stock of human skill capital in large part through its educational

[2] See [16, 19].

systems, into which it spends lot of money every year. Conventional national income accounts consider only educational expenditures incurred in man-made physical capital such as school buildings as investments. These expenditures may constitute only 10% of total education expenditures. The other expenditures consisting of teacher salaries, books, etc., are treated as consumption expenditures which are not correct in the context of measuring genuine savings. Education expenditures lead to the formation of human skill capital and therefore treated as the investment. However, the issues related to valuation of human skill capital are not yet completely understood because one dollar worth of educational expenditure may not necessarily yield one dollar worth of human skill capital. Therefore as an initial adjustment, current educational expenditures could be treated as part of genuine savings in the economy.

Value of depletion of exhaustible resources ($\mu_n \frac{dN}{dt}$)

Extraction of exhaustible natural resources such as crude oil, natural gas, coal, minerals and metals results in the depletion of resource stock extracted. The conventional national income accounts consider all the revenue earned net of cost of extraction of the resource as part of GDP. It is not a correct accounting method given that present and future generations have property rights for exhaustible resources. Therefore, measurement of genuine savings requires that value of depleted resource stocks has to be deducted from nation's savings. In the literature user cost and net price methods are used for valuing resource depletion.

Valuing degradation of environmental resources ($\mu_e \frac{dE}{dt}$)

Various developmental activities in the economy contribute to degradation of environmental resources due to pollution, soil erosion and deforestation. Conventional national income accounts do not account for value of environmental degradation. The methods of maintenance cost (cost of maintaining environmental resource stocks at sustainable levels) or social cost (health cost and income loss) are used for valuing environmental degradation.

2.3. Data

Studies providing estimates of genuine savings for different countries especially those by World Bank economists [9, 23, 24] provide good insights into how macroeconomic data from secondary sources could be used for this purpose. They have attempted a comprehensive accounting of depletion of exhaustive resources in the measurement of genuine savings for different countries. These studies consider most of exhaustible energy resources including crude oil, natural gas, coal and lignite and minerals and metals comprising bauxite, copper, gold, iron, lead, nickel, phosphate, silver, tin and zinc. Resource rents for each resource are estimated as net price which is defined as unit price minus unit cost of extraction.[3] Unit cost of extraction is taken as the average cost instead of marginal cost because of data limitations. Since the unit cost of resource extraction could be different for different countries, a weighted average of unit costs is taken as the cost of extraction. World prices are taken as per unit resource prices, and since these prices may be different across the countries, again a weighted

[3]The basic approach to calculating resource rents for nonrenewable resources is to subtract country- or region-specific average costs of extraction from the world price for the resource in question, all expressed in current US dollars [19].

Region	Natural resource rents as percentage of GDP
East Asia and Pacific	1.2
Europe and Central Asia	1.2
Latin America and Caribbean	3.1
Middle East and North Africa	13.8
North America	0.3
South Asia	1.7
Sub-Sahara Africa	8.0
Low income	12.8
Lower middle income	2.9
Upper middle income	2.7
High income	1.1
India	1.9

Source: World Development Indicators, World Bank, 2016.

Table 1. Rents earned from natural resources (oil, natural gas, coal, minerals and forests) as percentage of GDP in the world regions including India in the year 2015.

average of these prices is considered. **Table 1** provides recent estimates of rents earned from natural resources (oil, natural gas, coal, minerals and forests) as percentage of GDP in different regions of the world including India in the year 2015.

The adjusted [genuine] savings estimates have to take into account the losses of benefits from environmental services of biodiversity, carbon sequestration, soil conservation and recreation from the unsustainable use of forests. They have to also account for losses due to air and water pollution and soil erosion during the accounting period. The disinvestment arising out of greenhouse gas emissions, a global externality of air pollution, has also to be accounted. The most recent estimates of adjusted savings (genuine savings) of the World Bank made for countries and various regions in the world have tried to take into account to the extent possibly these losses in environmental services in an accounting period.

3. Estimates of genuine savings

Estimation of adjusted (genuine) savings of different countries is a pioneering attempt by World Bank economists leading to generalization of national income accounts for estimating green GDP. It is a precursor to now available UN methodology of Environmental and Economic Accounting [UN, 2003]. The World Bank methodology apart from suggesting accounting of depletion of exhaustible resources and degradation of renewable environmental resources suggests also for accounting of human skill formation in measuring genuine savings. Expenditures in human skill formation or educational expenditures will be an addition to conventional net savings, while the value of natural resource depletion is a deletion.

Educational expenditures which are taken as consumption expenditures in conventional national income accounting constitute a significant part of GDP in both developed and developing countries.

