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From natural resources and environmental accounting to construction of indicators for sustainable development

Abstract:
Norway has a long history in trying to develop management tools for sustainable development. From the early development of natural resources accounts in the 1980's, through discussions of the usefulness of indices like "green GDP" to efforts of developing sustainable development indicators, experiences have been gained. The paper seeks to both describe the landscape and discussions associated with the key terms, and to communicate some lessons drawn from the Norwegian experiences. The conclusion focuses on the fact that whatever information is collected and organised to support the relevant decision-making processes, the final outcome should always be judged in terms of its impacts on policy processes. Thus, we issue a warning against large-scale development of information systems, without due regard to the final utilisation of the output.

Keywords: Green accounting, Natural resource and environmental accounting, sustainable development indicators, green GDP, SEEA

JEL classification: N5, Q2, Q3

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1. Introduction: The institutional history of natural resource accounting in Norway

Norway is among the fortunate countries that are richly endowed with natural resources of many kinds. Historically, exploitation of forests and fish has been important sources of income. Around the beginning of the 20th century energy resources like hydropower and, more recently, petroleum resources have contributed significantly to the industrialization of Norway. Being a sparsely populated country with only 4.6 million people distributed over 304 280 km^2 of land (resulting in only approximately 15 people per km^2) Norway is also well endowed with natural and environmental resources like clean air and water and unspoiled nature.

After a period of rapid economic development following the Second World War, voices of concern were, however, beginning to be heard on behalf of the environment in the late 1960s. Pollution levels in the air, water and soil became steadily more noticeable, and ever more of the inherited pristine environment succumbed to economic development and deteriorated. At the international level, several important books from Resources for the Future, together with more popular titles like The Silent Spring (Carson, 1962) and Limits to Growth (Meadows et al., 1972) provided background for this concern. The UN Conference on the Human Environment, which took place in Stockholm in 1972, was in many ways the manifestation that these concerns were having an impact on the arena of international politics. In the same year Norway established one of the world's first Ministries of Environment, thus marking the growing concern and a will to act.

At the outset the level of ambition for the new ministry was high, i.e. it was envisaged to be more or less on par with the Ministry of Finance. While the Ministry of Finance manages and controls the fiscal resources of the country, the Ministry of Environment should in a similar manner manage and control the physical resources of the country. Consequently, a search for suitable management tools for natural resources and the environment was initiated. Natural resource accounting (NRA) was seen as a potentially important part of the necessary tool kit, and from 1978 Statistics Norway was given task of developing such accounts for Norway. The aim was to ensure a better long-term natural resource management by:

- Providing new and better-suited data for monitoring natural resource use for long-term management purposes.

- Providing data in a form compatible with traditional economic accounts to facilitate integrated analyses of natural resource and economic issues.
- Avoiding double efforts in data collection and analysis.
- Developing a standard procedure for presentation of data and analyses on natural resources and the environment.

Statistics Norway is responsible for national accounting in Norway and also for the development and operation of some of the economic planning models employed by the Ministry of Finance and other ministries. Coordinating the work on the natural resource accounting with ongoing work on tools for economic planning turned out to be useful for a number of reasons:

- Locating the work on natural resource accounting to Statistics Norway has assured access to statistical expertise and closeness to primary statistics used in the development of the natural resource accounts.
- In Statistics Norway, the resource accounting framework was naturally based on existing economic standards and sector classification schemes, thus ensuring general consistency in the sectoral classification of economic and resource related data and statistics. In particular, the linkage to the UN System of National Accounts (SNA) has made it possible to integrate important natural resource variables and relations within already existing macroeconomic models.
- Use of a common set of standards and models in the analysis of resource issues has facilitated the communication between the ministries responsible for the management of the economy and the ministries responsible for the management of the natural resources; e.g. the Ministry of Finance and the Ministry of Environment, and precluded the development of competing data sets, models, etc.

The Norwegian system of natural resource accounting was established long before the SEEA and it is tempting to claim that at least some of Norway's experiences during the earlier years have had an impact on the development of the SEEA.

This paper summarises these experiences with natural resource accounting and the parallel debate on how far one should go in synthesising and summarising the information contained in natural resources and environmental accounts into a single aggregate measure like "green GDP". We will also briefly describe the latest development in Norway towards the establishment of a set of indicators of sustainable development, and address the relationship between accounting SEEA style and indicators. The paper ends with three warnings/recommendations.

2. The Norwegian accounting system

In the initial phase of resource accounting in Norway, considerable efforts were made to establish resource accounts for a large number of natural resources and environmental issues (Alfsen et al., 1987, Alfsen and Bye, 1990, Statistics Norway, 1981, Lone 1987, 1988). Thus, accounts were developed for: energy, minerals, sand and gravel, forests, fish, land use, fresh water, air pollution and waste. The accounts were kept in physical units and regarding the material resources, consisted of three parts covering 1) reserves or capital accounts, 2) extraction, conversion and trade accounts, and 3) end use accounts of the resources. By "reserves" is meant discovered resources that are economically extractable with today's technology. The general structures of the material resource accounts are as shown in table 1:

Table 1. Structure of the material resource accounts

I. Reserve accounts	
Beginning of period:	Resource base Reserves (developed, non-developed)
	Total gross extraction during period
	Adjustments of resource base (new discoveries, reappraisals)
	Adjustment of reserves (new technologies, cost of extraction, transport, etc., resource price)
End of period:	Resource base Reserves (developed, non-developed)
II. Extraction, conversion and trade accounts (by sector):	
	Gross extraction <u>- Use of resource in extraction sectors</u> = Net extraction
	Import <u>- Export</u> =Net import
	Changes in stocks
For domestic use:	Net extraction + net import ± changes in stock
III. End use accounts (by sector):	
	Domestic use

A number of points are worth noting with regard to the structure of these accounts.

1. The accounts consist of more than the reserves accounts alone (often presented as “natural resource accounts” in the international literature). This is of importance when it comes to employing the accounts for management purposes. It is then of relevance to know who is going to be affected by a change of policy. The end use account is essential for this kind of analysis.
2. The sectoral structure of the extraction, conversion and trade accounts and the end use accounts followed the classification in standards for national accounts (SNA). This facilitated the inter linkage between the resource accounts and the national accounts.
3. Although the accounts are kept in physical units, they were complemented with price information whenever market prices are available, allowing tables in monetary terms to be generated.
4. The accounts for the different resources differed with respect to details in the various parts of the accounts. Thus, a biotic resource like fish required a relatively detailed reserve or stock account with specification of age structure and localisation of the different fish stocks. The end use part of the accounts is, however, quite simple, since relatively few sectors use fish as an input factor in their production. Only a minor share is consumed domestically, the rest is exported. For other resources, like energy, the situation is different, since energy is an important input factor in almost all sectors of the economy, while the reserve account could be kept relatively simple.
5. Most of the natural resources and environmental accounts were established by utilising already collected information and existing statistics in Statistics Norway.

