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1	M
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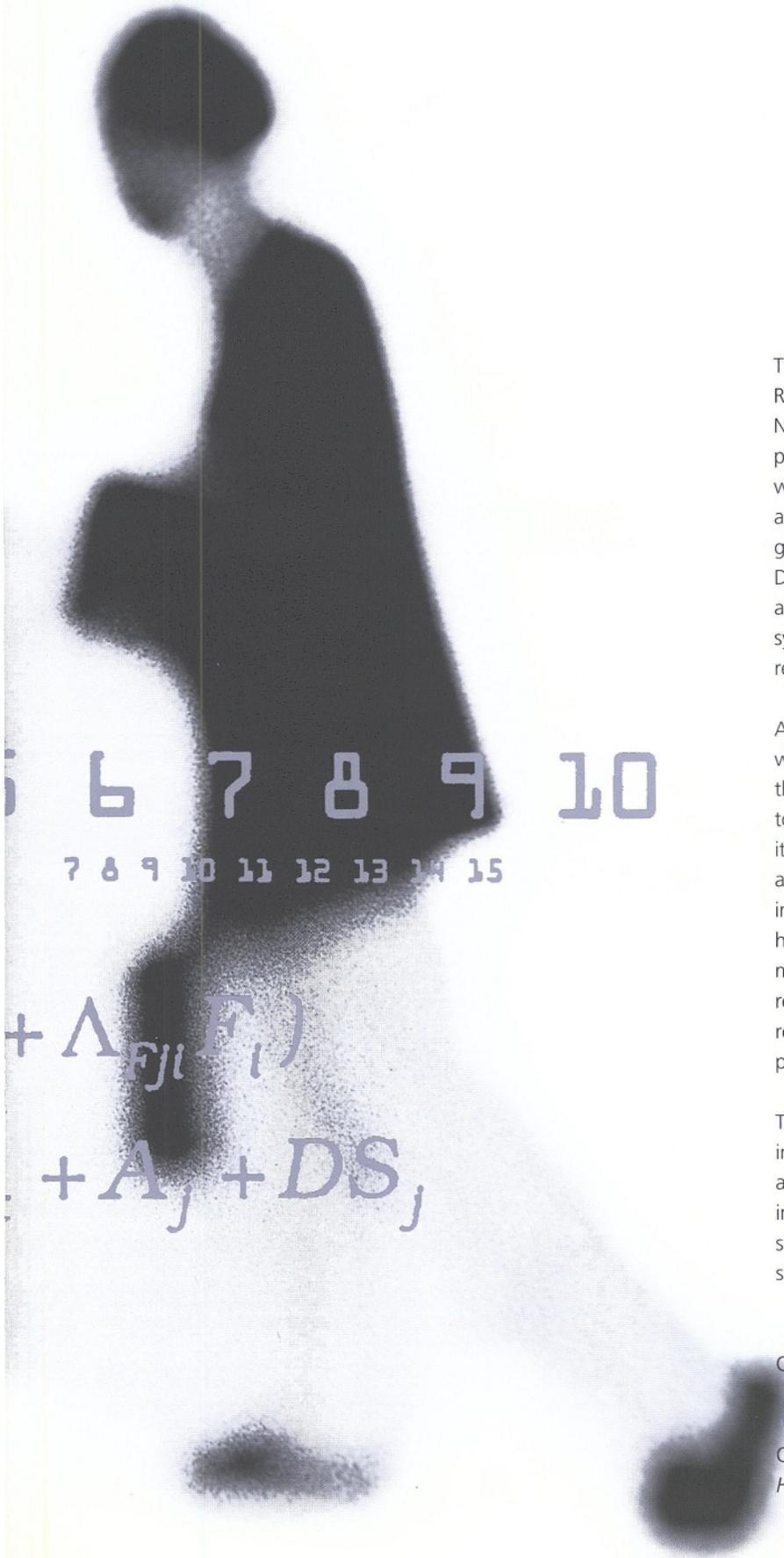
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$$I_j + \sum_i \Lambda_{Mji} X_i = \sum_l (\Lambda_{Mjl} M_l + \Lambda_{Ejl} E_l) + \sum_j \Lambda_{Cjl} C_l + \sum_k \Lambda_{Jjk} J_k$$



The Annual Report 1993 for the Research Department of Statistics Norway presents in outline major programmes and projects in 1993-94 with complete lists of publications and staff. The Annual Report also gives a brief history of the Department and its role as a social and economic research institution in symbiosis with the statistical responsibilities of Statistics Norway.

