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NATIONAL WEALTH AND THE CALCULATION OF THE HUMAN CAPITAL COMPONENT

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INTRODUCTION

1. One possible interpretation of the notion "sustainable development" is that the level of consumption in any particular year should not exceed the level making it impossible to maintain the same level of consumption in future years. A requirement that has been put forward to ensure that the level of consumption do not exceed such a critical level is that *national wealth* is kept intact. Hence, tracking the development in national wealth may tell us whether the current level of consumption is sustainable.

2. Statistics Norway occasionally calculates Norwegian national wealth, and each time we follow a specified procedure in order to facilitate comparison of wealth estimates for different years. National wealth consists of natural resource stocks, human capital stocks, physical capital holdings and financial assets. Both the value of physical capital and foreign financial holdings is given directly in the national accounts (NA), and hence, it is simple to calculate their contribution to national wealth.

3. On the other hand, the values of the resource stocks must be calculated. In the calculations net national income (NNI) is decomposed in order to obtain the net income from each available resource stock. Further, we evaluate the lifetime of each resource stock, and calculate future income from the resource stock. The contribution of each resource stock to national wealth is then given as the present value of the future stream of net incomes.

4. Among the resources are the renewable natural resources; land, forestry, fisheries and hydropower, the nonrenewable natural resources; oil, gas and mining, and what can loosely be denoted as human resources or *human capital*. With human capital we are referring to the education, skills and experience of the labor force. Despite Norway being very rich in natural resources, our calculations show that human capital is by far the most important component of Norwegian national wealth.

5. For instance, in the calculations we carried out in 2005, we found that human capital comprised 76% of national wealth, while oil and gas and physical capital comprised approximately 12% each. The contribution of the renewable natural resources taken together was around 0%. Furthermore, we showed that even if the value of the oil and gas resource stock fell by NOK 13 mia. from 2004 to 2005 due to extraction, national wealth per capita increased because the value of the human capital component was enlarged by NOK 1154 mia. (Greaker, Løkkevik og Walle, Statistics Norway 2005).

6. This result is not reflected in the procedure for how national wealth is calculated. While we calculate the resource rents for each tiny resource, even for moose and deer hunting, the income from human capital is only calculated residually. That is, we subtract the income from all assets and all other resources from NNI, and equate the residual with the income from human capital. Moreover, while we take great care to predict future price paths and extraction paths for oil and gas, we assume that the income contribution from human capital in one given year is kept constant for all future years.

7. In this paper we discuss various suggestions for how the calculation of the human capital component could be improved. Since human capital comprise the larger share of national wealth, much more care should be taken when current and future returns from this component is calculated. Moreover, the national wealth calculations would be far more interesting if the calculation could be used to explain why the human capital component was increasing or in some years, decreasing. We illustrate our suggestions with examples taken from Norway.

8. The result that the contribution of the renewable natural resources taken together comprised around 0% of national wealth is also "unsatisfactory". Firstly, it runs counter to most people's opinion that these resources are important for Norway, and hence, reduces the credibility of the national wealth calculations. Secondly, it masks a tendency for the state to use the natural resource management regime in order to reach regional policy goals. That is, instead of collecting the resource rents and redistributing them according to for instance regional policy goals, the management regime is made in order to fulfill some policy goals directly without redistributing resource rents. This dissipates the resource rents, and implies that if the renewable natural resource were ran down, the state would have to reallocate other resources in order to reach it goals. All other things equal, this would lower the income from these resources. We therefore also have some new suggestions on how renewable resources could be treated in the national wealth calculations.

BACKGROUND

9. There exist a large literature discussing the theoretical foundations of national wealth accounting, and we will not venture into this literature here, but only mention a few central contributions. The book Limits to Growth by Meadows et al (1972) initiated the early literature. In Limits to Growth the authors predict that the world will run out of nonrenewable resources, and that the world population will collapse through famine and other disasters. Economists in general were very skeptical to the method employed in the book and to its predictions, and a strand of literature followed discussing whether production with nonrenewable resources eventually would mean doom, see for instance Dasgupta and Heal (1979).

10. The literature culminated in the seminal article by Hartwick (1977), which shows what came to be known as Hartwick's rule: In an economy with a finite amount of a nonrenewable

natural resource essential for production, investing each year exactly the resource rent from depletion in physical capital will achieve constant consumption over time. Since physical capital and the depletable resource are the only inputs to production in the model of Hartvick, the rule also reads as "zero net investment forever results in constant consumption forever". Zero net investment seems to imply no changes to national wealth, and hence, Hartvick's rule should be compatible with the above-mentioned prescription to keep national wealth intact.

