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On Natural Resource Rent and the Wealth of a Nation

A Study Based on National Accounts in Norway 1930-95

Abstract:
National wealth can be divided into real capital, financial capital, human capital and natural resource wealth. We use the National Accounts measures to illustrate the development of the wealth from 1930 to 1995, with special focus on the contribution from the natural resources. Norway is often described as an economy that is very dependent on its natural resources. However, apart from the petroleum sector, the resource rent for the natural resource sectors was generally small or negative over this period. This may indicate that these industries to a large degree fulfilled political goals as stimulating employment possibilities in sparsely populated areas. The contribution from the traditional natural resources to the national wealth declined somewhat over the period. Norway seems to have been just as dependent on these traditional natural resources in the 1930s as we were on the natural resource industries in the nineties, when we in addition extracted oil and gas. This may be somewhat surprising, as a common apprehension is that Norway becoming an oil producer to a large extent increased the importance of the natural resources in the economy. The most important economic resource throughout the period was a highly qualified labour force, varying from 60 to 80 percent of the total national wealth in most years. In years with strong technological progress human capital reached over 80 percent of the total wealth, as development in know-how and technology ascribes to this category of wealth.

Keywords: Human capital, National Accounts, national wealth, resource rent

JEL classification: E20, N00, O10, Q00

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1. Introduction

Norway is often described as an economy that is very dependent on its natural resources. The picture of a natural resource based nation has been strengthened after the discovery of large oil and gas resources on the continental shelf in the 1970s. In this study we discuss whether such a description is valid, measuring the contribution from the natural resource industries to total national wealth from 1930 to 1995. We also discuss to what extent the growing-up of the petroleum sector has made Norway more dependent on the natural resources in general.

Our analysis covers a period that is often described as a transitory period with a growing industrial sector and a further development into the post-industrial society. Although Norway still may be described as a resource-based economy in terms of revenue (as we shall see later), the natural resource sector's importance for employment has declined substantially over the years. The labour force in these industries has been reduced from around 40 % of total employment in 1930 to 7 % in 1995. Of the total loss of man-years in the natural resource based industries eight out of ten were from agriculture. The relative amount of labour in manufacturing industries over the period 1930 to the early 1970s increased from around 23 % in 1930 to 34 %, before it was reduced to somewhat under 20 % in the nineties. The service sector has nearly doubled its labour force share, from around 37 % of total man-years in 1930 to nearly 74 % in 1995. Hence, the reduction in employment in the natural resource industries has been absorbed by services sectors like trade, transport and other private and government services. This change into the post-industrial society is found in most high-income countries, and is above all due to industrial differences in productivity growth and to different income elasticities on the demand side (see, e.g., Hodne and Grytten, 1992).

In the light of this change into the post-industrial society we will also discuss how the contribution from real capital and human capital to total wealth has changed over the years. Has human capital become relatively more important, or is real capital more significant than 60-70 years ago? We will also estimate the contribution from the technological progress in the total economy in each year, and discuss how this change in total factor productivity affects our estimates of human and real capital.

The National Accounts (NA) generally includes only estimates of real capital (infrastructure, buildings, machinery, transport equipment, dwellings) and financial capital (claims or debt abroad). In this study we use NA measures to estimate the wealth of human capital (raw labour, health status, technology, know-how) and natural resource capital (fish, forest, land in agriculture, water in electricity generation, minerals in mining and petroleum). In line with the NA we interpret national

wealth in a somewhat restrictive manner, as we do not include the status of the environment.[1] This means that we disregard pollution, the value of untouched nature, biological diversity, aesthetic experiences of nature as such etc.

Statistics Norway (1993) describes a method for, and presents estimates for the different components of the national wealth for the single year 1992. In our analysis we employ the same method to estimate the development of the different categories of wealth from 1930 to 1995, excluding the years of Second World War due to lack of data. To our knowledge we are the first to derive an annual time series for these components of the national wealth solely based on NA measures. The World Bank (1995) takes a somewhat different approach and makes use of other data sources besides NA, presenting 1994-estimates of the components of wealth for different regions of the world. Other attempts to measure national wealth often do not impute a value to human wealth.[2] Jorgenson and Fraumeni (1989) estimate total wealth in the U.S. from 1948 to 1984 and include the value of non-market activities such as household production and leisure time in their calculations of human wealth. We will compare the results of both The World Bank and Jorgenson and Fraumeni with our findings.

Our way of expressing the components of national wealth in quantitative terms in each year of estimation is based on a simple prolongation of disposable national income (DNI) and resource rent into the future, applying fixed rates of interest and an estimated technological growth. We discuss how the assumption of a constant resource rent into the future fits with our empirical findings of the time-path of the resource rent for different industries. It may be possible to modify and supplement our results with more realistic estimates from other sources than the NA, but this is beyond the scope of this paper. Our study is thus more an illustration of a method, than an attempt to try to grasp all aspects of national wealth formation.

Since our estimates are based on the NA, however, this will give us the actual income from the resource given the present management of the resource, and not an optimal or potential income. With a sound management a natural resource should give rise to a positive resource rent. According to the World Bank (1995) growth of a country is connected to, among other factors, the use of the rents from the natural resource base in the building of produced assets and human capital. But as poor management can lead to a small or negative resource rent, it can also be the result of deliberate political decisions. As will be clear in the following, most natural resource industries in Norway have

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[1] The System of National Accounts from 1993 included *satellite accounts* of the depletion of natural resources and selected environmental indicators.

[2] See, e.g., estimates for USA in National Bureau of Economic Research (1964) and estimates for Sweden in Ministry of Finance (1992) although the latter refers to our method.

been important in establishing activity in parts of the country with few alternative employment possibilities.

The structure of this paper is as follows. In section 2 we describe the data and basic concepts. In section 3 we present the development of the natural resource rent. Section 4 discusses the development of the different components of national wealth and we conclude in section 5.

2. Data and basic concepts

The System of National Accounts (SNA) has been revised several times and the alternative versions of the SNA differ in definitions and classification. In addition, main revisions normally introduce new methods of estimation based on new statistics and better utilisation of the many important primary statistical sources behind the NA estimation.

The first long-term series of NA in Norway was based on a national standard and covered the period 1865-1960 (Statistics Norway, 1965b). Figures for different industries were possible to trace back to 1930, and hence the first period in our study covers 1930-60. After the publication of "A System of National Accounts" (United Nations, 1968), Norway adopted the new international recommendations. Statistics Norway (1981) presented revised figures back to 1949. We employ figures based on SNA (1968) for the period 1950-83. Hence, we estimate two parallel time-series for the period 1950-60, one based on the old national standard and one based on the SNA (1968). The next major revision was called SNA (1993) (see Commission for the European Communities et al, 1993). Based on this new revision we employ figures covering the period 1978-95 (Statistics Norway, 1998). Consequently, we also get two parallel time series for the years 1978-83; one based on SNA (1968) and the other on SNA (1993). We comment on major consequences for our estimates of the different revisions in the Appendix. [3]

How precise the NA is depends on the quality of primary statistics and the compilation methods. Because of lack of primary statistics or bad quality in certain areas, the NA may include several poorly estimated figures. But it seems reasonable to assume that the figures get more accurate with each new revision. In our study some figures are calculated further from the NA due to lack of data, which is explained in the Appendix.

When we calculate the national wealth our starting point is Net National Income (NNI). Gross national income measures the value of total output in the economy during the year. Deducting the depreciation

[3] We also use Statistics Norway (1968, 1971, 1979, 1982, 1986, 1995) to get complete time-series for certain variables.

of existing capital during the period results in NNI. Including net interest and transfers from abroad we arrive at the Disposable National Income (DNI). DNI measures the value of all the goods disposable for the nation's inhabitants.

We calculate *total national wealth* as the present value of the future disposable national income (*DNI*). Let DNI_s for $s = t, t+1, \ldots$ be the disposable national income in each year, assuming constant future income so that $DNI_t = DNI_s$. We apply two alternative discount rates of 4 and 7 %, and an estimated rate of technical progress in each year in the economy that is not ascribed to increased volume of real capital or man-years (often called total factor productivity or the Solow residual). Let a_t be technological rate of growth in year t and we assume $a_s = a_t$ so that future technological progress equals the growth in each year of estimation. We then measure national wealth (W_t) at time t as[4]:

$$(1)\ W_t = \sum_{s=t}^{\infty} DNI_s \cdot \frac{(1+a_s)^{s-t}}{(1+r)^{s-t}},$$

where r is the discount rate.

Real capital consists of fixed capital and inventories. Fixed capital further comprises both tangible fixed assets (as dwellings, other buildings and structures, machinery and equipment), cultivated assets (like livestock and fruit-trees) and intangible fixed assets (like petroleum exploration and computer software). Only inventories and valuables that are used repeatedly in production count as fixed assets. Only assets that are produced count as real capital and hence natural assets (land, petroleum resources, forest[5]) are not included. The principles of valuation of livestock differ from those used for other types of real capital. The estimation of this item (in addition to land and forest) is based on assumed market prices instead of reduced replacement costs. As inventories are not distributed across industries (except livestock and fruit-trees), we use the term fixed capital in industries.

Natural resource wealth is usually defined as the present discounted value of all future resource rents. Let μ_s for $s = t, t+1, \ldots$ be the resource rent in each year, assuming constant future rent so that $\mu_s = \mu_t$. With a constant discount rate and disregarding technological growth, we measure the natural resource wealth at time t as:

[4] We use the old national standard from 1930 to 1960, 1961-77 is based on SNA (1968) and 1978-95 follows the SNA (1993). In this way we get two long time-series, each based on its own standard.

[5] This is not in line with SNA (1993), but is reasonable for our purpose as we measure the income in forestry as the value of roundwood cut.

$$(2)\ W_t^{resource} = \sum_{s=t}^{\infty} \mu_s \cdot \frac{1}{(1+r)^{s-t}}$$

The resource rent is the part of the income from the resource extraction that remains after all costs including a normal return on capital have been deducted. The resource rent is described in the literature as stemming from the fact that there is only a limited amount of the resource, the resource is of a special quality or it has few owners. To estimate resource wealth we simply assume that the resource rent in the year of calculation is maintained indefinitely, as in Lurås (1994). In a way we presuppose constant prices for raw materials on the world market, constant costs and extraction rates. For the petroleum sector, we have independent wealth measures as we apply the authorities' estimation of wealth based on their assumptions of future extraction, costs and prices and a 7 % discount rent. We ignore technological progress for the total economy in (2), as we do not ascribe this growth to the natural resource in a specific industry, but to the human capital, as will be clear later. Besides, one of our objectives is to separate the contribution from real capital, financial capital, human capital and the natural resources to total wealth.