2.1 Use and non-use of the accounts: an evaluation

By the middle of the 1980's, after close to ten year of efforts, time was ripe for evaluating the natural resource and environmental accounting experience. An evaluation was reported in Alfsen et al., (1987). The main message of the evaluation was that most of the accounts were under-utilized by the relevant decision makers. The only account that was actively and routinely used was the energy account. The reason for the relative success of the energy accounts can be sought in the tight integration of energy issues with the economy, and hence with the macroeconomic modelling tools employed by the government. Already at an early stage, the economic models were extended to include energy as a separate input factor in production. Also, the energy producing sectors were described in great detail in the models. Finally, the energy accounts proved essential in the development of most of the emission inventories and in the modelling of emission scenarios.

Overall, we must conclude that most of the initial effort in developing pilot accounts gave rather disappointing results in terms of relevance for policy making.

These experiences lead in turn to a stronger focus on accounts for energy resources in Norway, together with important environmental issues like air pollution where several international protocols regulate national emission levels. On the basis of the energy and emission accounts, the analytical work was extended to cover economic damages from energy use and air pollution, see Rosendahl (ed) (1998). The forest, fish and land use accounts are, on the other hand, continued on a minimum basis only, while the mineral accounts at present are discontinued. However, Statistics Norway continues to produce detailed statistics for, for instance, forests. These statistics are used for management purposes. What has been abandoned is the structuring of this statistics into sectoral reserves, transformation and end use accounts.

Presently, the sectoral macroeconomic models employed by the Ministry of Finance for medium and long term economic projections include energy and air pollution variables, and integrated forecasts are now routinely made of economic development, demand for energy and the consequences for emissions to air of several important polluting compounds. In addition, the models have recently been extended further to incorporate waste generation in manufacturing and consumption activities; see Bruvoll and Ibenholt, 1996.

Summarizing, the development in natural resource accounting in Norway during the 1980s and 1990s went from a broad and comprehensive coverage of many, mainly natural, resource categories to a more selective approach with greater emphasize on analysis and integration of resource and environmental issues into the analyses of the Norwegian economy and thus in economic planning. At the same time the focus also shifted from mismanagement of material resources to problems associated with a deteriorating environment.

Seemingly, the idea of constructing "green GDP" as an environmentally corrected GDP number does not appear in this history. This is only partially right. The idea was considered seriously some fifteen years ago, but although it attracted positive attention as a theoretical concept, it was deemed to be impractical for a number of reasons described below, see also Aaheim, A. and K. Nyborg (1995).

2.2 Why not a green GDP in Norway?

GDP, or gross domestic product, is a national accounting term designating the domestic output measured in value terms minus costs associated with input of goods and services. Thus, GDP is measuring the value added of production, a value added that is available for payment of use of input factors like capital and labour.

"Green GDP" on the other hand, is a term much used, but only seldom precisely defined. Most commonly, and perhaps most correctly, it has been used to designate a "corrected" GDP number, or sometimes a "corrected" GDP growth rate. The correction seeks to take into account the depletion of non-renewable resources, as well as various damages to the environment due to pollution to air, water and soil, and also sometimes loss of ecosystem services as a consequence of pollution from economic activities. Hence, adjusting GDP in this manner resembles the calculation of *net national product* (NNP) i.e. adjusting GDP for the consumption of produced capital.

Valuations in the national accounts are mostly done on the basis of market prices, i.e. prices that are actually used in transactions in shops and elsewhere, or for services produced by the public sector, on the basis of accounted costs. Valuation of goods that are not traded in any market, or for which costs are hard to account for, for example environmental assets, is more problematic. Even so, such valuation is absolutely essential if we are to adjust GDP or any other economic indicator for changes in the state of the environment. The problem of environmental pricing can be illustrated by the following example. .

Consider a plant that uses water from a river in the production process and discharges polluted water back to the river. Suppose also that a town situated downstream uses the river for supply of drinking water. What is the value of the water in this case? From the *supply side* it can be argued that the *cost of purifying* the water to an acceptable drinking quality represents the value of the water. In other words, the value of the water is determined on the basis of the cost of procuring pure drinking water. Seen from the *demand side* on the other hand, the value of the water equals the town's *willingness to pay*[1]. The two methods of valuation are likely to give widely differing results, and it is by no means obvious

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[1] A further aspect is that surveying willingness to pay in a reasonably reliable manner may pose problems. In the same way the factory's clean-up costs may be difficult to determine. Perhaps the factory has been issued with an injunction to prevent it polluting the river, and, instead of purifying its emissions, it closes down or starts producing other goods. The "purification cost" is then equal to the loss in producer surplus from the change in production, which of course also is hard to obtain. We will let these problems lie for the present.

which of them should be used to adjust GDP. For this reason the SEEA-2003 includes both approaches as options for countries to use.

The problem is compounded, however, by the following factors. If the factory had in fact purified its wastewater, its production costs would have increased, and to the extent that competition is not perfect, so would also the price of its products. This would in turn affect other prices in the economy, which would lead to changes both in what is produced and consumed in the economy. Finally, GDP itself would be affected. This effect would be particularly important to take into account if the action taken is "big" in the sense that it affects large sections of the economy. General objectives of reducing emission levels in a country may be an example of a "big" initiative. In other words it is not enough merely to find the value of the water in order to adjust the value of GDP, the traditional GDP measure also has to be adjusted. Doing this requires a model of the economy, and the entire task of adjusting GDP becomes a fairly wide-ranging analysis of inter-relationships in the economy, an analysis that differs from what we usually associate with keeping accounts[2].

The above is intended to illustrate some of the problems faced in valuing environmental assets. This is not to say that information on willingness to pay or cleaning costs is without relevance. On the contrary, it is clearly important for decision-makers to be provided with such information. But in our view it is not correct for the statistical accountants to take controversial decisions about the value of environmental assets and to incorporate such decisions, and to some extent conceal them, in apparently neutral information about the trend in an environment-adjusted GDP. Such information should instead be presented by way of analyses whose assumptions and suppositions are clearly presented and discussed. Thus, the SEEA 2003 includes modelling approaches as another option for a macroeconomic statistic that can be compiled (Ch. 10) —rather than including this approach under the modelling applications of the SEEA (Ch. 11).

If the conclusion from the above is that adjusting GDP for changes in the state of the environment is a complicated matter, it may perhaps be hoped that fewer problems are presented by natural resources that are traded in the market. In the case of Norway it should at least be possible to adjust GDP for the oil and gas that we drain from the North Sea each year. Let us briefly consider this now.

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[2] The distinction between analysis and accounting is not always clear-cut, but in vague terms we could say that analysis results depend on a greater number of assumptions (often hypothetical and thus controversial) than those required for accounting purposes.