11. Solow (1986) shows this formally, that is, Hartvick's rule implies maintaining aggregate wealth or "some appropriately defined stock of capital … including … resources" at a constant level over time. As noted by Lars Svensson (1986) in the commentary to Solow's article, Solow assumes a constant interest rate, while in the model of Hartwick the interest rate is steadily declining due to less resource extraction and increasing capital accumulation. With a declining interest rate, wealth must be increased in order to keep the return from wealth constant, see Brekke (1997). On the other hand, since Norway is a small open economy, we can assume the interest rate to be given from abroad and constant. Accordingly, Brekke (1997) shows that in a small open economy with access to a perfect capital market, non-declining wealth is consistent with sustainable consumption (see also Solow, 1993).

12. The literature applying sustainability criteria to national account numbers is scarcer. Pearce and Atkinson (1993) was an early contribution tracking net investments or as it has come to be called, *genuine investment*, in 18 different countries. The genuine investment indicator can be seen as a direct application of Hartwick's rule. Applying Hartwick's rule strictly would imply that none of the resource rents could be consumed, that is, all resource rents must be reinvested and *not* consumed! As mentioned above, for an open economy this is not necessarily so since future resource rents adds to your wealth. This again implies that the rents on your resource wealth can be consumed.

13. Later contributions are for instance Hanley et al (1999) and The World Bank (2005). Hanley et al compare different sustainability indicators, among others genuine investments and green national product, for Scotland, and found that the indicators lead to different conclusions. The World Bank looks at genuine savings for as much as 140 countries. They include investments in human capital by counting expenses for education as a positive investment, and they find that the level of genuine investment is positive for developed countries, but not for all developing countries.

14. While most of the applied literature seems to focus on genuine savings as the sustainability indicator, Statistics Norway has continued to calculate and monitor national wealth. In Norway a commission was established in 2004 to put forward a proposal for a set of indicators for sustainable development, and they delivered their report in 2005 entitled "Simple signals in a complex world" (NOU 2005). In order to create a unifying framework, the commission chose to base the indicator set on *national wealth*, and to broaden the concept compared to how it has traditionally been used at Statistics Norway. The definition used by the commission not only includes resources that have a market value, but also natural and environmental resources that not so easily can be valued in money terms (see for instance Alfsen and Greaker, 2007). The focus in this paper is however the part of Norwegian national wealth that can be given an economic value.

15. From the beginning the issue *sustainable development* was tightly linked to resource management, and to what extent depletion of all kinds of non-renewable natural resources could be exchanged for increased levels of physical capital. The concept of human capital has later

been introduced as an alternative investment prospect for resource rents. However, the measure of human capital is more difficult since human capital is intrinsically linked to persons, and cannot be bought and sold in markets. In order to frame our discussion we start with a detailed description on the procedure currently used by Statistics Norway.

CURRENT PRACTISE AT STATISTICS NORWAY OF CALCULATING NATIONAL WEALTH

16. The value of a resource stock is defined as the present value of the income stream accruing from it. In calculating this value all use of other resources in order to obtain the income must be subtracted. With respect to the different types of natural resources the income is coined *resource rents*. National wealth is calculated in three steps:

Step 1: Calculating resource rents

17. The resource rents are the additional income a nation/region obtains from having the exclusive right to exploit a natural resource. With point of departure in the national accounts, Eurostat (2001) and SEEA-2003 defines resource rent in the following way:

Resource rent =

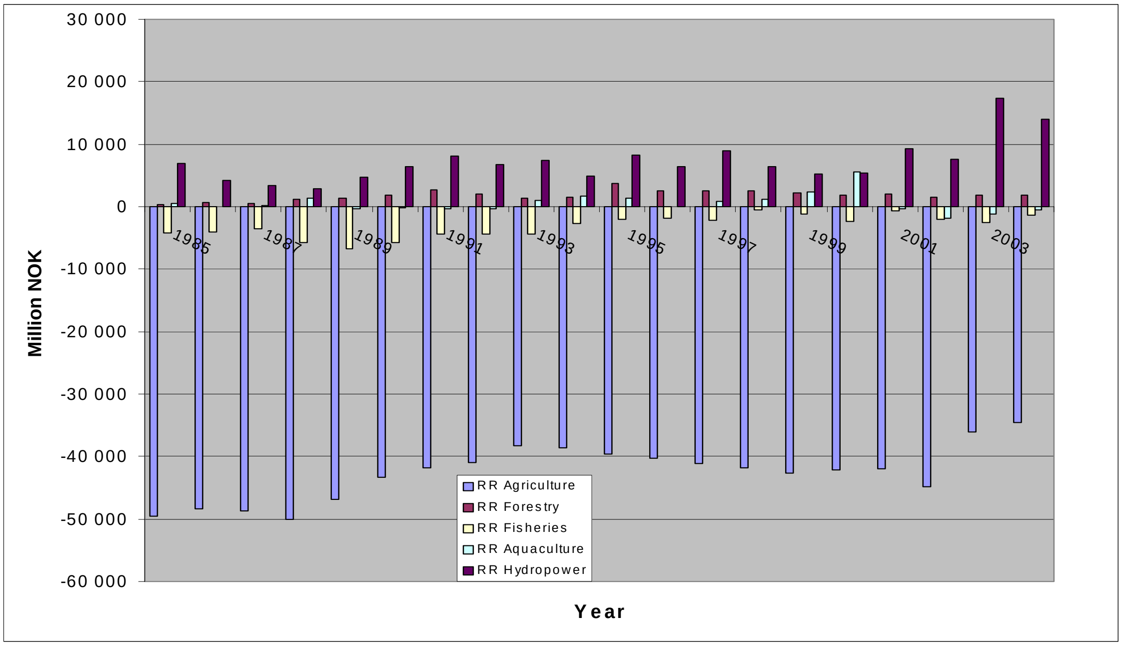
i)	+ Basic value of output/production
ii)	- Intermediate uses
iii)	+ Taxes on products
iv)	- Subsidies on products
v)	- Non-industry specific taxes
vi)	+ Non-industry specific subsidies
vii)	- Compensation of employees
viii)	- Return on fixed capital
ix)	- Capital consumption