We estimate the *resource rent* for the natural resource based industries as:

	Factor income
+	Indirect industry taxes
-	Industry subsidies
=	Industry Net Product (INP)
-	Normal return on fixed capital
-	Compensation of employees
=	Resource rent

The factor income is the value added in the industry less capital consumption, and equals the income in the industry after all costs except wage and capital costs have been deducted. Adding indirect industry taxes (i.e., taxes that are not levied on all goods and services) and deducting subsidies, gives the Industry Net Product (INP). The INP tells us the earning of the industry's factors of production, labour and capital. We disregard general taxes, because these are also levied in alternative use[6]. We also only deduct subsidies related to sector from the factor income, and not subsidies on products, partly due to data limitations.

[6] We disregard general product taxes like VAT and investment levy, which both were introduced in 1970 (and the general purchase tax which existed 1967-69).

Labour cost in the NA is equal to the firms' payment in compensation for the employees. We introduce the concept of Industry Compensation of Employees (ICE), defined as wages and employers' social contributions. Wages are both in cash and in kind. We include an estimated wage for self-employed, as this is not included in the labour costs statistics. In each industry we simply use the average compensation of an employee as a measure for the labour cost of a self-employed in the same industry. The number of self-employed is significant in agriculture and fishery, and to a somewhat lesser extent in forestry. In agriculture we include self-employed man-years from family members. We also estimate an alternative compensation of employees (ACE) based on a weighted average of the different ICE in the resource-based industries, using the total number of man-years in each industry as weights. This measure is meant to reflect the value of the labour force in alternative use. Because of a much higher ICE in the petroleum industry, we exclude this sector from the ACE.

Calculating the resource rent we must also deduct from the INP the part of the income obtained from investment. We deduct the return that the investment would have produced in another sector, i.e. normal return on capital. To illustrate the importance of different rates of return, we use a discount rate of both 4 % and 7 %.[7] When we have deducted from the INP a normal rate of return on capital and the compensation of employees, we get the resource rent.

When we have estimated total national wealth, resource wealth, financial wealth and real capital, *human wealth* is defined as the residual value. This is total wealth less the value of real capital, financial capital and the natural resources.

We value all goods at constant prices as an attempt to measure the volume changes in output. We deflate all figures with the price index of the national product. The activity classification in the different industries refers to aggregates that are used in the Standard Industrial Classification (Statistics Norway, 1998).

3. Natural resource rent

It is common to divide natural resources into non-renewable, conditionally renewable and permanent resources. We start with the permanent resources like *land* in agriculture and *water* in electricity

[7] Lorentsen, Kartevoll and Strøm (1980) estimated the average return in Norwegian manufacturing to 7 %. A discount rate of 4 % is in keeping with the risk-free rent Long-term Program (Ministry of Finance, 1997) and this rate was also used in World Bank (1995, 1997). Ministry of Finance (1998) suggests a risk-free rent of 3.5 % for the public sector and a mark-up according to the risk-group of the project, making the discount rate vary from 4 % for projects with low risk to 8 % for projects with high risk.

supply, where the stock of the resource is independent of the management (for land this only applies to a certain extent). Then we study *forest* and *fish*, which are biological and conditionally renewable resources. The stock is renewed continuously, but will be affected by the management. The extraction rate of these resources cannot exceed the growth rate over a longer period without exhausting the resource. At last we study the non-renewable minerals, i.e. the *mining* and *petroleum* sector. When we extract these resources, future production possibilities will be reduced correspondingly. In line with the NA we only include resources that are sold on a market and, hence, services from the resources that are not commercial in a private or public way are not included.

In the classical theory of economic rent according to Ricardo (see, e.g., Sraffa and Dobb, 1951-73), increased demand for agricultural products results in a situation where also less productive agricultural area is taken into use. Those farmers who possess the early cultivated and more productive area will receive a higher than normal profit. Differences in marginal extraction costs are the explanation for the economic rent. Hotelling (1931) developed a similar concept for non-renewable resources. His starting point was scarcity and not differences in marginal extraction costs. A more than normal return stems from the fact that by extracting these resources today, the available resources for later extraction are reduced. This part of the resource rent is often labelled Hotelling rent. But one cannot link our estimated resource rent directly to the existence of scarcity or differences in extraction costs. Firstly, the size of the rent varies from year to year because of changes in economic cycles. Secondly, part of the rent can be the result of market power, domestically or on export markets, and therefore a monopoly profit is received.

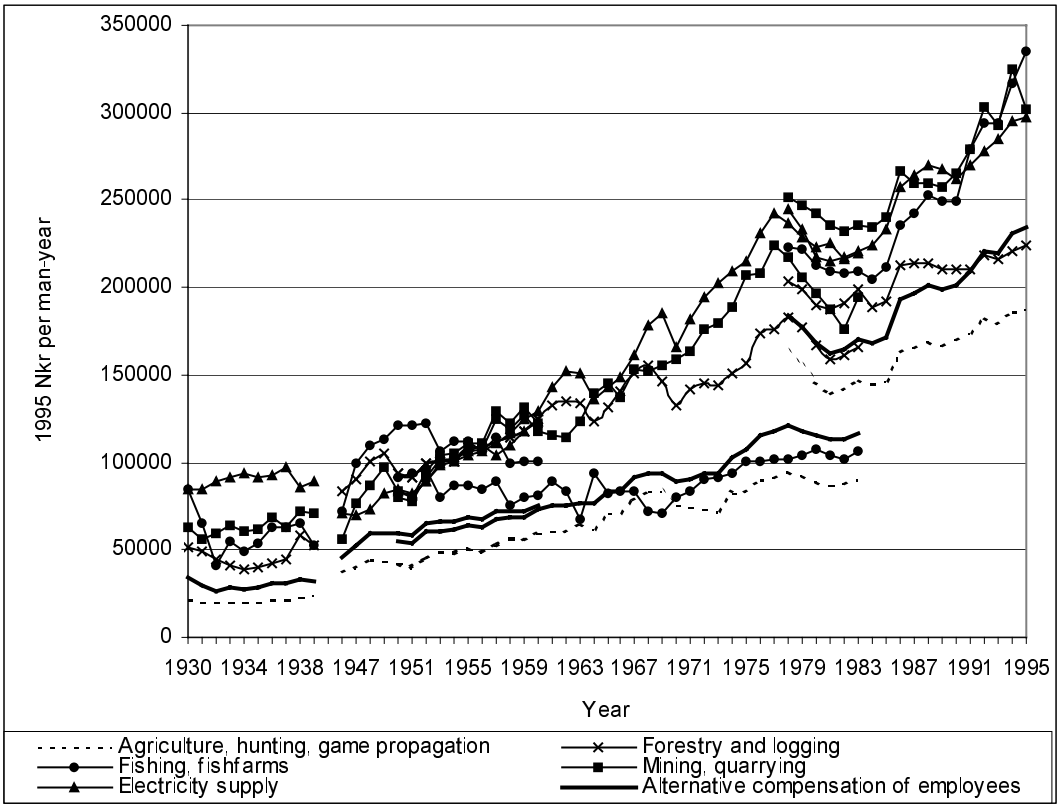
Can anything generally be said about the size and the time-path of the resource rent for the different industries? With a sound management of the conditionally renewable resources, they may give rise to a continual and positive resource rent as the permanent resources can. The resource owner has to take into account the natural rate of replenishment when he chooses the rate of harvest. According to the principle of "maximum sustainable yield" any renewable resource stock should be maintained at a certain level, at which its exploitable productivity is at a maximum. This principle is complicated by the fact that many resources have different uses and users, imperfection of ownership rights, stochastic replenishment and a variety of externalities.

Farzin (1992) comments on other studies on non-renewable resources that either find monotonically rising or declining resource rents as the stock nears exhaustion. Farzin includes variable unit costs and technological progress in extraction, and shows that the development of the resource rent is undecided; it can either rise or fall and generally it is non-monotonic along an optimal extraction path.

3.1. Industry Compensation of Employees

Figure 1 shows the ICE for different industries and the ACE in 1995-Nkr per man-year[8]. The lowest ICE per man-year is clearly in agriculture, while in the other end of the scale we find electricity supply and mining (as well as fishery in some periods). The growth rate in the ICE varies from 2 % per year in electricity supply to 3.4 % in agriculture, when we use the average growth-rate over the whole period covering different data sets. The ICE-level in electricity supply was four times higher than in agriculture in the thirties, but in the 1980s and 1990s the difference was only 50-60 %.

Figure 1. Compensation of employees per man-year in different industries



Around 80 % and 60 % of the total labour force in the resource-based industries worked in agriculture in 1930 and 1995, respectively. At the same time employment in the resource-based industries dropped. As the majority has been working in agriculture, we see from figure 1 that the ACE is relatively close to the ICE per man-year in this sector. This leads to slightly higher labour costs in agriculture if we use the ACE instead of this sector's ICE. The other industries' ICE is higher than the ACE for most years.

[8] Man-years are estimated as full-time equivalent persons and include part-time employed recalculated to a full-time equivalent basis.

The ACE rises from about 33 000 Nkr in 1930 to 235 000 Nkr in 1995, an increase of around 600 %. This amounts to a growth rate of 3.1 % per year. The reason for the negative growth in the ACE from the mid-seventies was higher energy prices and inflation that lead to a negative development in the real value of wages.

The revision of the SNA in 1993 resulted in an increase in the ACE in the range of 42-53 % between 1978 and 1983. The highest increase in the ICE was in fishery with 97-120 % and in agriculture with 63-73 %. In forestry and mining the increase in ICE was between 10-30 %, while in electricity supply there were only minor changes. The reason for this upward adjustment seems to be new methods of estimation based on new statistics, and not changes in definitions (Fløttum, 1996). This coincides with the official goal from the late seventies that the income of a farmer should be equal to the industrial worker. This may also have had consequences for the income in other natural resource-based sectors, above all in fishery.

Is it reasonable to measure the alternative cost of labour in different industries and different periods with the ACE? For example, in a situation with few alternative employment possibilities, the alternative cost will clearly be lower than the ACE. Especially in the interwar years there was a stagnating demand for labour from other industries. But as we have told the natural resource industries lost over 80 % of its man-years from 1930 to 1995, so clearly there have been alternative employment possibilities. We also choose to employ the ACE because it is a simple and coherent measure that is identical for all resource industries over time. The *hourly* earnings in manufacturing are somewhat higher than in agriculture throughout most of the period, according to different statistical sources.[9] Hence, the ACE per man-year seems to some extent to coincide with the ICE in manufacturing.

In addition, because of problems with working a full man-year in one industry, it is and has been customary to combine working in different industries, above all in agriculture and fishing, and agriculture and forestry. This supports the use of a combined measure over different industries, keeping the petroleum sector apart due to its extraordinary high compensation of employees.[10] We will to some extent discuss how sensitive the resource rent is to whether we employ the ICE instead of the ACE.

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[9] However, according to these sources (Statistics Norway, 1955, Statistics Norway, 1965a and Statistics Norway, 1998) the hourly earnings in agriculture and manufacturing are not directly comparable between, due to definitional reasons.

[10] The ICE is not a measure of the purchasing power of a worker in the particular industries. If we were to measure the cost of living, the correct deflator might be an index of these costs. The cost of living is probably lower in rural than in urban areas. This should lead to an upward adjustment of the income in industries outside the cities. From the point of view of an employer we should use some sort of index for the prices of inputs. Another question is whether the average compensation for an employee is the correct measure for the alternative cost of a self-employed (e.g. in fishery and agriculture). There can be other motives for being self-employed like control over one's working day instead of a high income.