2.3 Adjusting GDP for depletion of the natural resource wealth

Instead of adjusting GDP directly for depletion of non-renewable resources and for future potential reductions in the harvesting of contingent renewable resources, the practice followed by Statistics Norway has been to occasionally calculate changes in *national wealth*. A central element in the call for sustainable development is that our wealth should be passed on to the next generation intact, in particular it should not decrease. Besides foreign claims, fixed capital (machinery, buildings and infrastructure) and human capital (raw labour, knowledge and technical insight), national wealth comprises *natural capital*. When calculating national wealth, *net national income* (NNI) is decomposed into the contributions from these different types of capital.

The value of a capital asset is usually reckoned as the total discounted income accruing from it. With respect to natural capital this is usually referred to as a stream of *resource rents*. With point of departure in the national accounts, Eurostat (2001) and SEEA-2003 defines resource rent in the following way:

Resource rent =

i)	+ Basic value of output/production
ii)	- Intermediate uses
iii)	+ Taxes on products
iv)	- Subsidies on products
v)	- Non-industry specific taxes
vi)	+ Non-industry specific subsidies
vii)	- Compensation of employees
viii)	- Return on fixed capital
ix)	- Capital consumption

When calculating compensation of employees and return to fixed capital, the idea is to use wage rates and rates of return that reflect the *alternative value* of both the workers and the capital employed to extract the resource. At Statistics Norway we have used the *average* wage rate and the *averag*e rate of return to capital for all non-natural resource industries as this *alternative* value. Then, in order to calculate the compensation of employees in the natural resource sectors, we multiply our average wage rate from the non-natural resource sectors with the number of hours worked in each natural resource sector. Moreover, we multiply our average rate of return to capital from the non-natural resource sectors with the capital employed in each natural resource sector to get return on fixed capital. Hence, the resource rent can be interpreted as the extra income one obtains from having the right to utilize a natural resource.

Net National Income (NNI) for any given year can then be decomposed in the following way:

NNI =

i)	+ Resource rents from renewable natural resources; fish, aquaculture, forestry, agriculture, hydropower, etc.
ii)	+ Resource rents from non-renewable natural resources: oil and gas, mining, etc.
iii)	+ Net return on fixed capital
iv)	+ Net income from financial wealth
v)	+ Return on human capital

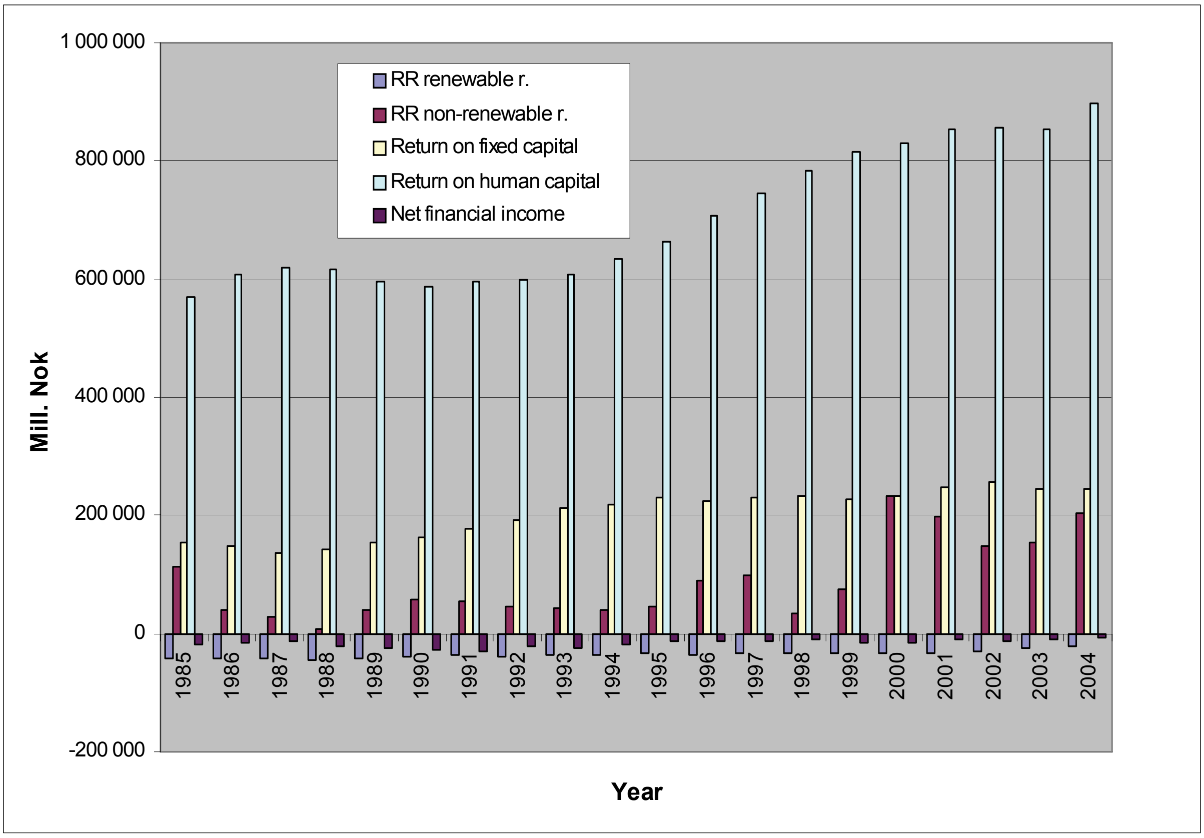
Resource rents are calculated as described above. The value of fixed capital is given in the national accounts. In order to calculate total return we have used the same rate of return as we used for the resource rents calculations, i.e. the average rate of return to capital for all non-natural resource industries in that particular year. Net income from financial wealth is given in the national accounts. Lastly, the return on human capital is calculated residually:

Return on human capital = NNI – Resource rents – net return on fixed capital

(See the Appendix for a formal treatment of the decomposition of NNI).

The return on human capital should compromise all contributions from labour, that is, raw labour, the effect of education and so-called *social capital*. Clearly, since it is calculated residually, it also compromises all kinds of positive externalities between capital, technology and labour; in particular, it will pick up all the growth in NNI that cannot be explained by increased factor usage. In figure 1 we show the decomposition of NNI for Norway.

Figure 1. Decomposition of Norwegian net national income (NNI)



Note that the return on human capital is by far the most important factor for all years. Further, note that the resource rent from non-renewable resources, which almost entirely consist of resource rents from the oil and gas extraction, varies a lot depending on the international prices. For the last 5 years, the resource rent from oil and gas has made up about 15% of NNI. Finally, observe that the resource rents from the renewable resources are negative in the whole period. This is mainly due to the very high subsidies in Norwegian farming.