18. 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 for all non-natural resource industries as the *alternative* value of labour. 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.

19. For the alternative value of capital we have either used 4% rate of return, or we have used the *averag*e rate of return to capital for all non-natural resource industries in Norway. The latter can be calculated from the operating surplus of the industries given in the NA. Further, 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.

20. In Figure 1 we show the resource rents in Norway for the period 1985 to 2006:

Figure 1 "Resource rents based on NA for Norway"



Step 2: Decomposing NNI

21. 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)	+ Value added tax
vi)	+ Return on human capital

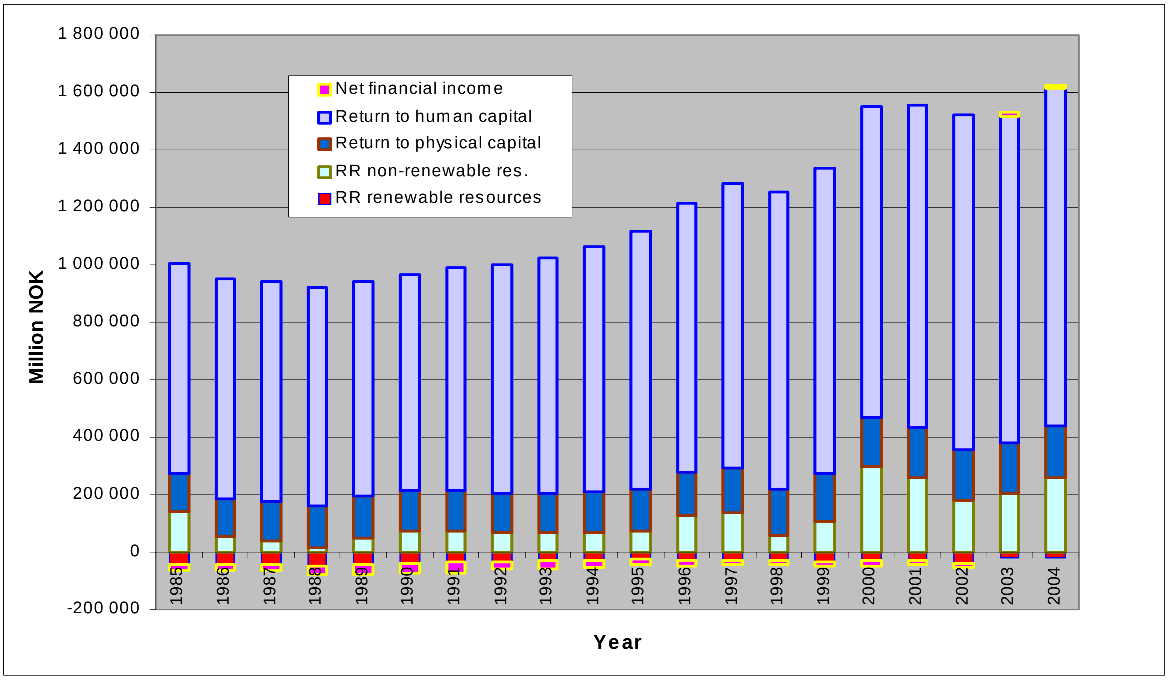
22. Resource rents are calculated as described above. The value of fixed capital is given in the national accounts. In order to calculate total return we have used the same rate of return as we used for the resource rents calculations, i.e. either 4% or the average rate of return to capital for all non-natural 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 - net income from financial wealth

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

23. Note that the value added tax is included in the human capital component. 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 2 we show the decomposition of NNI for Norway.

Figure 2 "Decomposition of NNI"



24. We note that the human capital component dominates, and that its contribution to NNI increases with approximately the same rate as NNI itself. We also note that the contribution from the non-renewable resource sector, mainly oil and natural gas, is highly volatile, which is due to variations in the world price on oil and gas. As mentioned the renewable resource sectors taken together do not contribute to NNI. The reason is mainly the high subsidies in agriculture, which leads to negative resource rents, see Figure 1.