The adjusted [genuine] savings [AS] in an accounting period is estimated as:

adjusted savings [AS] = gross savings [GS] – consumption of fixed capital – depletion of exhaustible resources – degradation of environmental resources [particulate matter and CO_2 emissions, water pollution and soil and forest degradation] + additions to human skill capital [educational expenditure].

Tables 2–4 provide estimates of gross savings [GS] and adjusted [genuine] savings [AS] and reduction in gross savings [RGS] due to natural and environmental resource depletion in an accounting period for BRIC countries, developed countries and different regions of the world, respectively. Among BRIC countries, China has to account for the largest reduction in its GS amounting to 44.05% followed by Russia, 19.12; South Africa, 15.21; India, 14.23; and Brazil, 5.38% in the year 2015. Accounting for the particulate matter emissions in the current estimates of AS by the World Bank could be a reason for very steep fall in savings in countries like China and India. For South Africa, estimates of AS have become negative and negligible during

		2010	2011	2012	2013	2014	2015
Brazil	GS	18.50	19.06	18.44	18.56	16.34	14.74
	AS	12.45	12.41	12.33	12.66	10.31	9.36
	RGS	−6.05	−6.65	−6.11	−5.90	−6.03	−5.38
Russia	GS	28.05	30.16	28.73	25.54	25.86	28.08
	AS	12.09	12.83	10.60	7.30	6.43	8.96
	RGS	−15.96	−17.33	−8.13	−18.24	−19.43	−19.12
India	GS	38.65	35.79	34.43	33.70	34.01	32.88
	AS	25.00	22.00	20.54	20.10	20.23	18.65
	RGS	−13.65	−13.79	−13.89	−13.60	−13.78	−14.23
China	GS	51.72	49.93	49.87	49.33	49.49	48.58
	AS	4.66	3.72	3.92	4.85	4.18	4.53
	RGS	−47.06	−46.21	−45.95	−44.48	−45.31	−44.05
South Africa	GS	18.41	17.96	15.25	15.79	15.95	16.72
	AS	2.49	2.60	0.70	−0.02	0.01	1.51
	RGS	−15.92	−15.36	−14.55	−15.81	−15.94	−15.21

Notes: GS: gross savings; AS: adjusted savings due to depletion of man-made capital and natural capital; RGS: reduction in gross savings in the computation of adjusted net national income (ANNI).
Source: World Development Indicators, World Bank, 2016.

Table 2. Estimates of gross savings, adjusted savings and reduced gross savings for four BRIC countries during 2010–2015 (percentage of gross national income).

Country		2010	2011	2012	2014	2014	2015
Australia	GS	23.47	24.98	25.82	25.33	24.84	23.60
	AS	8.38	9.37	10.88	9.99	8.78	8.05
	RGS	−15.09	−15.61	−14.94	−15.34	−16.06	−15.55
Canada	GS	19.79	21.31	21.33	21.92	22.17	20.03
	AS	6.18	7.87	7.57	8.01	8.14	6.02
	AGNI	−13.61	−13.44	−13.76	−13.91	−14.03	−14.01
France	GS	19.78	20.66	19.57	19.44	19.63	20.46
	AS	7.15	7.83	6.40	6.28	6.18	7.36
	RGS	−12.63	−12.83	−13.17	−13.16	−13.45	−13.10
Germany	GS	24.74	26.53	25.72	25.61	26.49	27.17
	AS	11.29	13.26	12.23	12.14	13.10	13.71
	RGS	−13.45	−13.27	−13.49	−13.47	−13.39	−13.46
Japan	GS	24.29	23.50	22.94	23.25	23.78	26.01
	AS	6.14	5.14	5.04	5.18	5.53	6.75
	RGS	−18.15	−18.36	−17.90	−18.07	−18.25	−19.26
UK	GS	12.53	13.46	11.92	11.72	12.00	12.11
	AS	4.28	4.72	3.22	3.33	3.96	4.31
	RGS	−8.25	−8.74	−8.70	−8.39	−8.04	−7.80
USA	GS	15.16	17.50	18.13	19.04	18.96	17.77
	AS	2.73	3.62	5.81	6.26	7.08	7.41
	RGS	−12.43	−13.88	−12.32	−12.78	−11.88	−10.36

Notes: GS: gross savings; AS: adjusted savings due to depletion of man-made capital and natural capital; RGS: reduction in gross savings in the computation of adjusted net national income (ANNI).
Source: World Development Report, 2016.

Table 3. Estimates of gross savings, adjusted savings and reduced gross savings for seven developed countries during 2010–2015 (percentage of gross national income).

recent years implying negative growth or negligible growth rate of well-being measured as green national income [GNP].

Table 3 shows estimates of AS for developed countries during the period 2010–2015. Estimates show that reduction in savings is highest for Japan amounting to 19.16% followed by Australia 15.55; Canada, 14.01; Germany, 13.46; France, 13.10; the USA, 10.36; and the UK, 7.90%. Accounting for air pollution in estimating AGS could be a reason for the sharp fall in savings even in these developed countries.