National wealth has then been calculated as a third step. In order to calculate national wealth properly, one must evaluate to what extent the contribution from a type of capital in a given year can be continued in the following years. With respect to the renewable natural resources, information about the stock of the resource is crucial. This is not given in the national accounts, but in the already mentioned system of material accounts at Statistics Norway. To the extent that the stock is kept constant or increasing, we have assumed that this year's resource rent is the best prediction for the resource rent in the coming years. On the other hand, if the stock is decreasing (for fish stocks under a critical value), we have treated the resource as a non-renewable resource and calculated an "extraction path" based on the harvest for the actual year. This is the same method that is being employed by the World Bank (see WB (1998, 2005).

With respect to Norway, of the non-renewable resources, oil and gas have for the latter 30 years dominated totally. Statistics Norway regularly obtains estimates for available reserves of oil and gas from the Norwegian Oil Directorate. These reserve estimates have then been used to construct extraction paths based on current production and an *a priori* assumption that the extraction path is declining (especially towards the end). Extraction cost estimates, that is intermediate inputs, labour and capital, have been taken from the lasts year's national accounts, and have been used for future extraction costs. Hence, we have implicitly assumed that cost savings due to technological development will be exactly counterbalanced by the extraction cost increases due to smaller reserves. Finally, we have recently started to use an in-house model of the global oil and gas markets in order to predict future prices of oil and gas.

National wealth (NW) is then given:

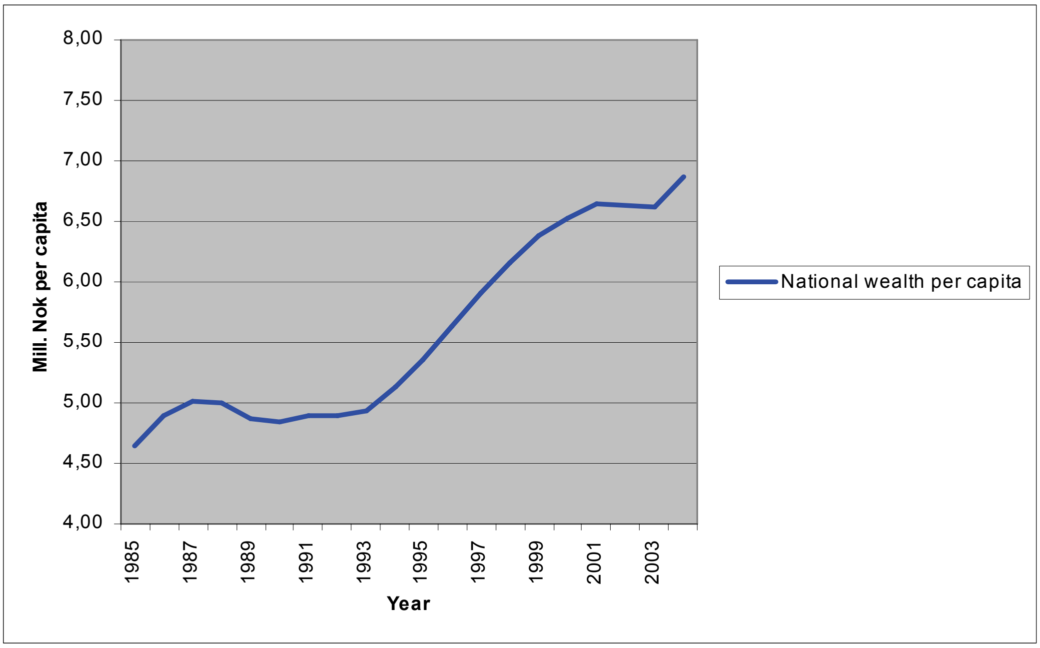
NW =

i)	+ present value of future resource rents from renewable natural resources
ii)	+ present value of future resource rents from non-renewable natural resources
iii)	+ present value of future contribution from human capital
iv)	+ current value of fixed capital as given by NA
v)	+ net financial wealth

If the extraction of non-renewable natural resources is constant or declining, and if the resource rent per unit of extracted resource is constant, and if reserves are not upgraded, point ii) above will decline as time passes. Thus, in order to keep NW constant or increasing, one or more of the other components of NW have to increase. Typically, this has especially been the case for point iii) human capital since human capital will tend to pick up all economic growth that is due to technological change. All the same, we have not included a growth in human capital in our calculations of point iii) above. That is, we have assumed that this year's contribution from human capital is prolonged infinitely into the future (for more about the method see the Appendix).

In 2005 we (Greaker et al., 2005) calculated Norwegian national wealth per capita for the period 1985 - 2004 based on the national accounts, and the material accounts for fisheries, forests, oil and natural gas. There was no need to treat fisheries or forests as non-renewable resources since the volume of standing timber has been increasing, and since the stocks for all the valuable fisheries were above their critical sizes. In figure 2, we present our results for Norwegian national wealth per capita[3]:

Figure 2. The development in Norwegian national wealth per capita



As can easily be seen from the figure, national wealth per capita has been steady increasing apart from a period in the beginning of the 1990s. The growth was especially strong between 2003 and 2004. Even if the value of the Norwegian oil and gas resources decreased from NOK 13 billion from 2003 to 2004 due to extraction, national wealth per capita increased significantly because the value of human capital increased by NOK 1154 billion from 2003 to 2004.

Clearly, national wealth accounting has many shortcomings. First of all, far too many renewable resources are not included; for instance ecosystem services, natural amenities etc. One major reason is that prices on the services that these renewable resources supplies do not exist as already mentioned. And further, that calculating prices is complicated as described above. Consequently, our calculations can show that the national wealth is increasing, while in reality, it may not be. One example could be productivity improvements in forestry that increases the resource rents from the sector, but at the same

[3] All values are converted to NOK 2000-values. That is, in order to compare the years we have transformed all nominal values for each year by using an index. The index is a combination of the consumer price index and the public consumption index. The combination is based on their relative share of total consumption.

time hampers the supply of non-timber values from forests to such a significant degree that the national wealth actually has decreased.

Secondly, too much seems to depend on uncertain future prices. In practice it turns out that people hold widely differing views as to what are reasonable price and production paths in the case of for example oil and gas. Brekke et al., (1989) for instance, estimated the value of the oil wealth on the basis of official government price projections published in various years. They found that the year-on-year changes in the oil wealth essentially were due to changes in price expectations. Furthermore, for several years the changes were of a scale that exceeded that year's GDP! In other words, the uncertainty as to future oil prices is so great that adjusting GDP for depletion of the non-renewable resources becomes virtually irrelevant. Nonetheless analyses such as this represent useful information for politicians and others. Once again we find that the analysis results should not without further ado be incorporated in the accounts and in the indicators based on them.

Lastly, the method by which the most important factor, human capital, is calculated is clearly unsatisfactory. Since it is calculated residually, it is hard to understand what really drives the development in this factor, and hence, what determines the development in national wealth.