Step 3: Calculating contributions to national wealth

25. The point of departure for the third step is the decomposing described above. Firstly, we evaluate to what extent current income from the renewable resources is sustainable. Statistics Norway publish stock data for the most important stocks like standing forest, arctic cod etc. We check these stock data for each resource, and if the stock is constant or increasing, we assume that the income stream can be continued for all subsequent years. The value of a renewable resource in this case is:

(i) $$NV_i = \sum_{t=t_0}^{\infty} \frac{RR_{t_0}^i}{(1+\delta)^{t-t_0}},$$

where NV_i is the present value of the income stream from resource i, $RR_{t_0}^i$ is resource rents from resource i for the year t_0, that is, the year for which we calculate national wealth, and δ is the discount rate. Note that if $RR_{t_0}^i$ is low, for instance due to bad management of the resource, we implicitly assume that the bad management will continue. Thus, the calculation only tells us the value of the resource given the management practice of today, and not the value given that the management practice were chosen to maximize the resource rents.

26. This implies that the value can be negative if the bad management leads to a negative resource rent. In such cases we have argued that the value should be set to zero since one at any time has the opportunity to stop harvesting the resource. We have also argued that the theoretical value of the resource given an optimal management practice should be calculated. This has been done several times for the Norwegian fisheries (see for example Flåm, Kjellemyr and Rødseth, 1996), and we propose to do the same for forestry and agriculture. However, the current procedure is to include resources with a negative resource rent as a negative wealth component.

27. For the nonrenewable natural resources we know that the resource rents are forced to stop some time in the future. We therefore base our calculations on time paths for the price, the extraction and the cost of extraction for these natural resources. The time paths for extraction are obtained from the Ministry of Oil and Energy in Norway. The price path of oil and gas are based on an in-house model of the global oil and gas markets at Statistics Norway, while the extraction costs are based on historical costs reported in the NA.

28. The value of a nonrenewable resource is thus given:

(ii) $$NV_j = \sum_{t=t_0}^{T} \frac{(\omega_t^j z_t^j - \overline{c_t^j} z_t^j)}{(1+\delta)^{t-t_0}} ,$$

where ω_t^j is the price of resource j in year t, z_t^j is the extraction of resource j in year t, $\overline{c_t^j}$ is the average extraction cost of resource j in year t and T is the year where the resource is depleted.

29. Each time we calculate national wealth we also update the calculations for earlier years in order to be able to track the development in the wealth figures (see Greaker, Løkkevik og Walle (2005). Through this process the expectations about future prices and costs are updated. For instance, if national wealth is calculated for year t_0 and year t_0 +1, then with respect to the latter calculation, we set $\omega_t^j = \omega_{t-1}^j$, $z_t^j = z_{t-1}^j$ and $\overline{c_t^j} = \overline{c_{t-1}^j}$, $\forall t \geq t_0 + 1$. Hence, changing expectations about future resource prices will not in itself affect the development in the wealth figures since they are continuously updated.

30. With respect to the human capital component, we have historically witnessed a steadily increasing return. On the other hand, if we assume that this trend will continue, we may be criticized for being too optimistic. We therefore normally make calculations of national wealth both with and without growth in the return from human capital. The value of the human capital component is then given:

(iii) $$NV_{HK} = \sum_{t=t_0}^{\infty} \frac{HK_{t_0}^{i}(1+g)^{t-t_0}}{(1+\delta)^{t-t_0}}, g < \delta ,$$

where $HK_{t_0}^{i}$ is the contribution from the human capital component to NNI in year t_0 (i.e. the residual above), and g is the rate of growth in the return to the human capital component. As mentioned the calculations are carried out for both g = 0 and g > 0.

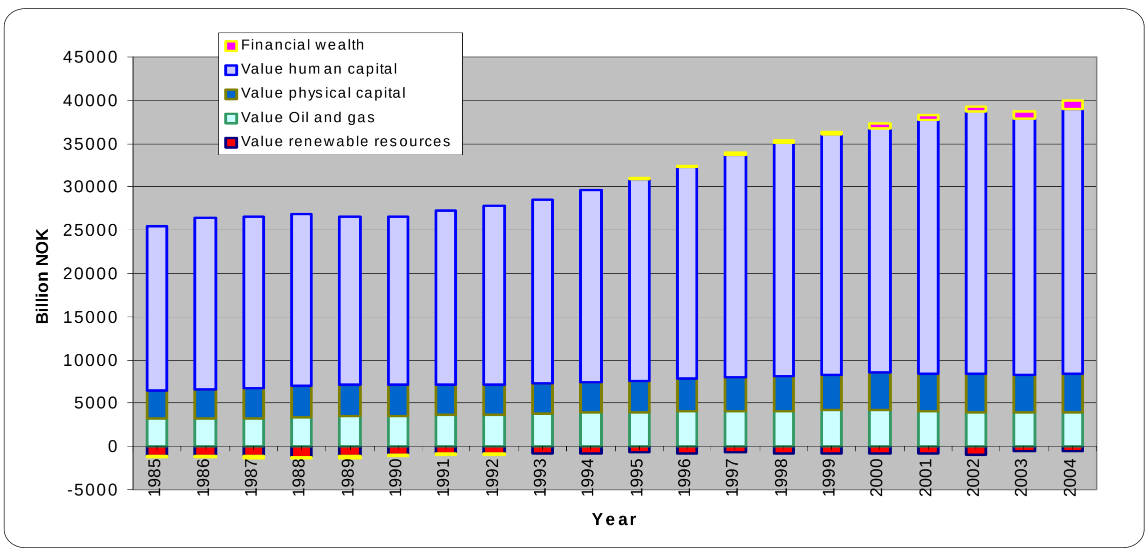
31. Lastly, national wealth NW can be calculated as the sum of the different components:

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

32. As mentioned, the values of both iv) and v) are given directly in NA. 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. Below we present the result from the most recent calculations:

Figure 3: The development in national wealth in Norway



33. From Figure 3 we note that national wealth is increasing, and that the human capital component is the major cause behind the growth. The value of the human capital component is just a direct transformation of the "return to human capital" given in Figure 2. Thus, Figure 3 does not contain any new information about the expected future return to the human capital component apart from the assumption that the return can be kept at the same level for all future years.

ALTERNATIVE WAYS TO CALCULATE THE HUMAN CAPITAL COMPONENT

34. So far we have been treating human capital together with labour as one entity. In the literature our human capital component is sometimes decomposed into *raw labour*, *education/skills* and *social capital*. Clearly, it is difficult to estimate each of these three parts separately, and especially the latter part, which often ends up being included in the two other.

35. In the literature there exist many proposals on how to estimate human capital. We divide the approaches into two strands of literature; one in which sustainable development is the point of departure, and in which explaining economic growth is the main objective.

Approaches followed in the sustainable development literature

36. As already mentioned, most of the literature on indicators for sustainable development choose to focus on the genuine savings indicator. It is easier to give the genuine saving indicator a formal backing (see e.g. Asheim, 2004 and the discussion above). The genuine savings indicator has undergone some development since first applied by Pearce and Atkinson (1993). In the book "Where is the wealth of nations?" (World Bank, 2005), the genuine savings indicator is calculated in the following way:

Genuine savings =

+ i)	Net investments in physical capital
+ ii)	Expenses for education e.g. wages paid to teachers, but excluding investment in buildings etc.
- iii)	Resource rents in the non-renewable natural resource sectors
- iv)	Damages to the environment from particulate matter and carbon dioxide

37. As already noted, a non-negative genuine savings indicator indicates that consumption is sustainable.

38. The genuine savings indicator equals changes in the human capital component with expenses to education in a particular year. As the authors of the book note, this is a crude measure, and in another chapter of their book "Where is the wealth of nations?" (World bank, 2005) the authors investigate to what extent different factors related to education, skills and social capital could explain the human capital component. Their point of departure is the following definition of national wealth:

(iv) $$NF = \sum_{t=t_0}^{t=25} \frac{\overline{C}}{(1+\rho)^{t-t_0}},$$

where NF is national wealth, $\overline{C}$ is average consumption over the last three years and ρ is the pure rate of time preference, which is set equal to 1,5 %. Furthermore, a time horizon of 25 years is chosen since according to the authors this is the time span of generation. It is also a crude estimate on the average years left in the labour force for the current workforce[1].

39. Having calculated wealth in this manner for a cross section of countries, the authors decompose wealth in each country by the same approach as described in the former section. That is, they calculate the value of the natural resources, physical capital and financial holdings and subtract that from their wealth measure. The residual is denoted *intangible capital*, which among others by the definition of national wealth must comprise human capital and social capital. In their next step the authors run a regression aiming to explain the intangible capital residual by three variables: average length of education per worker, remittances from abroad and a rule of law index among others based on political stability and absence of violence. They then find that their variable explains 89% of the variation in the intangible capital residual.

Approaches in the growth literature

40. While the sustainability literature mostly has tracked changes in the value of human capital from the input side, that is, wages to teachers etc., the growth literature has measured human capital from the output side. In the book by Becker (1975) he calculates rates of return to education by looking at wage differentials between workers with different levels of education. Jorgenson and Fraumeni take Becker's approach a step further, and in a series of contributions they both calculate the human capital component of the US and explain their method (see Jorgenson and Fraumeni 1989 and 1992). On the other hand, as far as we know, the approach followed by Jorgenson and Fraumeni has not been applied by the literature on indicators for sustainable development. Very broadly their approach follows the following steps.

(a) Construct a database containing the economic value of labour market activities for various categories of people. At least the database should include wage rates and labour market participation cross-classified with sex, education attainment and age. The database should ideally comprise all persons aged 16 to 75.

(b) Program an algorithm calculating the lifetime income for each person in the database. That is, we assume that each person in the future will obtain the same wage rate and have the same labour market participation rates as elder persons with the same characteristics currently living. The sum of the lifetime incomes will be equal to the total human capital stock.