Table 4 provides estimates of AS [genuine savings] for countries in different income brackets [low income, middle income and high income] in the world. During recent 5-year period, low-income countries have negative genuine savings implying their growth rate of well-being [adjusted national income] is negative. During the same period, the middle-income countries

Country		2010	2011	2012	2013	2014	2015
Low income	GS	14.53	16.70	16.59	15.67	16.72	15.78
	AS	2.21	−1.51	−2.10	−6.06	−4.10	NA
	RGS	−12.32	−18.21	−18.69	−21.73	−20.82	NA
Middle income	GS	34.28	34.13	34.11	33.42	33.95	34.74
	AGS	17.82	16.12	16.04	15.09	15.81	16.91
	RGS	−16.46	−18.01	−18.07	−18.33	−18.14	−17.83
High income	GS	20.64	21.47	21.84	22.02	22.35	22.21
	AGS	7.11	7.87	8.29	10.40	8.88	9.07
	RGS	−13.53	−13.60	−13.55	−11.62	−13.47	−13.14

Notes: GS: gross savings; AS: adjusted savings due to depletion of man-made capital and natural capital; RGS: reduction in gross savings in the computation of adjusted net national income (ANNI).
Source: World Development Report, 2016.

Table 4. Estimates of gross savings, adjusted savings and reduced gross savings for low-income, middle-income and high-income countries during 2010–2015 as percentage of gross national income.

have experienced a sharp fall of savings amounting to 18%, while high-income countries have experienced a fall of 7–10%. This implies that the genuine or adjusted rate of growth of well-being of countries is much lower when accounted for the effects of economic development on environmental and natural resource stocks.

4. Critical assessment of genuine savings estimates and lessons for green GDP measurement in India

Estimation of AS [genuine savings] and the methodology used for it in the literature are pioneering contributions toward measurement of well-being or green national income of countries. Even though the accounting of costs of natural resource depletion and degradation is not yet fully done in the available studies, they clearly provided a way forward for the more comprehensive accounting of all costs. The important contribution of these studies is in:

A. providing methodologies and data sources for measuring the value of depletion of exhaustible resources (energy and mineral resources);

B. attempting for loss of environmental services due to air and water pollution and forest depletion; and

C. presenting a case for considering educational expenditures as contribution to human skill capital formation in a country.

Accounting of educational expenditures as accumulation of human skill capital will significantly increase the genuine savings rates of countries as most of these expenditures are treated as consumption expenditures in conventional national income accounting. However, the assumption that human skill capital is increased by the exact amount of educational expenditures made

in these studies may not be justifiable. There is a need for more studies to find out the relationship between educational expenditures and human skill formation.

The net price or resource rent used in these studies for accounting of depletion of exhaustible resources is not an appropriate method of accounting for depletion. The value of resource stocks valued at net price is already accounted in measuring gross national income [GNI] using conventional methods of national income accounting. Deduction of this amount again from GNI or country's net rate of savings does not give any credit to the country having these resources in comparison to the country not having them. Any method of valuation of resource depletion has to take into account the property rights of both present and future generations to an exhaustible resource stock and the problem of inter-temporal equity in resource use. The user cost could be an appropriate method for valuing the depletion of the resource because it is based on the concept of weak sustainability (man-made capital could be a substitute for natural capital) ensuring the same level of real income to the present as well as future generations from resource extraction. Therefore, in the context of measuring value of depletion of exhaustible resources, studies have to be done to estimate user cost of resource stocks of minerals, metals and fossil fuels.[4] The user cost method of accounting value of depletion takes into account the part of resource rents earned from extraction that is spent in accumulation of man-made physical capital and human skill capital. Therefore, using resource rents for valuing depletion could result in underestimation of cost of depletion of exhaustible resources.

It is difficult to get data for estimating costs of environmental degradation in the form of soil erosion, air pollution and water pollution for a large number of countries for which genuine savings estimates are obtained by these studies. Therefore, these costs are not fully accounted in the estimation. However, an attempt is made in the recent estimates AS for accounting of cost of particulate matter and CO_2 emissions for different countries.