2.4 A recapitulation of the Norwegian debate

A reasonable operationalization of the concept of sustainable development is that national spending should not exceed national income in the long run. The question, however, is how to define income. A definition of income that has gradually gained currency[4] is the following: income is that part of the monetary flow that a person or organisation can spend in the course of, say, one year without being worse off at the end of the year than at the start of the year. It is this principle that has motivated the calculations of national wealth at Statistics Norway.

On the other hand, we have argued that defining the value of environmental capital is highly problematic. Calculating the consumption of such capital is of course no less difficult and controversial. Indeed, even for an "ordinary" commodity such as oil it has proved difficult to find usable figures for the wealth it represents. These problems are closely related to the fact that definition of income depends on our vision of future events. The problem of course is that since the concept of income is critically dependent on expectations as regards future events the concept gives precious little guidance as to what conduct should be adopted. Put another way: if a mistake is made, a mistake is

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[4] John Hicks (1946): Chapter 14 of *Value and Capital*.

made - and not even an environment-adjusted GDP can say much more than that about what arrangements should be made.

3. From natural resource accounting to indicators for sustainable development

After the first decade with natural resource accounting and the realisation that the heavy investment in developing these accounts generally did not pay off in terms of better management, the question remained: How could politicians get the necessary information in order to secure a responsible development with respect to natural resources and the environment?

In the highly influential report "Our Common Future" from the World Commission on Environment and Development (WCED, 1987), and again at the UN conference in Rio de Janeiro in 1992, at least a part of the answer was sought by issuing a call to develop *sustainable development indicators* (SDI). Some countries and institutions eagerly took up the call, while others, Norway among them, largely neglected or delayed the call. In broad terms three different paths seems to have been followed in the international work on indicators for sustainable development (Giovannini, 2004).

One path, the accounting path, underlined the need for a full set of natural resources and environmental accounts in addition to accounts for the economic and social dimension, in order to form more aggregated indicators for sustainable development. The UN has published a handbook for the compilation of so-called satellite accounts; SEEA (United Nations et al. 2003). In this tradition, the Netherlands at an early stage developed methods for grouping together economic- and environment-related variables in its so-called NAMEA-system. Norway, in addition to developing comprehensive natural resource accounts, as described above, also has made some limited efforts to develop integrated economy-environment accounts along the NAMEA lines; see e.g. Sørensen (2000) and Hass et al. (2002a). However, these types of accounts involve large sets of numbers, and it is a demanding task to extract from the systems easily understandable and politically relevant information. This approach therefore mainly provides information more suitable as a basis for detailed (environmental) analysis than as core indicators of sustainable development.

A second path emphasised the collection, in a more or less ad hoc manner, of indicators for a large number of issues and problems thought to be of relevance to sustainability; usually without any underlying unifying framework or simply connected to policy statements, cf. various national sets of indicators, the UN's Commission for Sustainable Development, Eurostat, etc. A good summary of these and similar sets can be found in Hass et al. (2002).

A third path sought to define and work out a single or a few highly aggregated indicators based on more or less ad hoc methodologies for aggregating indicators for different environmental, economic and social themes (a short survey is provided in World Bank, 2003). The demand for a single "green GDP" index can be placed in this category. In this tradition the World Bank has developed and published an indicator called "genuine savings", where a country's net national product, the value created after subtraction of the maintenance of the capital stock, is adjusted for the use of non-renewable resources and depreciation of the environment, see Hamilton (2000). "The Genuine Progress Indicator" (Redefining Progress, 1999, 2001) and "Index of sustainable economic welfare" (Daly and Cobb 1989, Cobb and Cobb 1994) are other indicators that in various ways adjust net national product for loss of welfare related to environmental and social conditions. "Environmental pressure index" (Jesinghaus, 1999), "Environmental sustainability index" (World Economic Forum 2002) and "Well-being of nations" (Prescott-Allen 2001) are other approaches where a number of factors related to the environment and social conditions have been measured by separate indicators, and where an overall index is calculated using weights and by aggregating the various indicators. Among mainly biophysically based indicators we find "Ecological footprint", published by the World Nature Fund (WWF) (Rees and Wackernagel 1994, WWF 2004), which measures the amount of productive land needed to supply the world with food and fibre, as well as energy in renewable form. "Living planet index", tries to summarise the development of biodiversity in terrestrial, marine and fresh water based ecosystems (WWF 2004). Finally, we draw attention to material flow indicators seeking to indicate a society's overall consumption of materials (Bringezu and Schütz 2001a,b, Eurostat 2001, 2002).

The end result is a plethora of different indicator sets based on different and more or less sound methodologies. We argue that none of the approximate measures listed above can be said to have been successful as indicators of sustainable development, neither on a professional basis, nor on the basis of their influence on practical policy. This may in some cases be due to the fact that rather large numbers of indicators, often representing measurements without theory, have been developed which only to a limited extent have been able to focus on issues of critical importance for the sustainability of development. Instead, attempts have been made to measure almost all aspects of development. On the other hand, the construction of single aggregate indicators has often made it difficult to judge how individual areas of importance for sustainability have been weighted and aggregated. This uncertainty tends to reduce confidence and usefulness in such aggregate indicators and it often leads to discussions of methodology rather than substance. To us, the challenge consists of striking a balance between these various considerations, while at the same time maintaining a sharp focus on matters that are or may be of great political and practical importance for policies to enhance the sustainability of future long-term developments.

3.1 Indicators for sustainable development in Norway: a proposal

Almost ten years after the Rio conference, and as a preparation for the follow up conference Rio + 10 in Johannesburg, Norway finally came around to formulate both a strategy and an action plan for sustainable development (Ministry of Foreign Affairs, 2002, Ministry of Finance, 2003). A key action in the action plan was to develop a limited and focused set of indicators for sustainable development in Norway. A commission was established to put forward a proposal for such a set, and they delivered their report in 2005 entitled "Simple signals in a complex world" (NOU 2005). The Ministry of Finance (2005) provides an English summary. .

A major concern for the commission was to establish a theoretical framework for such an indicator set, and not to only propose a collection of more or less relevant individual indicators. Furthermore, they highlighted the need for the indicators to be as intuitively understandable as possible, and thus to avoid more dubious methods for aggregating numbers from very different areas. This was done in order to avoid endless and often frustrating discussions about methodological questions drawing attention away from the real concern: How to secure a more sustainable development of our societies.

To create a unifying framework, while at the same time keeping the indicators as intuitively understandable as possible, was clearly a challenging task. The solution, according to the commission, was to base the indicator set on *National wealth* as the key-unifying concept, however, to broaden the concept compared to how it has traditionally been used at Statistics Norway. While sustainable development is often interpreted as a long-term development securing the welfare level of the population, i.e. with focus on the output of our combined environmental, economic and social systems, the commission lowered the ambition level and focused instead on securing the input or resource base of our societal systems. According to this interpretation, sustainable development is not about preserving some particular development pathway, but about protecting development options for the future.