(c) Update the database periodically, ideally each year; such that all changes in human capital due to changes in education attainment, labour market participation, demographic development etc. can be traced.

41. Note that, Jorgenson and Fraumeni also included the value of leisure (by the after tax marginal wage rate of the person in question). The method of Jorgenson and Fraumeni has been applied to other countries than the US, se for instance an application to Australia by Hui Wei (2004).

[1] Assume that the work force consists of people uniformly distributed between 20 to 70 years. The average age of a worker is then 45 years, and this worker has 25 years left in the work force.

42. In the following we illustrate the three steps with a simple example. We concentrate on the current labour force, and leave out students. Let the labour force be dived into age and education attainment:

Table 1 "Decomposing the labour force"

	Young; u	Old; g
Primary schooling; s	$w_{t_0}^{us}, l_{t_0}^{us}, n_{t_0}^{us}$	$w_{t_0}^{gs}, l_{t_0}^{gs}, n_{t_0}^{gs}$
High school; v	$w_{t_0}^{uv}, l_{t_0}^{uv}, n_{t_0}^{uv}$	$w_{t_0}^{gv}, l_{t_0}^{gv}, n_{t_0}^{gv}$
College; h	$w_{t_0}^{uh}, l_{t_0}^{uh}, n_{t_0}^{uh}$	$w_{t_0}^{gh}, l_{t_0}^{gh}, n_{t_0}^{gh}$

where $w_{t_0}^{ij}, l_{t_0}^{ij}, n_{t_0}^{ij}, i = u, g, \; j = s, v, h$, is *average wage rate* for workers of age i and with education j at t_0, *number of hours worked* for age group i with education level j at time t_0, and *the size of the population* for age group i with education level j at time t_0.

43. The value of the human capital component in year t_0 is then equal to:

(v) $$HK_{t_0} = \sum_j w_{t_0}^{uj} l_{t_0}^{uj} + \sum_j w_{t_0}^{gj} l_{t_0}^{gj} + \theta \sum_j w_{t_0}^{gj} n_{t_0}^{uj} (l_{t_0}^{gj} / n_{t_0}^{gj})$$

where θ is the discount factor. The discount factor should include the probability of being alive. In the first period, the calculation is straight forward, and the income stream from the human capital component is equal to the sum of wage rate times hours worked for each combination in Table 1. This figure should coincide with average wage times total number of hours worked for the country as a whole.

44. In period two the old are retired and no longer participating in the labour force. Moreover, the young has overtaken the wage rate of the old with the same level of skills, and the labour participation of the formerly young is set equal to the labour participation of the old in the first period i.e. $(l_{t_0}^{gj} / n_{t_0}^{gj})$. Hence, we assume that the wage rates for equal combinations of skills/age are constant. On the other hand, the method picks up effects from higher average levels of education among the young. The method also takes into account demographic changes and labour market participation.

45. Including a student population $n_{t_0}^{c}$ and additional time period, would give the following changes to equation (5):

$$HK_{t_0} = \sum_j w_{t_0}^{uj} l_{t_0}^{uj} + \sum_j w_{t_0}^{gj} l_{t_0}^{gj} + \theta \sum_j w_{t_0}^{gj} n_{t_0}^{uj} (l_{t_0}^{gj} / n_{t_0}^{gj}) + \theta \sum_j \phi_j w_{t_0}^{uj} n_{t_0}^{c} (l_{t_0}^{uj} / n_{t_0}^{uj}) + \theta^2 \sum_j \phi_j w_{t_0}^{gj} n_{t_0}^{c} (l_{t_0}^{gj} / n_{t_0}^{gj})$$

where ϕ_j is the probability that a student in year t_0 obtains education of type j. The two last terms above are the expected incomes from the student population. In the simple example we assume that all people go through three stages; student, young workers and old workers. Hence, in the last period, only the students work. The probabilities ϕ_j will have to be estimated separately.

46. At Statistics Norway we have a model that can be used to calculate human capital by the above-mentioned procedure. The model is however hard to update due to a very high complexity, and are currently based on the population of 1993. There has also been proposed a project in the National Accounts department of constructing a database that can be updated more easily.

Using the current NA to derive an alterative measure of the human capital

47. Currently, in NA there are many measures of labour effort, and among these we have; hours worked by employees, and hours worked in total by both employees and self-employed. Moreover, NA covers total wages paid to wage earners.