The approach adopted in UN methodology of Environmental and Economic Accounting [UN, 2003] for measuring green GDP is similar to the approach described above for estimating genuine savings. UN methodology prescribes the development of asset and flow accounts of natural resources as satellite accounts of conventional national income accounts. The satellite accounts provide comprehensive information of depletion of exhaustible resources and

[4]User cost depends on the life of proven reserves and rate of discount used to address to the problem of intertemporal equity. It decreases with the rate of discount and life of the resource stock making it resource specific. The rate of discount depends on the value judgments of the government about the property rights of present versus future generations to the resource stock. This is called user cost method of accounting (El Serafy, 1989). Consider

X: true or permanent income or income to present as well as future generations from resource extraction

O_t: net operating surplus from resource extraction in year t (O_t = turnover-cost of extraction − return on man-made capital used)

r: rate of discount or market rate of interest

T: life of exhaustible resource (proven reserves/rate of extraction)

The true or sustainable income from resource extraction is defined as X such that

$$\sum_{t=1}^{T} O_t/(1+r)^t = \sum_{t=1}^{\infty} X/(1+r)^t$$

for given (O_1 .....O_T), r and T. Assuming O_t = O, t = 1,....T, the user cost (O-X) could be obtained as

$O\text{-}X = O/(1 + r)^T$

degradation of environmental resources in terms of physical quantities and monetary values. The information available in these accounts could be used to obtain estimates of rate of AS or genuine savings for countries. However, these estimates differ from the ones discussed above in two ways. First of all UN methodology does not consider educational expenditures contributing to formation of human skill capital as part of savings. Secondly, it requires comprehensive accounting of monetary values of environmental degradation. These include losses of both marketable and nonmarketable services from soil erosion, forest degradation, air pollution and water pollution.

In an attempt of having green accounting in developing macro-economic statistics in India, the Central Statistical Organization [CSO] and other concerned organizations could try to get independent estimates of AS using the above-described methodology. Macroeconomic aggregates of human skill capital formation and cost of depletion of exhaustible resources could be estimated using data from secondary sources as described above. Estimation of cost of depletion using user costs instead of resource rents as unit costs is possible with data available in India from secondary sources. However, data from secondary sources alone is not sufficient to estimate the cost of degradation of environmental resources. Detailed empirical studies of using data from both primary and secondary sources have to be done in India for estimating the macro-economic aggregate of cost of environmental degradation.

Estimates of adjusted national income or well-being for depletion and degradation of natural resources could be obtained given an estimate of rate of AS or genuine savings. If the difference between GS or conventional gross rate of savings and AS or rate of genuine savings (excluding education expenditure) is positive, the adjusted national income is lower than the conventional national income for a country. As discussed earlier, the World Bank's estimates of AS or genuine savings for India indicate that adjusted national income in India and other countries is lower than the conventional national income. For some low-income countries, AS becomes negative implying negative rate of growth of well-being.

5. Conclusion

Genuine savings or AS consisting of net accumulation of man-made physical capital and human skill capital and depletion of natural resource stocks is an indicator of sustainable income path of a country. They could be positive or negative depending if net accumulation of man-made capital is higher or lower than the value of depletion of natural resource stocks. Negative genuine savings indicate unsustainable income path, and available estimates of genuine savings for different countries show that some low-income countries have negative genuine savings.

The methodology and estimates of genuine savings reviewed in this chapter are pioneering contributions to fast-growing literature on estimation of green national income of a country. The studies of genuine savings apart from suggesting accounting of depletion of exhaustible resources and degradation of renewable environmental resources suggest also for accounting of human skill formation in measuring genuine savings. Expenditures in human skill formation or educational expenditures will be an addition to conventional net savings, while the value of natural resource depletion is a deletion.

We found that genuine savings studies reviewed in this chapter could measure only some important components of genuine savings, especially the cost of depletion of exhaustible resources and degradation of air quality by particulate matter and CO_2 emissions. A comprehensive accounting of cost of environmental degradation could not be attempted in these studies because of data limitations. The important contribution of these studies is in discussing secondary data sources of different countries for measuring the value of depletion of exhaustible resources such as energy and mineral resources.

The satellite accounts of natural resources in UN methodology of Environmental and Economic Accounting provide comprehensive information of depletion of exhaustible resources and degradation of environmental resources in terms of physical quantities and monetary values. The information available in these accounts could be used to obtain very comprehensive estimates of rate of genuine savings for countries. However, these estimates differ from the ones reviewed in this chapter in two ways. First of all UN methodology does not consider educational expenditures contributing to formation of human skill capital as part of savings. Secondly, it requires comprehensive accounting of monetary values of environmental degradation. These include losses of both marketable and nonmarketable services from soil erosion, forest degradation, air pollution and water pollution.

In an attempt of having green accounting in developing macro-economic statistics in India, CSO and other concerned organizations could try to get independent estimates of genuine savings using the above-described methodology and the data from secondary sources. Macro-economic aggregates of human skill capital formation and cost of depletion of exhaustible resources could be estimated using data from secondary sources as described above. Estimation of cost of depletion using user costs instead of resource rents as unit costs is possible with data available in India from secondary sources. However, data from secondary sources alone is not sufficient to estimate the cost of degradation of environmental resources. Detailed empirical studies of using data from both primary and secondary sources have to be done in India for estimating the macroeconomic aggregate of cost of environmental degradation.

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