In the following the alternative compensation of employees (ACE) in an industry is the alternative compensation per man-year times total man-years.

3.2. Agriculture, hunting and game propagation

The resource rent for agriculture refers to the agricultural area, including outlying meadows. Topography, soil and climate set narrow limits on agricultural production in Norway. Of the total area a little more than 3 % is agricultural area in use. This area is as large in the nineties as in 1930 (Statistics Norway, 1998), and this makes it more plausible to estimate the resource wealth as the present value of an infinite stream of resource rents. Two-thirds of the income in the agricultural sector comes from livestock products where milk is more important than meat. The rest comes from crops, where grain is most important. Since the 1930s livestock products have become slightly less important, while grain has increased its share of total income (Statistics Norway, 1995). Grain production is concentrated in the most suitable districts. The production of milk has been concentrated in the mountains, hills, fjords and coastal areas.

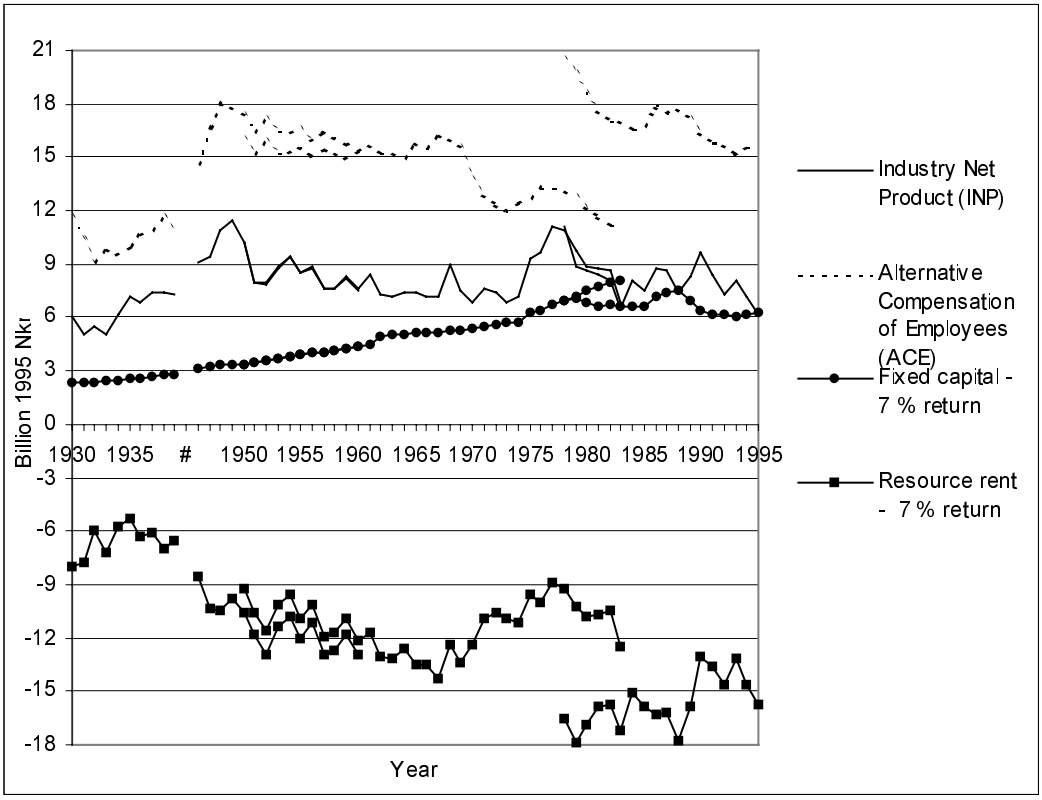
Norwegian agriculture is a protected industry like in most industrialised countries today. The political authorities have decided out of regional employment aims that the industry shall be more comprehensive than it would have been without protection, and that the farmer shall have a higher income than generated from a free competitive market. In addition to import protection, the sales of agricultural goods are regulated so that the realised producer prices are above what they would have been with perfect competition (Munthe, 1988). Moreover, various subsidies secure transfers from the taxpayers to the farmers.

Problems with over-production (and debt) in the 1930s hit all the countries in Western Europe and led to protectionist measures in most countries in our part of the world (Tracey, 1964). The interwar years saw the breakthrough of nation-wide agricultural co-operatives controlling the sale of agricultural products (particularly first-hand sales), while the system of individual producers was maintained. A major task was to adjust production to domestic demand at the politically decided price-level. After World War II the government played a more leading role and agricultural products were subsidised directly over the state budget in order to keep the consumer price index below a certain ceiling. The price subsidies were mainly introduced for consumer purposes, but gradually subsidies became crucial for the realisation of income equality between agricultural producers and industrial workers (Bergh et al, 1981).

Figure 2 shows that the INP in agriculture varied between 5 and 11 billion 1995 Nkr. The INP increased somewhat from the thirties to the post-war years. After 1950 it has stayed fairly constant,

except for a period with a somewhat larger INP during the seventies. Since 1930 there have been large increases in agricultural yield and livestock products (and big game falled, as hunting is a part of the agricultural sector). Even if the income has increased, the INP has stayed relatively stable over the 65-year long period. The main reason is that agriculture became a strongly subsidised industry. The net subsidies (sector subsidies less taxes) increased from 3 % of the INP in 1930 to about 40 % in 1960. Between 1960 and 1990 the net subsidies were 50-70 % and in 1995 it reached an all-time high of 123 %.

Figure 2. Agriculture, hunting and game propagation: The composition of resource rent with 7 % return



The volume of fixed capital in agriculture increased by 168 % from 1930 to 1995. This equals an increase of 1.5 % per year in the volume and therefore in the return on fixed capital. There has been a tremendous increase in the use of tractors and other farm machinery, commercial fertilisers, concentrated feed etc. The volume stayed fairly constant during the last 20 years[11].

[11] The reduction in the return on fixed capital in the period 1988-90 is related to a reduction in gross fixed capital formation. This downward trend is found in all industries, except for the petroleum industry where the volume of fixed capital stayed fairly constant during this period. There was a credit-financed boom in the mid-eighties, but afterwards the real interest rates started to increase and the flow of credit contracted.

In 1930 there were 337 000 man-years in agriculture, both self-employed and employees. The number of man-years declined to 66 700 in 1995, which is a reduction of 80 %. This entails a reduction of 2.5 % per year and as a consequence there was fourteen times more capital behind each man-year in 1995 compared to 1930. In line with this development the number of farms has decreased, while the farms have become larger and more specialised, although they still are fairly small.

The reduction in employment started after the Second World War, which is reflected in figure 2 as a stabilisation and later reduction in ACE until the late 1970s. After 1945 agriculture served as a supplier of labour to the secondary and tertiary sectors. The reasons for this development were a strong growth in productivity as well as a limited increase in demand for agricultural products (due to a slow growth in population and inelastic demand for most agricultural goods). The revision of the SNA in 1993 lead to an upward shift in the ACE in agriculture, and was a consequence of the higher compensation per man-year as shown in figure 1, and actually a slightly higher number of man-years around 1980.

There was an increasing absolute compensation for fixed capital over the period, due to the growing amount of real capital. But we see from figure 2 that the ACE is much higher, and actually higher than the INP over all years. The resource rent varied between -5 and -8 billion Nkr in the thirties and it decreased to a level in the range of –13 to –18 billion in the 1990s. The strong development towards a highly capital-intensive industry did not lead to a normal return on the production factors. Hence, agriculture has not contributed to the national wealth as measured by the resource rent. In line with the political goals the primary contribution from agriculture seems to have been to try to maintain the settlements in sparsely populated areas through employment possibilities, in spite of the great loss of labour from the industry. Another important task for the various governments has been to maintain the size of agricultural production and a relatively high degree of self-sufficiency (Ministry of Agriculture, 1999).

3.3. Electricity supply

A shortage of hydropower projects and differences in costs for developing and operating hydroelectric power stations indicate a potential for resource rent, unless there exists alternative cheap technology for producing electricity. Norway has been Europe's largest producer of hydroelectric power from 1930 to 1995. Already before World War I Norway acquired considerable economic advantage from hydro-electricity since it had much larger and cheaper waterpower potential than any other European country. The establishment of power-intensive large-scale manufacturing industries followed the development of hydroelectric power plants. At that time the cost of transporting electricity over longer distances was very high, accordingly a number of new industrial town-ships grew up in the vicinity of

large waterfalls. These industries were primarily pulp and paper, electrometallurgical (electrolytic melting of metals like aluminium, nickel, zinc, iron and ferro-alloys) and electrochemical (saltpetre, calsiumcarbide etc.). The result was a strong increase in the export of semi-processed industrial goods. These industries often obtained long-term contracts for purchase of electricity at politically decided and low prices as well as licences to operate power plants on their own. While around 65 % of the production went to these power-intensive industries (including pulp and paper) in the thirties, it decreased to 30 % in 1995. Private household consumption (including agriculture) increased from around 20 % to 35 % in the same period.

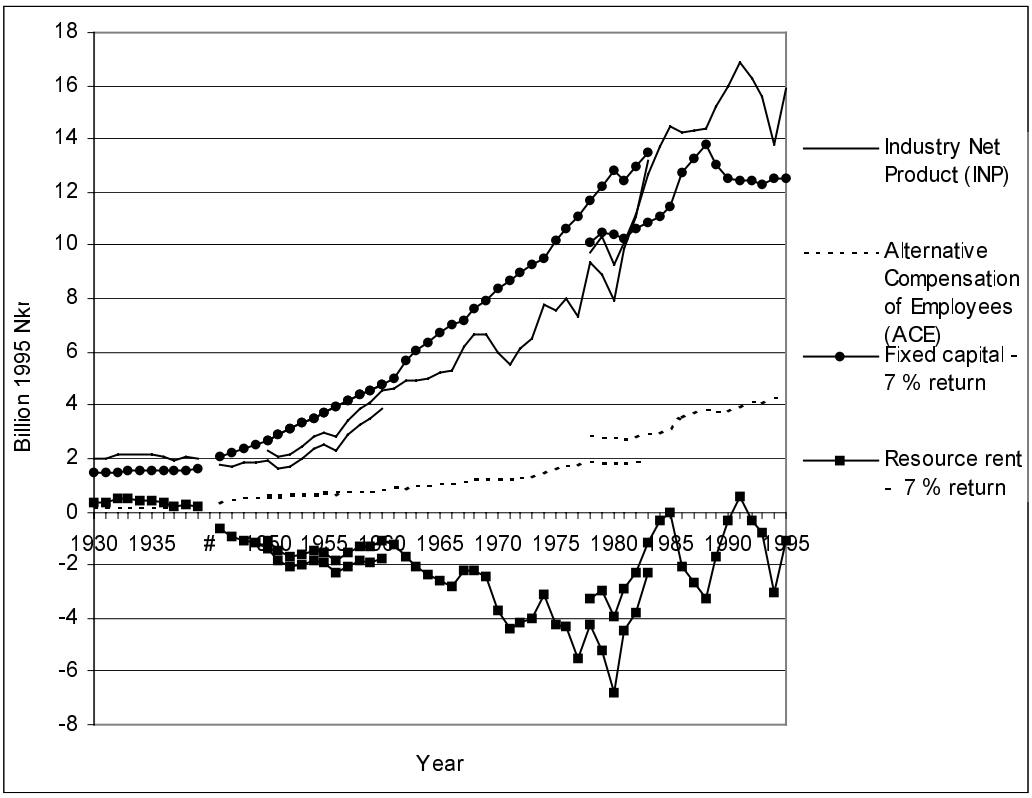
Hydroelectric power production increased from a level of about 10 TWh during the period 1930-47, to about 20 TWh in 1954. A second doubling took place during the next ten years. By the end of the 1970s power production reached a level of 80 TWh. In 1995 production reached 123 TWh and at that time around 60 % of Norway's total hydropower potential was developed and 20 % was permanently protected (Statistics Norway, 1996).