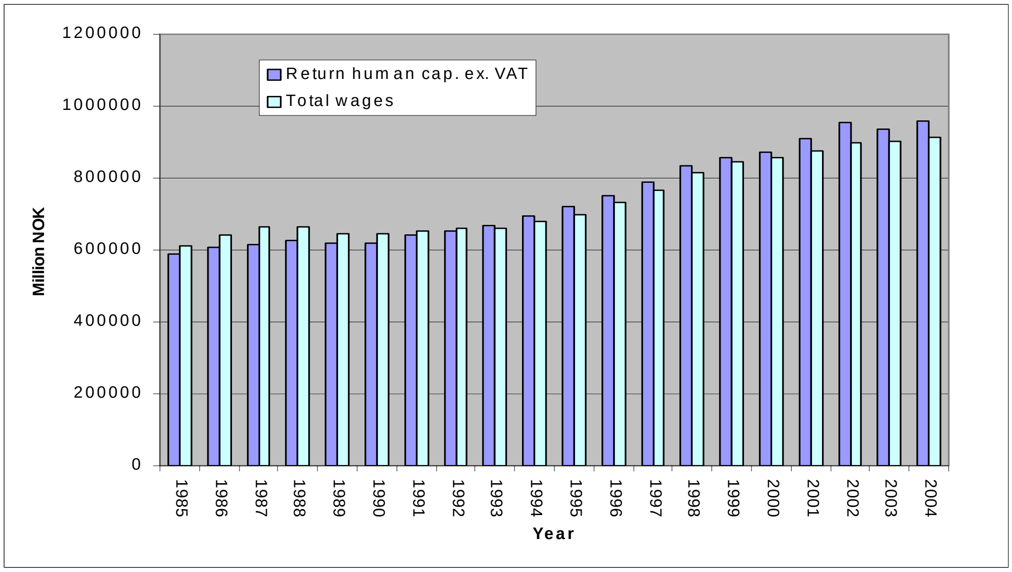
48. From hours worked by employees in the non natural resource sectors and total wages paid to wage earners in the same sectors, we obtain an average wage rate for the country as a whole. Assuming that self-employed could obtain this average wage in the labour market, we can calculate total value of work effort as total hours worked in Norway as a whole times the average wage calculated as just described. This figure should coincide with the sum of raw labour and human capital.

49. Why do we include both hours worked by employees and hours worked by self-engaged? Firstly, some categories of self-engaged are not obliged to salary, but they do the same task as normal employees. Secondly, persons owning all shares in their firm often prefer to get their wage as dividends, and not as salary due to the tax system. This will tend to show up as fewer hours worked as employees.

50. When calculating the average wage, why do we not look at Norway as a whole, but only on the non natural resource sectors? Due to the high resource rents in some of the natural resource sectors workers may have been able to negotiate a higher wage rate that in the non natural resource sectors. By just look at the latter, we avoid this potential problem.

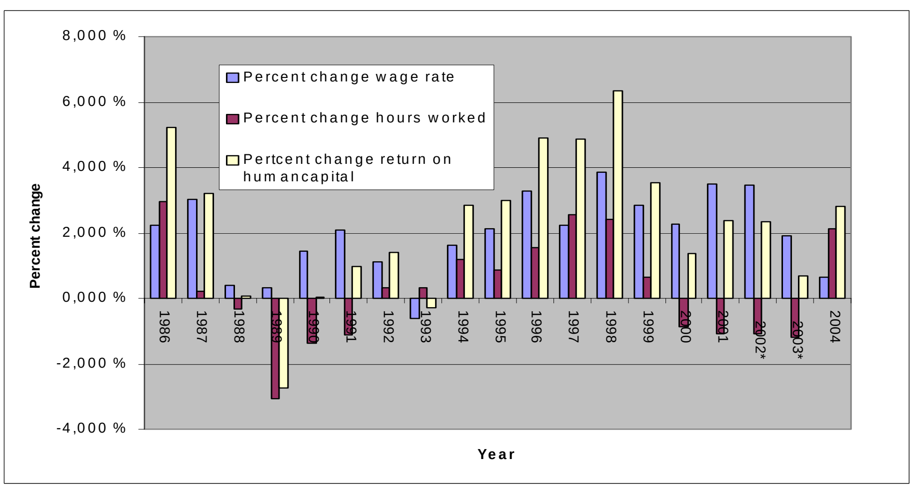
51. In the figure below we compare the human capital residual exclusive the value added tax with the calculated market value of all work effort.

Figure 4: Comparing two ways of calculating human capital



52. Note that the two measures follow each other closely, and in particular that they both increase sharply from 1994 and onwards. On the other hand, we have not explained why the human capital component increases in value. Of course we can decompose, the changes in the human capital component into a quantity and a price effect.