The resource base clearly encompasses natural and environmental resources, financial resources as well as man-made equipment and infrastructure, in addition to social resources like human work capacity, knowledge and know how. Altogether this constitutes our national wealth in the form of natural and environmental capital, financial and real capital and human capital.

According to the Norwegian commission, the question of sustainability can usefully be simplified to a question of whether we manage our resource base – our national wealth – in a way that secures its maintenance over time. Thereby, the focus of the sustainability debate has been sharpened, since the issue of sustainability has been put in concrete terms, i.e. a question whether our financial-, real-, natural-, environmental- and human capital increases or declines over time.

However, if one wealth component, e.g. petroleum wealth declines, is this being offset by growth of other components such as human capital? This question touches on a difficult point of whether, and to what extent, the various wealth components can be expected to substitute for each other as far as welfare effects are concerned. On this point, opinions may differ. There are clear-cut cases where substitution can be denied on technical grounds (ecosystem services are a good example). In other cases, the matter cannot be decided on technical grounds alone. The question of the substitutability at the margin of, say, some forestland for a shopping mall is one that is very difficult to make on purely technical grounds. It is best made on the basis of social preferences, expressed either through the market or democratic institutions or both. Robert Smith of Statistics Canada has noted (R. Smith, 2005) that marginality is a key concept here. To the extent that such decisions are truly marginal, then the liberal argument to allow the market and democratic institutions to decide holds. If, however, our impact on the environment is becoming less and less marginal, as many scientists believe, then the liberal argument weakens and may even become dangerous. In this case, there is no other recourse than to return to technical grounds for decision-making; regrettably, our technical knowledge of these impacts is generally insufficient to make wise decision-making a possibility. Then, in the last instance, the political authorities will have to decide.

Thus, the commission recognized that it is unwise to aggregate all the wealth components into a single total national wealth indicator, since the various components cannot always replace each other. Incomplete knowledge of the functioning of for instance ecosystems, provides an additional reason why key individual elements of the national wealth, and not only the total value, are important.

Even though making rather crude estimates of national wealth is now standard procedure in most national statistical agencies in OECD countries, it is well known that there are many practical problems associated with this. In order to add the various components of national wealth, they have to be expressed in a common unit of measurement, usually in the form of money. Ideally, the value of a unit of national wealth should reflect how a unit of the relevant element could contribute to our welfare. However, it is difficult to estimate these so-called shadow prices, especially if the services are not traded in perfectly functioning markets. Thus, estimates of national wealth are usually incomplete.

It is at this point that *indicators of sustainability* are useful, if they are selected in such a way that they represent what the expected welfare effects of the key components of national wealth. The strategy as far as the selection of indicators of sustainability is concerned is therefore as follows: *to chose indicators that best reflect the value, defined as the welfare effects, of the various components of national wealth.* The Norwegian strategy is thus similar to the one Canada has described as "a capital approach", see Smith et al. 2001, and is also discussed in the SEEA as one of its guiding theoretical approaches.

A general overview of the indicator set is presented below in table 2, together with illustrations and brief descriptions. This is a first version of the indicator set, and it will of course be further developed as experiences are gained.

Throughout we have tried to base the indicators on uncontroversial and direct data, thus avoiding as much as possible use of non-transparent methods to arrive at the indicators. A few exceptions are however, based on SEEA type of data.

Table 2. Indicators of sustainable development

Issues that the indicators shall cover	Indicators
1. Climate change	Norwegian emission of greenhouse gases compared with the Kyoto target
2. Acidification	Percentage of Norway's land area where the critical load for acidification has been exceeded
3. Terrestrial ecosystems	Bird index—population trends of nesting wild birds
4. Fresh water ecosystems	Percentage of rivers and lakes with clearly good ecological status
5. Coastal ecosystems	Percentage of localities along coastal waters with clearly good ecological status
6. Efficiency of resource use	Energy use per capita
7. Management of renewable resources	Recommended quota, TAC actually set, and catches of Northeast Arctic cod.
8. Hazardous substances	Household consumption of hazardous substances
9. Sources of income	Net national income per capita, by sources of income: • resource rent from renewable natural resources, • resource rent from non-renewable natural resources, • return on produced assets, • return on human and environmental capital, and • net income from abroad
10. Sustainable consumption	Petroleum adjusted savings
11. Level of education	Population by highest level of education completed
12. Sustainable public finances	Generational accounts: need for tightening of public finances as share of GDP
13. Health and welfare	Life expectancy at birth
14. Exclusion for the labour market	Long-term unemployed persons and disability pensioners
15. Global poverty reduction	Trade with Africa, by LDC counties and other African countries
16. Global poverty reduction	Norwegian development assistance as percentage of gross national income

3.2 Links between accounting and indicators

Having concluded that the development of indicators for the (comprehensive) wealth of a nation (or a region) is a useful way towards securing sustainable development at the national or regional scale, we are of course confronted with the question of what kind of information is needed in order to construct and understand reliable indicators. It is at this point that we are brought back to the issue of accounting. Accounts have the potential of providing a dynamic framework for analysing and for increasing our understanding of the messages delivered by the indicators, and should encompass economic, natural resource and environmental issues, but also, in addition to previous exercises, measure human capital. The main audience of the accounts is thus no longer decision makers directly, but rather statisticians and other experts involved in compiling indicators of national wealth and sustainable development indicators.

Thus, over time we have come to understand that extended, or green, accounting is an exercise that should support and be directed by the development of policy relevant indicators for sustainable development. In light of this, the early Norwegian enthusiasm for green accounting was premature, focusing on too many issues and with a too short time horizon. The point is rather to identify long-term issues of high relevance to the sustainable development of our societies, and then to develop the necessary informational basis for understanding and analysing these issues and trends.

4. Conclusions and recommendations

Based on our, admittedly limited, experiences we would like to highlight the following conclusions.

1. A one-sided focus on the development of large-scale natural resources and environmental accounts without a clear plan for their eventual utilisation is likely to be a waste of efforts. Potential uses of the accounts are analysis of trends in more aggregated indicators, and as input to economic models for analysis of interactions between economic development, natural resource use and the environment.
2. On the other hand, a one-sided focus on aggregated indicators (for sustainable development or in the green GDP tradition) without a theoretical framework and a solid statistical underpinning is likely to lead to little policy relevant information. As mentioned, we favour a broad theoretical framework based on the concept of comprehensive national wealth. This should be supported by capital accounts of the relevant assets, as well as conversion and end use accounts for analysis of policy impacts.
3. Finally, we argue that the time has come to work on a common framework for indicators for sustainable development among countries, based on a resource or capital approach. In addition to nation indicators, it would be desirable to establish an authoritative set of *global* indicators for sustainable development based on the concept of national wealth.

References

Aaheim, A. and K. Nyborg (1995): On the interpretation and applicability of a green national product, *Review of Income and Wealth* **41**(1).