Electricity supply has generally been a growing sector measured with INP, fixed capital and ACE since the Second World War as shown in figure 3. Precipitation and inflow to the reservoirs also cause variation in production. Since 1930 the INP has grown with 3.3 % per year. The volume of fixed capital actually increased slightly more, i.e. with 3.4 % per year. The ACE was 20 times higher in 1995 than in 1930, not only as a result of a higher compensation per man-year but also because the number of man-years increased from 6 000 to 18 900. Net subsidies fluctuated between 5 and 10 % in the post-war years, but after 1955 the net subsidies have been negative.

In the pre-war period the resource rent was slightly positive, when the stock of capital and, hence, compensation of capital was low. From the Second World War the resource rent fell from around -1 billion Nkr to -6 billion in 1980, as the volume of capital increased more than the INP, possibly due to increasing long-term marginal costs of water-power projects. Starting in the eighties the resource rent increased somewhat to a level between 0 and -3 billion Nkr, because of a faster increase in INP than in labour and capital costs. This increase in income was probably related to the decision to escalate the prices for regular supply to a level where they reflected the long-term marginal costs for new waterpower projects (Ministry of Finance, 1979).

With a more optimal pricing for delivery to the power-intensive industries the resource rent would have been higher. Hence, we may say that part of the resource rent went to these industries. In addition there are substantial differences in production costs between power plants, and for those with low costs and low prices we may say that part of the resource rent went to the consumer.

Figure 3. Electricity supply: the composition of resource rent with 7 % return



We conclude that the income in electricity supply has not been sufficient to cover operating costs, compensation for labour and a 7 % return on capital. Because electricity supply is a highly capital-intensive industry, a 4 % return leads to a positive resource rent for most years. Various governments have argued for continued low prices for the power intensive industries, as they were often located in industrial town-ships with few alternative employment possibilities. Hence, also for this industry a measure of the cost of maintaining an existing employment structure can be the difference between actual and potential resource rent.

3.4. Forestry and logging

Of Norway's total area around 23 % is defined as productive forest area where spruce and pine dominates. This corresponds to 60 % of the total area of forest (Statistics Norway, 1995). The volume of the growing stock of forest has doubled from 1930 to 1995. Hence, the harvest has been smaller than the gross increment, and this makes it more reasonable to estimate the resource wealth as a present value of an infinite stream of rents. The productive area has been divided between 120-130 000 forest properties over the period, of which 70-80 % were owned by individuals. While around 90 % of the properties were managed in combination with agricultural operations around the thirties, this decreased to somewhat over 50 % in the nineties (Statistics Norway 1969, 1993).

Although there is a discussion to what extent forests shall be regarded as cultivated (see, e.g., Hass and Sørensen, 1999), we include the total harvest of forest in our calculations of output and resource rent.

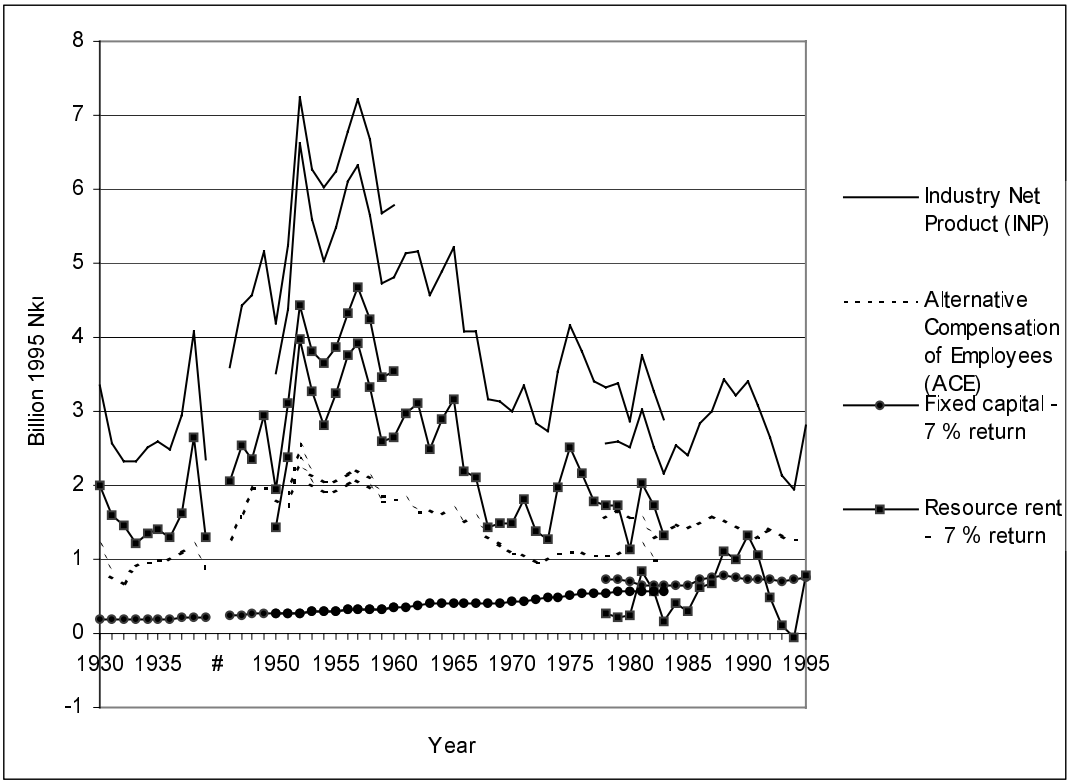
Compared to agriculture, forestry has been a less protected industry and more dependent on the development of international prices of wood and paper products. The roundwood cut for sale and industrial production varied between 4 and 11 million m^3 from 1930 to 1995. Even if production fluctuated, the basic prices of timber seemed to be of greater importance in deciding the factor income. The main commercial uses of forest resources were in the sawmilling and pulp and paper industries.

Figure 4 shows that the INP in forestry increased from 2-4 billion Nkr in the thirties to 5-7 billion in the fifties. From then on INP declined down to a level of 2-3 billion Nkr in 1990-95. Increased roundwood cut seems partly to explain the increased resource rent up to the late 1950s, but the falling rent in the following periods does not go along with reduced extraction. While the export of sawn and planed wood was reduced after 1930, there was an increased delivery to the woodworking industry, especially due to a larger home-market for furniture and other finished products. Although the volume of roundwood cut delivered to the wood-processing industry in the making of paper and pulp products was almost stable from 1930 to 1950, output in the industry increased due to technological progress (Statistics Norway, 1955). During and after the Korean War the export-prices for forest-products surged (and also as a result of the devaluation in 1949), which is reflected in the rise in the INP. Then the prices fell by almost 20 % from the mid-fifties to the mid-sixties. The reason was probably larger international trade and increased competition. The introduction of new technology gradually made the production costs for the different export goods lower and as a consequence the world prices fell (Statistics Norway, 1965a).[12] We may conclude that the prices for both saw logs and pulpwood in the fifties were extraordinary high, while the prices in the thirties and the last two-three decades were at a more normal level. This is an indication of how changes in economic cycles affect our measure of resource rent.

The forest industry has been much less subsidised than agriculture in line with its stronger dependency on international markets. Net subsidies have generally been less than 7 % of INP. Forestry has also been a less capital-intensive industry than agriculture, measured as the ratio between fixed capital and INP. But the volume of fixed capital increased with 2.5 % per year from 1930 to 1995, which was a higher growth than in agriculture. This strong mechanisation process consisted of increased use of power saws, industrial barking, special tractors etc.

[12] Another explanation for the falling INP from around 1960 may be a lower willingness to pay on the part of the domestic pulp and paper industry, due to a reduction in the rate of assistance to this sector.

Figure 4. Forestry and logging: the composition of resource rent with 7 % return



The ACE varied between 0.7 and 2.5 billion Nkr. The number of man-years in forestry was relatively stable to the late fifties, ranging from 25 000 to 39 000, before it decreased down to 5 400 man-years in 1995. The relative reduction in man-years over the whole period is slightly stronger than in agriculture.

Forestry has contributed positively to the national wealth over the years. Fluctuations in the resource rent were closely related to the development of the INP. The rent started from around 1-2 billion Nkr in the thirties and increased to 3-5 billion in the fifties, before it descended down to between 0 and 1 billion Nkr in the 1980s and 1990s. If we use this sector's ICE instead of the lower ACE, the resource rent decreases only somewhat, and it is positive for all years. It may be paradoxical that a sector with a more than normal return receives subsidies. But we must remember that the productive forest area is decided between more than 100 000 properties with variable income levels. If the subsidies are of a general kind both resource-owners with higher and lower revenue will receive financial assistance. In addition, part of these subsidies goes to efforts like forestation. Without this support these efforts probably would not have been carried out, because they only give a yield after several decades.