Figure 5: Changes in wage rates and number of hours worked

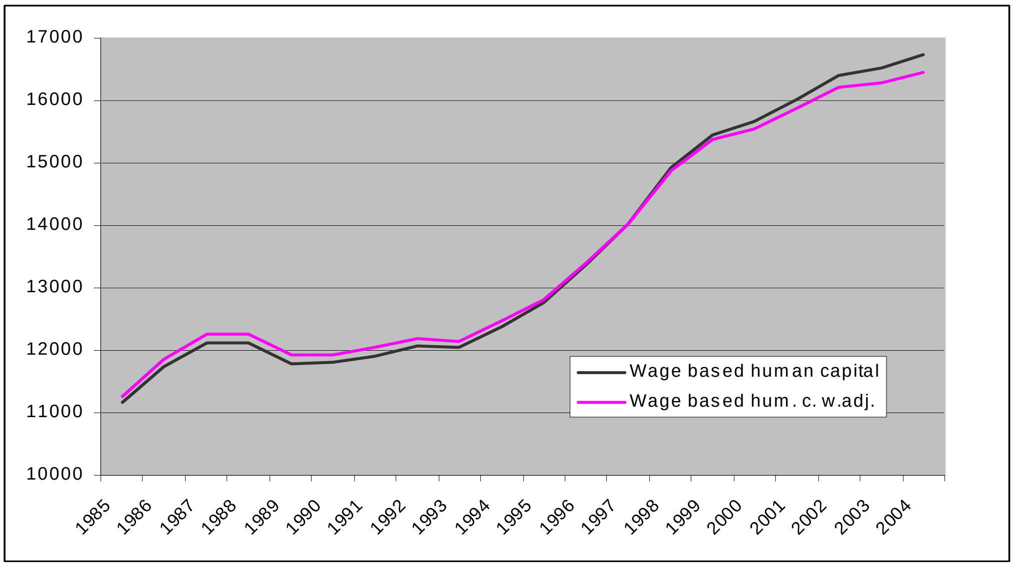


53. Note that the human capital component declined in 1989 and in 1993. Further that, the first decline was caused by a major decline in number of hours worked, and that a minor drop in the wage rate caused the second decline.

54. The total number of hours worked and the wage rate in a particular year do not however tell us much about how income from the human capital component is going to develop. In order

to get better predictions of future income, we suggest decomposing current income from the human capital component even further. One first attempt in this direction is to leave the assumption that the rate of return on human capital can be kept forever (e.g. see equation (3)), and to look at the average remaining work years of the current workforce. In Norway this figure has experienced a slight decline in the period 1986 to 2004. However, the decline is very small so that the effect of a shorter remaining return from the current human capital stock is small as well.

Figure 6 "Age adjusted human capital"



55. In Figure 6 we have calculated the human capital component based on the wage rates and the total number of hours worked. In addition we have adjusted the light curve for the average remaining work years of the current work force in each year. In order to compare the dark curve just assumes a fixed number of years remaining in the work force, which is equal to the average for the period as a whole. In the beginning of the period the average age of the workforce was declining, while at the end of the period, it increased. The effects of this are easily seen from the diagram. However, we have not taken into account that the number of hours worked per year may also depend on both the total number of people in the workforce and the age composition of the workforce. In order to include such effects we would need a more detailed decomposition of the workforce.

CONCLUSION

56. One of the strengths of the genuine savings indicator is that it does not depend on predictions of future prices. That is, changes in natural resource wealth, in physical capital and in human capital are all measured by the current prices only. Tracking changes in the human capital component by the output-based approach implies that one makes predictions about future prices. That is, the valuation is based on the assumption that younger people will in the future receive the same wages as the currently living elder people with the same characteristics. Thus with respect to the genuine savings indicator, basing the calculation of changes in the human capital component on the output-based approach would imply a break up with an important principle.

57. The genuine savings indicator is based on Hartwick's rule. Many researchers has questioned the appropriateness of Hartwick's rule for small open economies, see e.g. Svensson (1986). This suggests continuing to track the development in national wealth. National wealth calculations are all based on predictions about the future. Further, there clearly exist methods that could improve the measurement of human capital component of national wealth. The methods will in many instances require new databases to be constructed. We however propose that such databases are established, and that in the future the valuation of the human capital component is based on lifetime incomes of the current workforce population.

58. There is also ways to improve the input based valuation of human capital. For instance, one can treat forgone income by students as an investment, and leaves from the labour force as disinvestments e.g. due to retirement. Again we would need to construct a database tracking the number of students, time spent for study etc. All the same, this seems worth evaluating when applying the genuine savings indicator.

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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 all product specific taxes and subsidies be added/subtracted from the gross incomes. 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. We assume that a value added tax; t, is only levied on the traditional sector X.

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

(1) $NNI = ((1+t)x - v_x) + (y - v_y) + (z - v_z) - D_x - D_y - D_z + I$

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:

(2) $NNI = (y - v_y - rK_y - w_x h_y - D_y) + (z - v_z - rK_z - w_x h_z - D_z) + w_x (h_x + h_y + h_z) + r(K_x + K_y + K_z) + I + tx,$

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:

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

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)' $NNI = (y - v_y) + (z - v_z) - D_y - D_z + A_x + rK_x + I + tx$

By comparing (1) and (2)', we note that the decomposing is only correct as long as: $A_x + rK_x = (x - v_x) - D_x$. 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)" $A_{tot} = NNI - (y - v_y - rK_y - A_y - D_y) - (z - v_z - rK_z - A_z - D_z) - r(K_x + K_y + K_z) - I,$

where $A_{tot} = w_x (h_x + h_y + h_z) + tx$. That is, value added tax is included in the human capital component. Further, NW in any given year t can then be written:

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

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} (= $K_x + K_y + K_z$) 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:

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

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.