Alfsen, K.H., K.A. Brekke, F. Brunvoll, H. Lurås, K. Nyborg and H.V. Sæbø (1992): *Environmental indicators*, Discussion Paper no. 71, Statistics Norway, Oslo.

Alfsen, K.H., and H.V. Sæbø (1993): Environmental quality indicators: Background, principles and examples from Norway, *Environmental and Resource Economics* **3**, 415-435.

Alfsen, K.H., T. Bye and L. Lorentsen (1987): *Natural resource accounting and analysis. The Norwegian experience 1978-1986*. Sosiale og økonomiske studier 65, Central Bureau of Statistics of Norway, Oslo.

Borgström, G. (1964), *Gränser för vår tillvaro*, LTs förlag, Stockholm.

Brekke, K.A., T.A. Johnsen and A. Aaheim (1989): Petroleumsformuen - Prinsipper og beregninger, Økonomiske analyser no. 5, Statistisk sentralbyrå, Oslo.

Bringezu, S. og H. Schütz (2001a): *Total material requirement of the European union*, Technical Report No. 55, European Environment Agency, Copenhagen.

Bringezu, S. og H. Schütz (2001b): *Total material requirement of the European union - Technical part*, Technical Report No. 56, European Environment Agency, Copenhagen.

Carson, R. (1962): *The Silent Spring*, Houghton Mifflin, Harmonds Worth, Boston. New edition 1982, Penguin Books, Harmondsworth.

Cobb, C.W. and J.B. Cobb (1994): *The green national product: A proposed index of sustainable economic welfare*. University Press of America, Lanham.

Cobb, J.B. jr., and H. Daly (1989): *For the common good*. Green Print, London.

Commission of the European Communities, International Monetary Fund, Organisation for Economic Co-operation and Development, United Nations and World Bank (1993): System of National Accounts 1993, Brussels/Luxembourg, New York, Paris, Washington D.C.

Central Bureau of Statistics of Norway (1981): Resource Accounts, Statistiske analyser 46, Oslo

Daly, H. and J.B. Cobb (1989): *For the common good*. Beacon Press, Boston.

Eurostat (2001): Economy-wide material flow account and derived indicators. A methodological guide. Statistical Office of the European Commission, Brussels.

Eurostat (2002): Material use in the European Union 1980-2000: Indicators and analysis. Statistical Office of the European Commission, Brussels.

Giovannini, E. (2004): The Statistical Measurement of Sustainable Development: Lessons Learned from the OECD Project, Presentation given on the Vettre-conference on indicators for sustainable development, Asker, June 2004. http://www.odin.dep.no/fin/norsk/tema/norsk_okonomi/21/006071-210106/dok-bn.html

Greaker, Mads, Pål Løkkevik og Mari Aasgaard Walle (2005): Utviklingen i den norske nasjonalformuen fra 1985 til 2004. Et eksempel på bærekraftig utvikling? (translation: Development of the Norwegian national wealth 1985-2004. An example of sustainable development?) Report 2005/13, Statistics Norway, Oslo. ISBN 82-537-6789-7.

Hamilton, K. (2000): Genuine savings as a sustainability indicator. *World Bank Environmental Economics Series* **77**, Washington, D.C.

Hass, J.L., F. Brunvoll and H. Høie (2002): Overview of sustainable development indicators used by national and international agencies. OECD Statistics Working Paper 2002/1, STD/DOC (2002)2, Paris: Organisation for Economic Co-operation and Development.

Hass, J.L., K.Ø. Sørensen and K. Erlandsen (2002a): Norwegian Economic and Environment Accounts (NOREEA). Project Report - 2001. Documents 2002/15, Statistics Norway, Oslo.

Hicks, J. (1946): *Value and Capital, 2nd edition*, Oxford at the Clarendon Press, Oxford.

Jesinghaus, J. (1999): Case Study: The European Environmental Pressure Indices Project, A Case Study Prepared for the Workshop “Beyond Delusion: Science and Policy Dialogue on Designing Effective Indicators of Sustainable Development", The International Institute for Sustainable Development, Costa Rica, 6 – 9 May 1999.

Lone, Ø. (1992): "Accounting for sustainability: "Greening" the national accounts?", paper to CIDIE workshop on environmental and natural resource accounting, Nairobi, 24-26 February 1992.

Låg, J. (editor)(1982): *Basis of accounts for Norway's natural resources*, Universitetsforslaget, Oslo.

Meadows, D.L.; D.H. Meadows, J. Randers and W.W. Behrens III (1972): The Limits to Growth: a report for the Club of Rome's project on the predicament of mankind, Earth Island, London.

Ministry of Finance (2003): Nasjonal handlingsplan for bærekraftig utvikling (National Action Plan for Sustainable Development, National Agenda 21) St. meld. 1 (2003-2004).

Ministry of Finance (2005): Indicators for policies to enhance sustainable development, Oslo.

Ministry of Foreign Affairs (2002): National Strategy for Sustainable Development, http://odin.dep.no/ud/english/doc/plans/032121-120004/dok-bn.html (accessed 16. August 2005).
Mishan, E. J. (1967): The cost of economic growth, Staples Press, London. Revised edition published in 1993 by Weidefeld & Nicolson Ltd., London.

Nordhaus, W. and J. Tobin (1972): "Is growth obsolete?", in Economic Growth, National Bureau of Economic Research General Series, no. 96E, Colombia University Press, New York.

Nordhaus, W. And E.C. Kokkelenberg (eds.) (1999): *Nature’s numbers. Expanding the National Economic Accounts to Include the Environment*. National Academy Press, Washington D.C.

NOU (2005): Enkle signaler i en kompleks verden. 2005:5 (transl. Simple signals in a complex world) Ministry of Finance: Oslo.

Peskin, H.M. (1996): Alternative resource and environmental accounting. Concepts and their contribution to policy, mimeo 1/24/96.

Peskin, H.M. (1999): “Alternative resource and environmental accounting approaches and their contribution to policy”, in A. Lanza (ed.): *Resources accounting in China*, Kluwer Academic Press, New York.

Prescott-Allen, R. (2001): *The Wellbeing of Nations*, Island Press, Washington, Covelo, London.

Redefining Progress (1999): The 1998 U.S. Genuine Progress Indicator: Methodology Handbook, San Francisco.

Redefining Progress (2001): The 2000 Genuine Progress Indicator, San Francisco.

Rees, W.E. and M. Wackernagel (1994): “Ecological footprints and appropriate carrying capacity: Measuring the natural capital requirements of the human ecology", i: A. Jansson, M. Hammer, C. Folke og R. Constanza (eds.): *Investing in Natural Capital*, Island Press, Washington DC.

Rosendahl, K.E. (ed.) (1998): *Social costs of air pollution and fossil fuel use. A Macroeconomic approach*. Social and economic studies No. 99, Statistics Norway, Oslo, 147 pp.