3.5. Fishing and fish farming

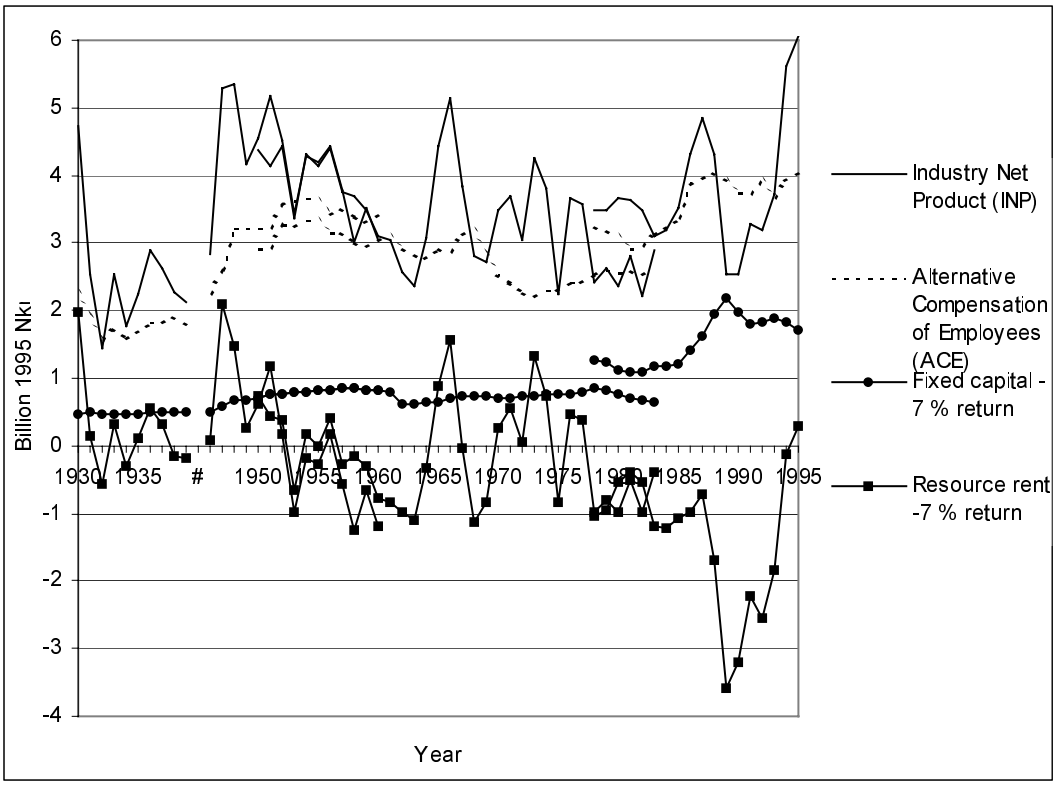
With its long coastal line Norway is one of the world's largest exporters of fish and fish products. Disregarding the bounded fish farms, fish is a mobile resource. Catches may vary immensely with the vagaries of nature and also as a result of international overexploitation. Over the years between 70 % and 90 % of the total Norwegian catch has been exported. While agriculture could be protected from competition, the fisheries were dependent on demand and prices on international markets (except for some possible market-power on markets where Norway was a dominant exporter). In Hass and Sørensen (1999) only fish in the open sea is considered a natural resource, while fish in fish farms is regarded as produced. We define all fish as the same natural resource, focusing on their dependence on the same natural environment, which is the sea.

During the depression in the 1930s Norwegian exporters were exposed to increasingly stiff competition in shrinking markets. During the interwar years regulations and controls became the order of the day, in fishing as in agriculture. The co-operatives in the dairy sector in agriculture were partially a model for fishermen's co-operatives. The first-hand sales of fish were gradually transferred to fishermen's sales organisations. Controls, regulations and subsidies were introduced to give the fishermen a decent income and to preserve jobs within the existing decentralised structure of the industry. Even today, two-thirds of the food fish landed in Norway are caught by fairly small coastal boats, a large number of them less than 30 feet. Small-scale fisheries are in other words still of major importance in the Norwegian fishing industry (Bergh et al, 1981 and Statistics Norway, 1995).

While 65 % of the fishermen in 1939 listed fishing as their sole or main occupation, this share increased to 70-80 % in the 1990s (Statistics Norway 1969, 1997b). Farming and fishing could easily be combined, as was the case with farming and forestry. The great seasonal fisheries took place during winter and early spring when the demand for farm labour was at a minimum. To the farmer-fisherman fishing represented both an important source of food during the season, and an important source of cash income.

Like in forestry, the INP showed greater variation on a year-to-year basis than in agriculture (see figure 5). INP varied between 1.5 and 6 billion Nkr from 1930 to 1995. Like forestry and mining fishery has been an export sector. Besides fluctuations in the size of the catches it is the world prices that decide the income. After a post-war golden age of large catches and high profits, higher costs and rapidly declining catches created a new crisis in the late 1950s. After the failure of the herring fisheries in these years, and the relative decline in cod fishery after World War II, the industry switched to mackerel and capelin as raw material base. From the late sixties catches of seal and whale decreased.

Figure 5. Fishing and fish farming: the composition of resource rent with 7 % return



With the exception of trawl fisheries there was little regulation of the Norwegian fisheries until the 1960s. Today both fishing effort (licences, number of vessels, type of gear) and harvesting (various forms of quotas) are regulated (Statistics Norway, 1999). The overexploitation of natural resources by fishermen of all nations has on the one hand led to periodic crises in the industry, on the other contributed to a considerable extension of the raw material base, as the industry has started looking for new resources.

The proportion of the catch for oil and meal was in periods much higher for Norway than for most other major fishing nations, although oil and meal are low-priced products (Bergh et al, 1981). The oil and meal plants handled in the late seventies 70-80 % of the total value of the catch, but this decreased to less than 40 % in 1995, while fish for fresh use, freezing, drying, and salting increased. Fish farming of salmon and rainbow trout has been a growing industry from the beginning of the seventies. In 1995 Norway accounted for around 50 % of the total world production of farmed Atlantic salmon (Statistics Norway, 1997a). The value of the production of farmed fish was closing in on that of the traditional catches in the mid-nineties.

The net subsidies in fishery have been higher than in forestry, but lower than in agriculture. The ratio of net subsidies to the INP was generally lower than 10 % before the seventies, except for the thirties

when it reached 20 %. In the eighties it varied between 15 and 55 %, and in 1994 and 1995 there was actually a zero net subsidy in the industry.

The ACE varied between 1.5 and 4 billion Nkr. In 1930 there were 66 000 man-years in the industry compared to 17 300 in 1995, a reduction of almost 75 %. Throughout the post-war period fisheries, with farming, served as a manpower reserve for the expanding Norwegian economy. The total amount of man-years decreased with around 2 % per year over the period, although it stayed fairly constant the last twenty years. The growth in real income per man-year the last 20 years resulted in a higher ACE, while the labour force in fishery was relatively stable.

The volume of fixed capital increased with 2.4 % per annum from 1930 to 1995, with the bulk of growth the last 10-20 years. Trawling, purse seining, the echo sounder and the sonar have revolutionised the task of locating and catching fish. Due to the increasing efficiency of boat and gear the catches have increased two-three times since 1930.

The resource rent fluctuated from negative to positive values in the interval from +2 billion Nkr to -3.5 billion. This illustrates that income only in some years was sufficient to cover operating costs and compensation of labour and capital, and may be a consequence of the fact that resources that are viewed as common tend to be overexploited (see, e.g., Harlin, 1968). In the absence of property rights, each exploiter tends to ignore the effects that his own removals will have on the total resource stock and its future production. The increased resource rent in the nineties in figure 5 goes in line with a reduction in the subsidies. In this period there were increased catches of cod, saithe and herring as well as increased export from the fish farming sector.

Changing Norwegian governments have tried to uphold the settlement structure of many sparsely populated coastal areas, adjusting the fishermen's incomes to those of society at large. In this process two opposite forces seem to have been working: the technological progress and centralising tendencies on one side versus keeping a small-scale individual ownership and a decentralised fishing structure on the other.

3.6. Mining and quarrying

Mining includes metal ore mining and other mining. *Metal ore mining* covers extraction of metals like iron, copper, zinc, pyrite, lead, titanium and nickel, while *other mining* includes minerals like gravel, sand, stone, clay, limestone and other industrial minerals. Production changes as new deposits are found and as ores dry out. Like fishery and forestry, the mining industry has been dependent on

international prices and demand. Mining has also supplied raw material to the domestic electrometallurgical industries and to the building and construction sector.

Through the interwar years there was a large increase in metal ore mining mainly due to the international rearmament. The INP increased from 0.7 billion Nkr in 1930 to 1.3 billion Nkr in 1939, as shown in figure 6. During the Second World War the INP declined with as much as 50 % as many mines were destroyed. In the years to follow the INP grew rapidly and from 1950 to the late 1970s it fluctuated between 1.5 and 2.5 billion Nkr. Through the post-war years extraction of metals for export increased and there was also a rise in the delivery to the domestic electrometallurgical industry, demanding inputs like iron ore and pyrite. In addition supply from *other mining* increased, above all for delivery to the building and construction industry demanding inputs in the making of roads and constructions of concrete.

As for other export sectors there was a surge in the export prices during and after the Korean War (and the Norwegian devaluation in 1949). From 1956-58 to 1962 there was a fall in export prices mainly because of increased international competition, but as from 1960 the extraction of especially iron and copper increased. This is seen as a fall and later rise in the INP. From 1970 to 1980 many ores went dry and as a consequence the income declined in this period. Starting in 1980 the INP varied between 1 and 1.5 billion Nkr. Although production continued to decrease somewhat from the early eighties, the INP stayed fairly stable until 1995, possibly because the less profitable ores were shut down (Lurås, 1994).

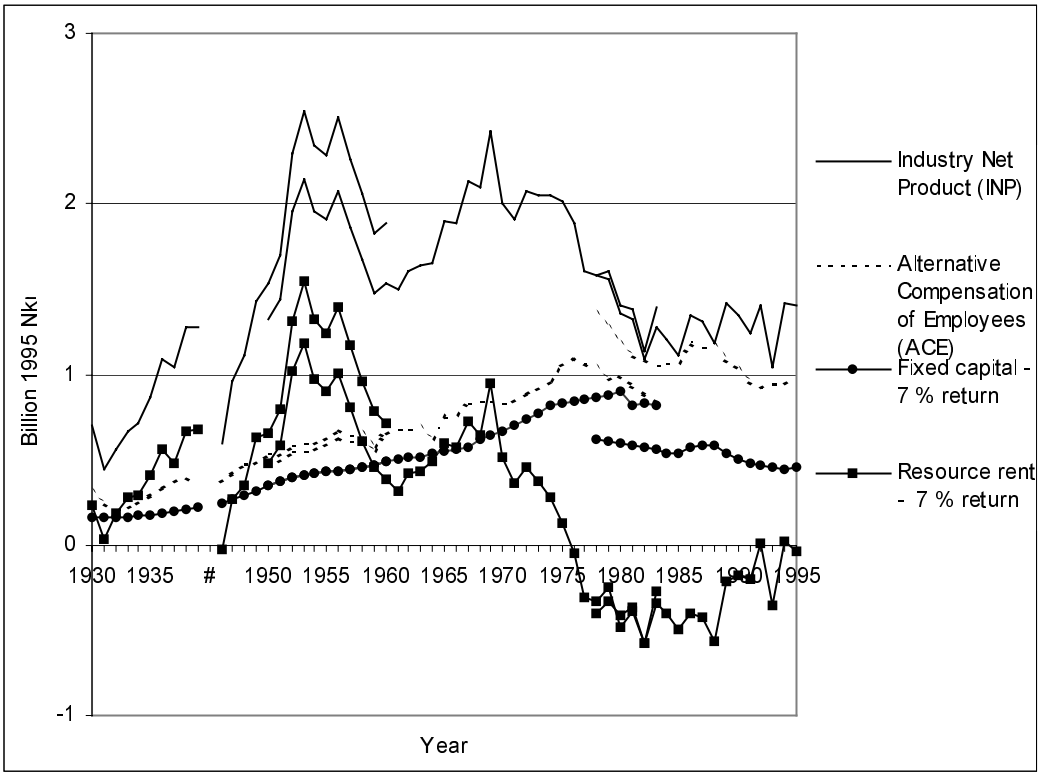
The volume of fixed capital increased relatively slowly with 1.6 % per year from 1930 to 1995. The growth was strong until the mid-seventies, but the stock of fixed capital was built down from around 1980 in line with a reduction in extraction. The number of man-years was relatively stable from 1930 to the beginning of the eighties. From then on the number of man-years declined with almost 50 % to 4 200 in 1995.

Although mining has been a relatively highly subsidised industry the last two decades, the net subsidies were generally less than 5 % of the INP until 1970. It increased to 15 % in 1980 and reached almost 50 % in the late eighties. The net subsidies have fluctuated between 20 % and 25 % of the INP during the nineties.

The resource rent varied between 0 and 1.5 billion Nkr until 1976. The resource rent decreased from the beginning of the seventies in line with reduced extraction; possibly leading to the increased subsidies that were introduced during this period. Starting in 1976 the resource rent fluctuated between

0 and -0.5 billion. From the late eighties the rent showed a minor increase, possibly because the less profitable ores were shut down as is seen in the reduction in compensation for real capital and employees. Other studies find a small, but positive resource rent for *other mining* from 1975 to 1992 (Statistics Norway, 1989 and Lurås, 1994), and part of the reason may be that this was a less subsidised sector than *metal ore mining*. If we use the ICE in mining over the whole period instead of the lower ACE, the resource rent is only marginally reduced, like in forestry. Mining has been important in establishing activity in parts of the country with few alternative employment possibilities, which also was the official argument for the periodically high subsidies.

Figure 6. Mining and quarrying: the composition of resource rent with 7 % return



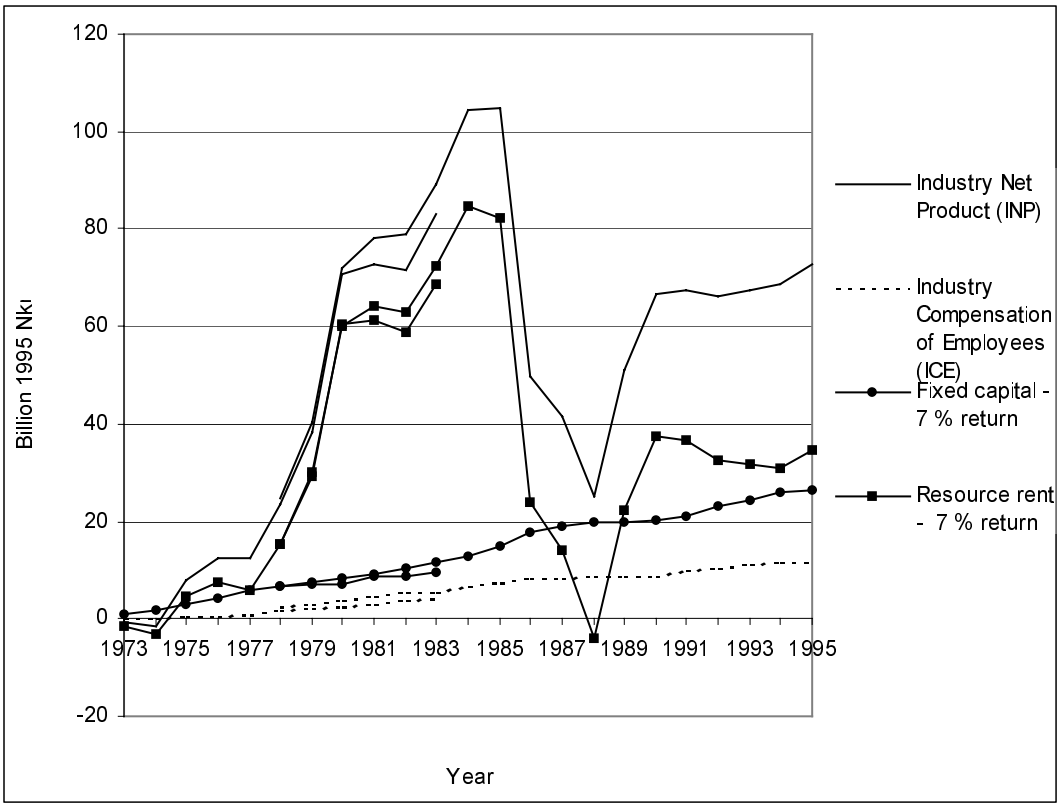
3.7. Petroleum

Resource rent

The petroleum sector includes oil and natural gas extraction, as well as transport via pipelines. The petroleum sector is a relatively young industry in Norway. We choose to start the analysis in 1973, although there were some small net investments in exploration and drilling already in 1965. Starting in 1973 figure 7 shows that the oil and gas industry has experienced a rapid growth in both fixed capital and number of man-years, i.e. 16.8 % and 23.5 % per year, respectively.

The ICE per man-year has been much higher than in other industries and as a consequence we use this measure instead of the ACE in the calculation of the labour costs. It increased from 340 000 Nkr in 1975 to 560 000 Nkr in 1995. The ICE was from 2.5 to 3 times higher than the ACE for the other natural resource industries. Hence, one might say that part of the resource rent is accrued to the labour force, maybe because of risk and uncomfortable working conditions. As electricity supply this sector is highly capital intensive, which is seen in figure 7 as a higher compensation of capital than of labour.

Figure 7. Petroleum: the composition of resource rent with 7 % return



The INP showed a remarkable growth from 8 billion Nkr in 1975 to 104 billion in 1984/85. Increased extraction can only to some extents explain this development, as the main reason was the oil price increase with OPEC I in 1973/74 and OPEC II in 1979/80. The INP declined to 25 billion Nkr in 1988, following the fall in the oil price in 1986. After 1990 the INP has been relatively stable, between 67 and 73 billion. The oil price was higher in all following years after 1988 and extraction was almost twice as high in 1995 as in 1988. How sensitive the resource rent is to changes in the oil price was clearly demonstrated in 1986, when the resource rent decreased with around 60 billion Nkr.

Independent estimation of petroleum wealth

We use the resource rents derived in this section to estimate the resource wealth in each year in different industries, applying equation (2). As we simply assume that the resource rent in the year of

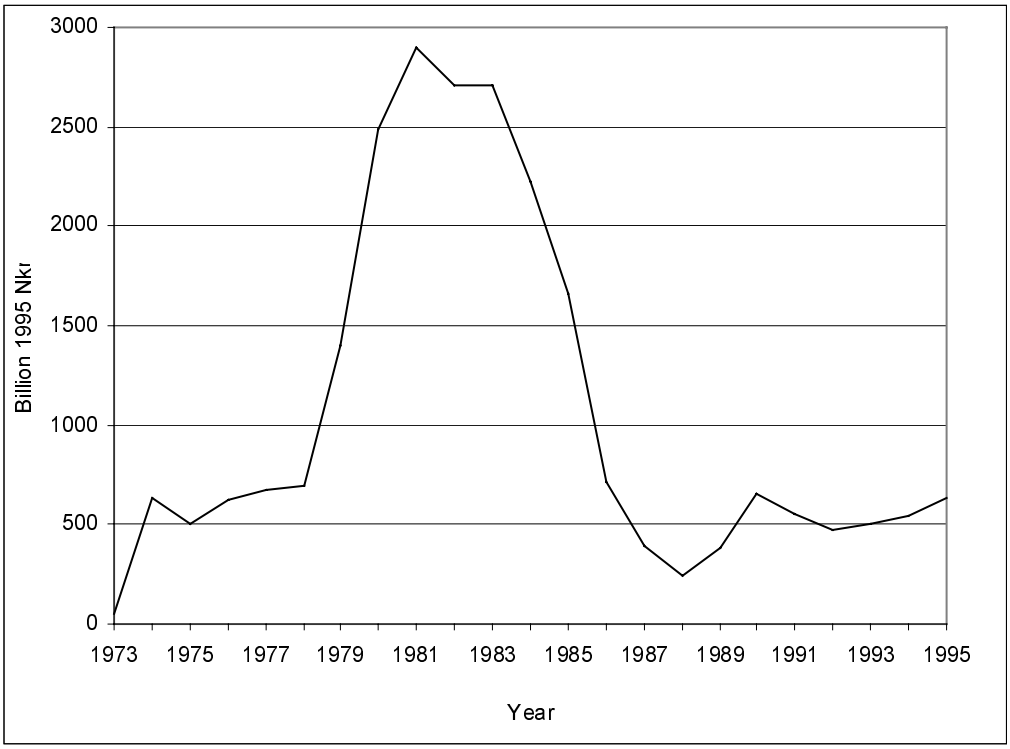
calculation is maintained indefinitely, we presuppose constant prices for raw materials on the world market, constant costs and extraction rates. The oil and gas sector is the only exception from this simplification, as we have independent measures of the petroleum wealth with a 7 % discount rate. Our point of departure is the expectations the authorities had at any point in time to prices, size of reserves, extraction costs and production profile.

Prior to 1990 the wealth estimates were conducted by Statistics Norway and were based on summarised information on production and costs (see e.g. Aslaksen et al, 1990). As from 1990 the estimates have been prepared by the Ministry of Energy and Industry and Ministry of Finance (and publicised in Long-term Programs and Revised National Budgets). These figures were based on detailed information on reserves, production profile and cost estimates for the different oil and gas fields. Both sources used a discount rate of 7 %. We do not have independent wealth measures with a 4 % discount rate. Hence, with this discount rate we use the petroleum rent described in figure 7 for measuring the wealth.

Figure 8 shows that the wealth estimates have changed remarkably over the years. Note that in each year the wealth is calculated as the current value in that particular year. Changes in expectations are caused by changes in expected prices, costs and size of the reserves. Expectations about prices are clearly the most important, but also an upward adjustment of the reserves has played a part. Besides changes in expectation, the wealth is reduced every year due to extraction (the resource rent) and is increased because the future stream of payment gets closer.

The price increases in 1973/74 and 1979/80 raised expectations of a high future oil price, in addition to new discoveries. This lead to a strong upward adjustment of estimated wealth. From 1981 to 1987 a steady reduction in price expectations led to a reduction in wealth from 2900 billion Nkr to 243 billion Nkr. This reduction was actually four times higher than the Norwegian gross national income in those years. It is interesting to notice that as early as in 1984, two years prior to the fall in the oil price, the wealth was adjusted downwards due to a less optimistic view on future oil prices. Another minor downward adjustment in oil prices took place during 1990. Through 1992 and 1993 there was an upward adjustment of the remaining reserves. Expected wealth in the nineties was at the same level as in the years prior to the major rise in the oil price in 1979/80.