Smith, R., C. Simard and A. Sharpe (2001): A proposed approach to environment and sustainable development indicators based on capital. A report prepared for the National Round Table on the Environment and the Economy's Environment and Sustainable Development Indicators Initiative. January 2001.

Smith, R. (2005): Personal communication (e-mail).

Sørensen, K.Ø. (2000): Environmental accounts in Norway, paper prepared for the 26th general conference of the International Association for Research in Income and Wealth, Cracow, Poland, 27 August- 2 September 2000. See www.stat.gov.pl and www.econ.nyu.edy/dept/iariw

United Nations Development Programme (UNDP) (1992): Human Development Report 1992, Oxford University Press, New York.

United Nations, European Commission, International Monetary Fund, Organisation for Economic Co-operation and Development and World Bank (2003): *Handbook of National Accounting, Integrated Environmental and Economic Accounting*, Studies in Methods, Series F, No.61, Rev.1 (ST/ESA/STAT/SER.F/61/Rev.1)

Uno, K. (1992): Composite measures of equality of life. Social, economic, and environmental accounting and modeling. Paper presented at the 22nd General Conference of the International Association for Research in Income and Wealth, Flims, Switzerland.

WCED (World Commission on Economy and Development) (1987): *Our Common Future*, Oxford University Press, Oxford.

World Bank (1998): *Estimating National Wealth: Methodology and Results*, Verdensbanken, Washington D.C.

World Bank (2003): Sustainable development in a dynamic world. Transforming institutions, growth, and the quality of life. World Development Report 2003, World Bank and Oxford University Press, Washington DC and New York.

World Bank (2005) *Where is the Wealth of Nations?* World Bank: Washington, D.C.

World Economic Forum (2002): 2002 Environmental Sustainability Index, An Initiative of the Global Leaders of Tomorrow Environment Task Force, World Economic Forum Annual Meeting 2002.

WWF (2004): Living planet report 2004. World Wide Fund for Nature, Gland. See http://www.panda.org/downloads/general/lpr2004.pdf

Appendix

Our method of calculating national wealth can also be illustrated with the following simple example. Let the economy consist of three sectors; one traditional sector *X*, one renewable resource sector *Y* and one non-renewable resource sector *Z*. Let; *x*, *y*, *z* denote gross income in the three sectors, and let further v_i be use of intermediates for each sector *i*, $i = x, y, z$. In the same way, let A_i, K_i, D_i, denote use of labour, capital stock and consumption of capital, respectively. Finally, let r_t denote the rate of return to capital in year *t*, and *I* the net income from financial wealth.

Net national income (*NNI*) for any year t can then be defined as follows:

$$NNI = (x - v_x) + (y - v_y) + (z - v_z) - D_x - D_y - D_z + I \,. \tag{1}$$

Let w_i denote the average wage rate in sector *i*, and h_i the number of hours worked in sector *i*. (That is, we have $A_i = w_i h_i$). We then decompose *NNI* for any year t in the following way:

$$\begin{aligned} NNI = {} & (y - v_y - rK_y - w_x h_y - D_y) + (z - v_z - rK_z - w_x h_z - D_z) + w_x (h_x + h_y + h_z) \\ & + r(K_x + K_y + K_z) + I, \end{aligned} \tag{2}$$

where the two first terms; $(y - v_y - rK_y - w_x h_y - D_y)$ and $(z - v_z - rK_z - w_x h_z - D_z)$, are the resource rents in sector *Y* and *Z*. The two next terms are the contribution from labour and the return on capital, respectively. Note that we set $w_x (h_x + h_y + h_z)$ equal to the return on human capital, and not $(A_x + A_y + A_z)$ since wage rates in the natural resource sectors may be higher than in the traditional sector due to wage bargaining over the resource rents.

For any year t, the rate of return on capital is calculated:

$$r = \frac{x - v_x - A_x - D_x}{K_x}, \tag{3}$$

that is, as operating surplus in sector *X* divided by the capital stock in sector *X*. One may ask whether the decomposition in (2) is correct? Equation (2) can be simplified:

(2)' $$NNI = \left(y - v_y\right) + \left(z - v_z\right) - D_y - D_z + A_x + rK_x + I\ .$$

By comparing (1) and (2)', we note that the decomposing is only correct as long as: $A_x + rK_x = \left(x - v_x\right) - D_x$. On the other hand, from (3), we observe that this is true by our method of calculating the rate of return to capital.

The contribution from human capital is then calculated residually in the following way:

(2)" $$A_{tot} = NNI - \left(y - v_y - rK_y - A_y - D_y\right) - \left(z - v_z - rK_z - A_z - D_z\right) - r\left(K_x + K_y + K_z\right) - I\ ,$$

where $A_{tot} = w_x\left(h_x + h_y + h_z\right)$. Further, *NW* in any given year *t* can then be written:

(4) $$NW = \sum_{t=0}^{\infty} \frac{\left(y - v_y - r_t K_y - w_x h_y - D_y\right)}{(1+\delta)^t} + \sum_{t=0}^{T} \frac{\left(z_t - v_{tz} - r_t K_{tz} - w_x h_{tz} - D_{tz}\right)}{(1+\delta)^t} + \sum_{t=0}^{\infty} \frac{A_{tot}}{(1+\delta)^t} + K_{tot} + F$$

where δ is the discount rate, *T* is the anticipated time when there are no more reserves of the non-renewable resource left, $K_{tot}\left(= K_x + K_y + K_z\right)$ is the capital stock as given from *NA* in the year *t*, and *F* is the net financial wealth as taken directly from *NA* in the year *t*. Note that it is assumed that the resource rent from the renewable resource in year t can be continued forever. The same assumption is also made for human capital.

In the calculation at Statistics Norway we have often used a discount factor that is smaller than the rate of return i.e. $\delta < r$. The difference can be interpreted as a risk premium. When the rate of return is calculated from (3), we do not properly include the risk of bankruptcy. In case of bankruptcy, all equity will be lost, however, such losses are not included in the operating surpluses from the national accounts (NA). With respect to δ, we use *the social rate of return on investment* (World bank 1998). In our calculation we have not included future, expected economic growth, although it is no problem. Usually it is done by assuming that the return on human capital will grow with a rate g. This yields the following expression for national wealth:

$$NW = \sum_{t=0}^{\infty} \frac{\left(y - v_y - r_t K_y - w_x h_y - D_y\right)}{(1+\delta)^t} + \sum_{t=0}^{T} \frac{\left(z_t - v_{tz} - r_t K_{tz} - w_x h_{tz} - D_{tz}\right)}{(1+\delta)^t} + \sum_{t=0}^{\infty} \frac{(1+g)^t A_{tot}}{(1+\delta)^t} + K_{tot} + F.$$

In order for national wealth to converge to a finite number we must have $g < \delta$. As mentioned we have set $g = 0$ in our calculations.

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