Figure 8. Independent estimation of petroleum wealth based on a 7 % discount rate



Note: The estimates are from the start of the year

4. The development of the components of national wealth

Before we present the development of the different components of the national wealth, we will discuss if the assumption of a constant natural resource rent is reasonable. The analysis of the resource rent in section 3 shows that simply extending the rent into the future is a somewhat dubious assumption. The resource rent for fishery fluctuated from negative to positive values, but on average it can be described as more or less constant. The rent for electricity supply declined up to around 1980 and then increased somewhat. In forestry and mining the resource rent was high in the years after the Second World War, maybe due to a more than normal price level, but was more or less constant the last twenty years.

The reason for the decline in resource rent for mining from the mid-1950s may partly be a depletion effect; it is a *non-renewable* resource and the best ores went dry in this period. For petroleum, the other exhaustible resource, we apply the resource rent in the wealth estimates with a 4 % return. We see from figure 7 that the rent showed large fluctuations, but was more or less constant from 1990 to 1995. For the non-renewable resources it may be questionable to assume an indefinitely and constant resource rent, as the resource may sooner or later be depleted. On the other hand, if the resource lasts long enough, this will be of minor importance because of discounting.

Even if we found that the resource rent for the different industries in section 3 often was negative, it may seem unreasonable to ascribe a negative value to the wealth of a resource. We follow the procedure in Statistics Norway (1993), where the wealth was set to zero when the resource rent was negative, on the argument that the natural resource had been managed to pursue other goals.

Since the mineral resources sooner or later will cease, we cannot expect that the non-renewable resources in the mining and petroleum sector will contribute to total wealth over all future years. Therefore we deduct the net product in these industries from the *DNI* in equation (1) to get the disposable national income for the rest of the economy, labelled *DNI (adj).* As before we simply assume that the future *DNI (adj)* is the same as the *DNI (adj)* in each year of estimation adjusted for technological growth. Then the discounted present value of this adjusted wealth in year *t* is calculated to:

$$(3)\ W(adj)_t = DNI(adj)_t \cdot \frac{(1+a_t)}{(r-a_t)}$$

We estimate the technological progress (a_t) as the part of the growth in NNI that cannot be ascribed to increased real capital or the number of man-years, which is often described as an estimate of total factor productivity or the Solow residual. The estimated technological growth varied between -0.9 % and 4,8 % per year.[13] See the accompanying publication Lindholt (2000) for a more thorough discussion of the development of the technological progress.

To get total national wealth we include the petroleum and mining wealth to equation (3). When we deduct financial debt, the value of real capital and the natural resource wealth from total wealth, the value of human capital will be the residual. Alternatively, human capital can be estimated as the present value of future income from labour. This is done by Jorgenson and Fraumeni (1989), which will be commented on later.

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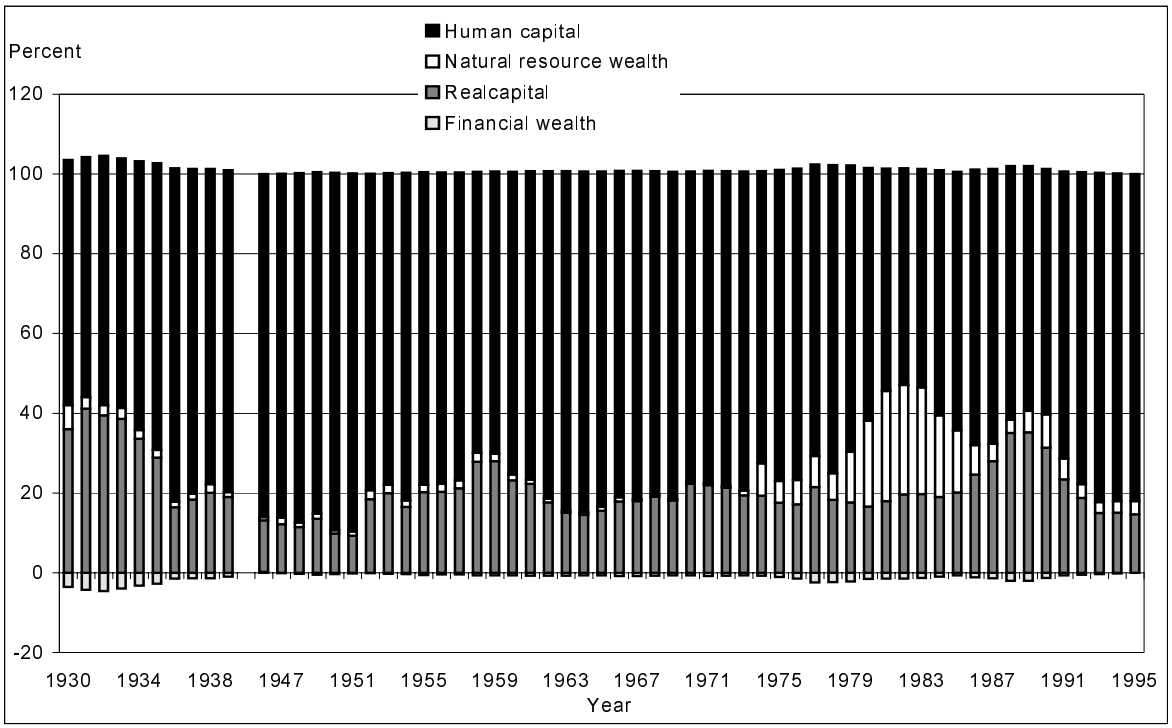
[13] We estimate a Cobb- Douglas production function of the formula $Y_t = A \cdot K_t^{\alpha_K} \cdot L_t^{\alpha_L} \cdot e^{at}$ where Y, K, L are the net national income at constant prices, the volume of real capital and the volume of man-years, respectively. Natural resources do not have any uniqueness in this production process. We assume that natural resource limitations are not fundamental, and that they can be overcome by substituting physical and human capital for limited natural resources. *A* is a constant. Since $\alpha_L + \alpha_K = 1$, we estimate α_L and α_K in each year as the income-share of the NNI of labour and capital, respectively. The item e^t is a trend factor supposed to indicate the effects on production of technological improvements in a wide sense. We estimate the rate of this growth for each year as: $a_t = \frac{\dot{Y}_t}{Y_t} - \alpha_K \cdot \frac{\dot{K}_t}{K_t} - \alpha_L \cdot \frac{\dot{L}_t}{L_t}, where\ \dot{Y}_t = Y_{t+1} - Y_t$ etc. We use a 5-year moving-average of the estimates of a_t.

Figure 9 shows that the financial debt was generally below 2 % of national wealth throughout the period, except for the first half of the thirties when it reached 3-4 %. In 1946 and 1995 Norway had a small claim abroad. The Petroleum Fund was established in 1995 with the intention of saving parts of the revenue from oil and gas extraction. If we exclude the petroleum sector, natural resource wealth was never more than 2 % of national wealth, except from the early thirties when it was around 3-6 %. Between 1975 and 1995 the contribution from these resources was generally below 0.5 % of the national wealth. Hence, the contribution from the traditional natural resources has been small, and in addition declined somewhat over the period. That is, the relative size of the excess return in these industries that could be used in the building of produced and human capital in other industries has declined. If the oil and gas sector is included, the natural resources were between 13 % and 28 % of national wealth from 1979 to 1985, when continuing high oil prices were expected. From 1980 to 1984 the estimates of the petroleum wealth were actually higher than the value of real capital. In the nineties the contribution from all natural resource industries was in the range of 3-8 %, only slightly higher than in the early thirties (an average of 3.4 % of total wealth from 1990 to 1995 compared to 3.2 % for the period 1930-35).

Figure 9. Estimates of the national wealth decomposed according to source and a 7 % discount rate



According to these figures we were as dependent on the traditional natural resources in the 1930s as we were on the natural resource industries in the nineties, when we in addition had built up our

petroleum sector. But with expectations of higher oil prices, as in the early eighties, the contribution from the natural resource industries will of course increase.

Because of the small contribution of the natural resource industries to national wealth (except for petroleum), a premature conclusion may be that Norway has not been very dependent on these natural resources. However, this statement requires that labour and capital could easily be moved to other industries if necessary. To get a more complete picture of the importance we can look at total income in these industries, which includes payment for labour and capital, besides the resource rent. If we exclude the petroleum sector the relative amount of the net national income in the traditional natural resource industries decreased from 20 % in 1930 to 4 % in 1995. Hence, although the contribution to total net national income from these traditional industries is declining over the period, the relative importance to income is clearly higher than measured with the resource rent. (If we include the oil and natural gas sector, the relative amount varied between 10 % and 23 % from 1975 to 1995). In addition, Norway has had a very open economy for a considerable period of time. From 1930 to 1960 the export share of the gross national income was between 25 % and 40 %. After that it has been around 40-45 % on average. Natural resources or semi-manufactured products from these industries have been a large part of this export.[14]

The value of real capital was between 20 % and 40 % of the total national wealth in most years. The share was lower in periods with rapid technological progress, as from 1946 to 1951, 1963-65 and from 1993 to 1995. In these periods the share fluctuated between 10 % and 20 % (as it did in some years when the expected petroleum wealth was large). It has to be stressed that technological growth leads to increased total national wealth, while financial wealth, real capital and resource wealth remains unchanged. Hence, increased technological progress only leads to increased human wealth, which is measured as the residual. If a constant technological growth of 1 % were expected, the real capital over the whole period was between 20 % and 30 % of total wealth, showing no clear trend or tendency over time. Correspondingly human capital was a larger part of total wealth in periods with rapid technological growth. From 1930 to 1995 the share fluctuated in most years between 60 % and 80 %. In years with strong technological progress human capital reached over 80 % of total wealth, as development in know-how, technology, education and training ascribes to this category of wealth besides raw labour. In addition, another type of growth effect applies to the movements of labour from low-productivity to high-productivity sectors. Hence, human capital in the form of a highly skilled and flexible labour force was Norway's most important *economical* resource.

[14] In the nineties around 70 % of the export value came from the export of these products.

With a 4 % discount rate[15] the compensation for capital declines and the resource wealth in the different industries increases. But at the same time total wealth is larger and, hence, the relative contribution from the natural resource industries only shows minor changes. As we now estimate petroleum wealth as the present value of a stream of constant resource rents and not based on more sophisticated expectations, natural wealth never reaches more than 11-12 % of the national wealth. The reason is that the independent wealth measures include expectations of increased extraction in the nearest future and also increased oil prices for some years. As human capital is measured as a residual, its importance increases because total wealth is larger with a 4 % discount rate. Correspondingly the contribution from real capital is smaller and never more than 25 % of total wealth. Jorgenson and Fraumeni (1989) derive a new system of NA for the U.S. economy. They define human wealth in the terms of lifetime labour income, including valuation of non-market activities such as investment in education, household production and leisure-time. They use a 4 % discount rate and conclude that human capital greatly predominates in the value of wealth, amounting to around 92-94 % of the total U.S. wealth from 1948 to 1984.

The contribution from human capital to total wealth probably to some degree is over-estimated. Firstly, because human capital is measured as a residual it will comprise all components that are not ascribed to the other elements, e.g. the value of urban land or private consumer capital other than dwellings. Secondly, human capital probably increases its share over the years because of definitional reasons. The NA does not cover household production, and the size of non-market production declines as the care of children and old is transferred from private unpaid care to institutions in the market. This latter activity is registered in the NA, which leads to increases in the NNI and the share of human capital over the years (as work of a caring nature is labour intensive). This problem applies to country comparisons also, as the informal sector generally is higher in low-income countries. Thirdly, the quality of a *new* fixed capital good may be higher than what is reflected in its price, i.e. the usual price indices over-estimate price increases. In addition, the value of real capital is in the NA equal to replacement costs which measure the volume of the real production resources and not the volume of *productive capacity* (Aukrust and Bjerke, 1958). This may lead to an under-estimation of the real value of old and discounted capital. Some of the quality improvements of real capital could be intercepted by the growth in total factor productivity, but in our study the technological progress is only accrued to human capital.

Dixon and Hamilton (1996), based on World Bank (1995), estimate the components of wealth for different regions of the world for the single year 1994. They use a somewhat different estimation

[15] For some years equation (1) becomes meaningless with a 4 % discount rate and a high technological growth.

method based on other data and do not take technological progress into account[16]. Their conclusion is that human capital is the dominant component of wealth, comprising between 40 and 80 % of total wealth in all regions. Natural capital accounts for a lower percentage share of national wealth in the rich countries, because of the relatively greater importance of above all human resources and to some extent produced assets.

One conclusion in the World Bank's report is that for poor countries, growth is connected to the use of the rents from the natural resource base in the building of produced assets and human capital. We have shown that the magnitude of this potential transformation of rents from the traditional natural resource industries into produced and human capital in other sectors has diminished in Norway over the 65-year long period.[17] The last two decades petroleum wealth has to some extent been consumed and also transformed into production capital (in the petroleum sector), human capital and financial wealth (which is reflected as a positive financial claim abroad as from 1995).

Does it make sense to decompose national wealth in different categories, as all components are necessary for production, and often simultaneously? We have assumed that Norway is able to trade with other countries, given fixed prices and perfect international markets for credit and goods. Hence, we have only a partial and not a global view on resource extraction as we have assumed constant prices on the world market. We assume that if Norway extracts its oil and gas reserves, it can import petroleum from abroad. But if all countries exhaust its resources, the resources will not be available on the world market (see, e.g., Brekke, 1997). In the context of sustainability it is especially important to what extent human and real capital can substitute natural capital. Our starting point is that as long as total wealth is unchanged between generations, natural resources can decline as the growth in man-made or human capital increases. In line with these complete substitution possibilities, we have assumed so-called "weak" sustainability (see, e.g. Solow, 1993).[18] For a more thorough discussion of sustainability and management of the Norwegian wealth, see Lindholt (2000).

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[16] The resource rent in different countries/regions is measured from world product prices and projections of productivity in the different industries. Although they concentrate on the use values of natural resource wealth like our study, they attempt to value the opportunity cost of such elements as non-timber forest benefits in forestry (non-timber products, recreation and tourism) and protected areas which is estimated as a part of the land rent together with agriculture. Like in our study human capital is measured as a residual, but the present value is only discounted over one generation. They use a 4 % discount rate. Due to lack of data the rent in fishery is not calculated. Real capital includes urban land valuation as a fixed proportion of real capital. Using a purchasing parity rate the World Bank makes comparisons between countries.

[17] One might say that indirectly *some part of difference between the actual and potential resource rent* has been transformed into produced and human capital in these traditional industries. But it is beyond the scope of this paper to try to measure how much of this potential loss that has been distributed to producers (or consumers), and how much that simply is wasted.

[18] "Strong" sustainability can be achieved by conserving the stock of human capital, real capital and natural resources (see, e.g. Daly and Cobb, 1989). The reason for the need to keep the value of natural capital at least constant is that natural capital is thought of as being complementary to man-made and human capital.

5. Concluding remarks

National wealth can be divided into real capital, financial capital, human capital and natural resource wealth. We use the National Accounts measures to illustrate the development of the wealth in Norway, a so called highly resource based country, from 1930 to 1995, with special focus on the contribution from the natural resources. In line with the NA we interpret national wealth in a somewhat restrict manner, as we do not include the status of the environment. Since our estimates are based on the NA, this will give us the actual income from the resource given the present management of the resource, and not an optimal or potential income. The strength of our study is to sum up the history in a simple and consistent way using the NA.

Financial debt was generally below 2 % of total national wealth throughout the period, except for the first half of the thirties when it reached 3-4 %. In 1946 and 1995 Norway had a small claim abroad. Norway is often described as an economy that is very dependent on its natural resources. However, apart from the petroleum sector, the resource rent for most natural resource sectors was generally small or negative. This may indicate that these industries to a large degree fulfilled political goals as stimulating employment possibilities in sparsely populated areas. Still, the amount of man-years in these industries has declined with over 80 % from 1930 to 1995. If we exclude the petroleum sector, natural resource wealth was never more than 2 % of national wealth, except from the early thirties when it was around 3-6 %. Between 1975 and 1995 the contribution from these natural resources was generally below 0.5 % of the national wealth. Hence, the contribution from the traditional natural resources has been small, and in addition declined somewhat over the period. That is, the relative size of the excess return in these industries that could be used in the building of produced and human capital in other industries has diminished. If the oil and gas sector is included, the natural resources were between 13 and 28 % of national wealth from 1979 to 1985, when continuing high oil prices were expected. In the nineties, with expectations of lower oil price level, the contribution from all resource industries was in the range of 3-8 %, i.e. only marginally higher than in the early thirties. Hence, we conclude that we were as dependent on the traditional natural resources in the 1930s as we were on the natural resource industries in the nineties, when we in addition had built up our petroleum sector. This may be somewhat surprising, as a common apprehension is that Norway becoming an oil producer to a large extent increased the importance of the natural resources in the economy. It has to be stressed that with expectations of higher oil prices, as in the early eighties, the contribution to total wealth from the natural resource industries will increase.

The share of the real capital of total wealth varied between 20 % and 40 % in most years, and showing no clear tendency over time. The share was lower in periods with rapid technological progress, when the share fluctuated between 10 % and 20 % (as it did in some years when the expected petroleum

wealth was large). The most important economic resource throughout the period was a highly qualified labour force, varying from 60 % to 80 % of the national wealth in most years. In years with strong technological progress human capital reached over 80 % of the total wealth, as development in know-how, technology, education and training ascribes to this category of wealth besides raw labour. In addition, another type of growth effect applies to the movements of labour from low-productivity to high-productivity sectors. Hence, human capital in the form of a highly skilled and flexible labour force was Norway's most important *economical* resource. Lowering the discount rate in our calculations increases the contribution from human capital.

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Appendix

Fixed capital estimates

With the SNA (1993) fixed capital estimates changed in most sectors for the years overlapping the old SNA (1968). This led to a higher rate of depreciation in the latest revision and the introduction of capital consumption for some types of structures for which capital consumption was not applied earlier (as public infrastructure like roads). Hence, in agriculture, mining and electricity supply the fixed capital was lower with the SNA (1993). For forestry and fishery the volume of capital was higher with the latest revision. This is probably due to an upward revision of the fixed capital formation that was stronger than the rise in capital consumption in these sectors.

Agriculture

Only subsidies related to sector are deducted from the factor income. Hence, in agriculture we disregard product subsidies like consumption grants on milk and milk products, price subsidies on margarine, subsidies from the Concentrated Feeds Fund, subsidies on fertilisers and compensation of VAT on food.

Price subsidies on milk and milk products are in the NA as from 1975 distributed between commodity subsidies and sector subsidies by classifying the consumption grants as commodity subsidies, and grants for realisation of the Agriculture Agreement as sector subsidies. We have estimated the sector price subsidies on milk from 1967 to 1974 as the share of these subsidies of total price subsidies on milk in 1974. The sector price subsidies on milk from 1950 to 1966 are estimated as the average share of these subsidies of total sector subsidies in agriculture in the period 1967-1970. Prior to 1950 it is not possible to deduct some sector subsidies (like price subsidies on milk and milk products and subsidies on grain and flour). These subsidies were 10 % of the INP in 1950. The sector taxes in agriculture are estimated from 1970 to 1977. The sector taxes were around 1 % of the INP in the years prior to 1970 and we assume a steady growth in these taxes over the period.

Production for own final use was included in the figures based on SNA (1993). As a consequence production and operating surplus increased with around 10 %.

In the NA the estimates for fixed capital included both agriculture and forestry from 1930 to 1969. The relative amount of capital in agriculture was 92.7 % of the total capital in both industries in 1970. We use this relative amount to estimate fixed capital in agriculture from 1930 to 1969.

The revision of NA in 1968 led to a reduction in the number of man-years, because housework from now on was not included. For the period 1950-60 this entailed a stable reduction of 22 % in the number of man-years each year, and we have reduced the number accordingly prior to 1950. See e.g., Statistics Norway (1995).

Electricity supply

With the revision of the NA in 1968 the INP was revised up with around 20 % in the fifties, mainly due to an upward adjustment in factor income. The INP in gas supply is included in electricity supply from 1950 to 1983, but this seems to be of minor importance since the INP in gas supply was less than 1 % of the INP in electricity production from 1958 to 1960.

Fixed capital in gas supply is included prior to 1962. Net investment in this sector was zero or slightly negative in the period 1930-61. Fixed capital originally included water supply from 1962 to 1969, but the stock of capital has been adjusted downwards with the amount of net investment in water supply in this period. Sector taxes 1970-77 are estimated through interpolation.

Forestry

With the SNA from 1968 the INP was revised down with 10-20 % from 1950 to 1960. The main reason was a downward adjustment in production and an upward revision of the intermediate consumption. Likewise, with the SNA from 1993 followed a new downward adjustment of the INP of the same magnitude.

In the NA the estimates for fixed capital included both agriculture and forestry from 1930 to 1969. The relative amount of capital in forestry was 7.3 % of the total capital in both industries in 1970. We use this relative amount to estimate fixed capital in forestry from 1930 to 1969.

Fishery

With the revision of the SNA in 1993 came major changes in central figures from 1978 to 1983: the operating surplus was adjusted upwards with 40-80 %, total number of man-years was now 20 % lower and the sector subsidies increased with 200-500 %.

Production for own final use was included in the figures based on SNA (1993). As a consequence production and operating surplus increased with around 10 % in fishery.

Only subsidies related to sector is deducted from the factor income. Product subsidies on fish are disregarded.

Mining

Total fixed capital from 1946 to 1969 included manufacturing and construction, and capital in mining is estimated by deducting the net investments in the industry before 1970. Prior to 1946 we use the share of capital in mining of total fixed capital in the three industries in 1946, which was 5.9 %.

The sector taxes 1970-77 are estimated through interpolation.

Petroleum

With the revision of the SNA in 1993 the operating surplus was adjusted upwards, especially from 1981 to 1983.

It did not exist wealth estimates for 1991, but we estimate the average for the two nearest years. For those years when there existed one high and one low estimate, we present the average.

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