Although the immediate targets as well as the ultimate aims of most of the research activities are directed towards applications within Norway, it is widely recognized that theories and methods are drawn from international research pools, and, hence, an unconditional need to maintain links to the international research community. This is also the reason why the Annual Report is published in English.

The Research Department welcomes interests in our publications, and we are happy to offer these delivered on individual requests or as institutional subscriptions free of charge under suitable exchange arrangements.

Oslo, 15 April 1994

*Olav Bjerkholt*

Olav Bjerkholt

Head of Research Department

## Brief history of **the Research Department**

The research activities of Statistics Norway have roots far back in the history of the institution. The statistical bureau of Norway was founded in 1876 by the establishment as an independent institution of a small statistical office from the Ministry of Interior. In the historical chronicles of Statistics Norway the background for the separation of the statistical service from the ministerial environment is stated as follows: "The work of the Office would be facilitated by more distance from the government offices; the scientific character of the Office would thus be better understood by the public." Since then Statistics Norway, or as it was known through much of its history – the Central Bureau of Statistics – has been the national statistical institution of Norway, part of the government administration but with an autonomy in statistical matters, like corresponding institutions in many other countries.

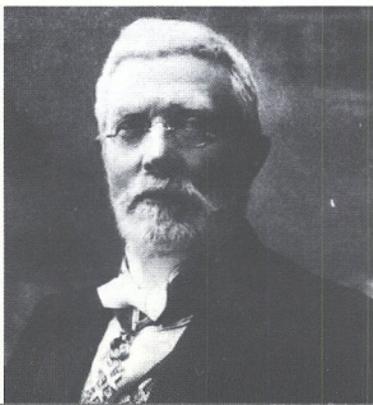
The first Director General of Statistics Norway, Anders N. Kiær (1876-1913), took active part in the international statistical cooperation and was a pioneer in the use of representative samples as a basis for statistics, especially with regard to income statistics. Kiær pioneered also in technical advances: a Hollerith electrical machine was employed in Norway for the first time in the compilation of statistics of incomes and wealth for 1891, shortly after its invention. The research activity of Statistics Norway in the early years was modest and mostly related to analysis of data from the population census and income statistics. Later on after the turn of the century social statistical investigations became an important area. After World War I Statistics Norway started to publish regular economic surveys.

A separate Research Department was not established, however, until 1950 on the initiative of the new Director General Petter Jakob Bjerve (1949-1980) who had strong academic interests and to whom applied economic and econometric research was a natural extension of the statistical work. In the years just preceding 1950 intensive efforts had taken place in establishing National Accounts, based on production statistics as the primary data source.

The pioneering national accounts work of this period was an empirical research frontier which should provide a basis for macroeconomic modelling and planning in the years to come. The national accounts system was completed in the early 1950s as one of the few internationally which produced detailed annual input-output tables.

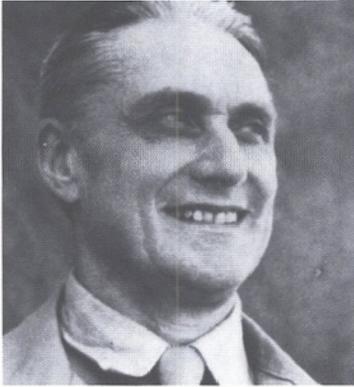
In the first decade the work of the Research Department comprised in addition to national accounts, tax research, monthly and annual economic surveys, and other economic research activities often directed towards improving methods of economic planning in the postwar period. Towards the end of the 1950s the first macroeconomic model of Statistics Norway – the MODIS I model – was developed as a simple input-output model, large in relation to the computer capabilities of the time. The model drew on inspiration from Leontief's pioneering work as well as the modelling experiments of Ragnar Frisch at the Institute of Economics (University of Oslo). The computer used to solve the MODIS I model from 1960 until its replacement in 1965 was a British built first-generation vacuum-tube computer called DEUCE, the only one of its kind in Scandinavia.

Anders N. Kiær





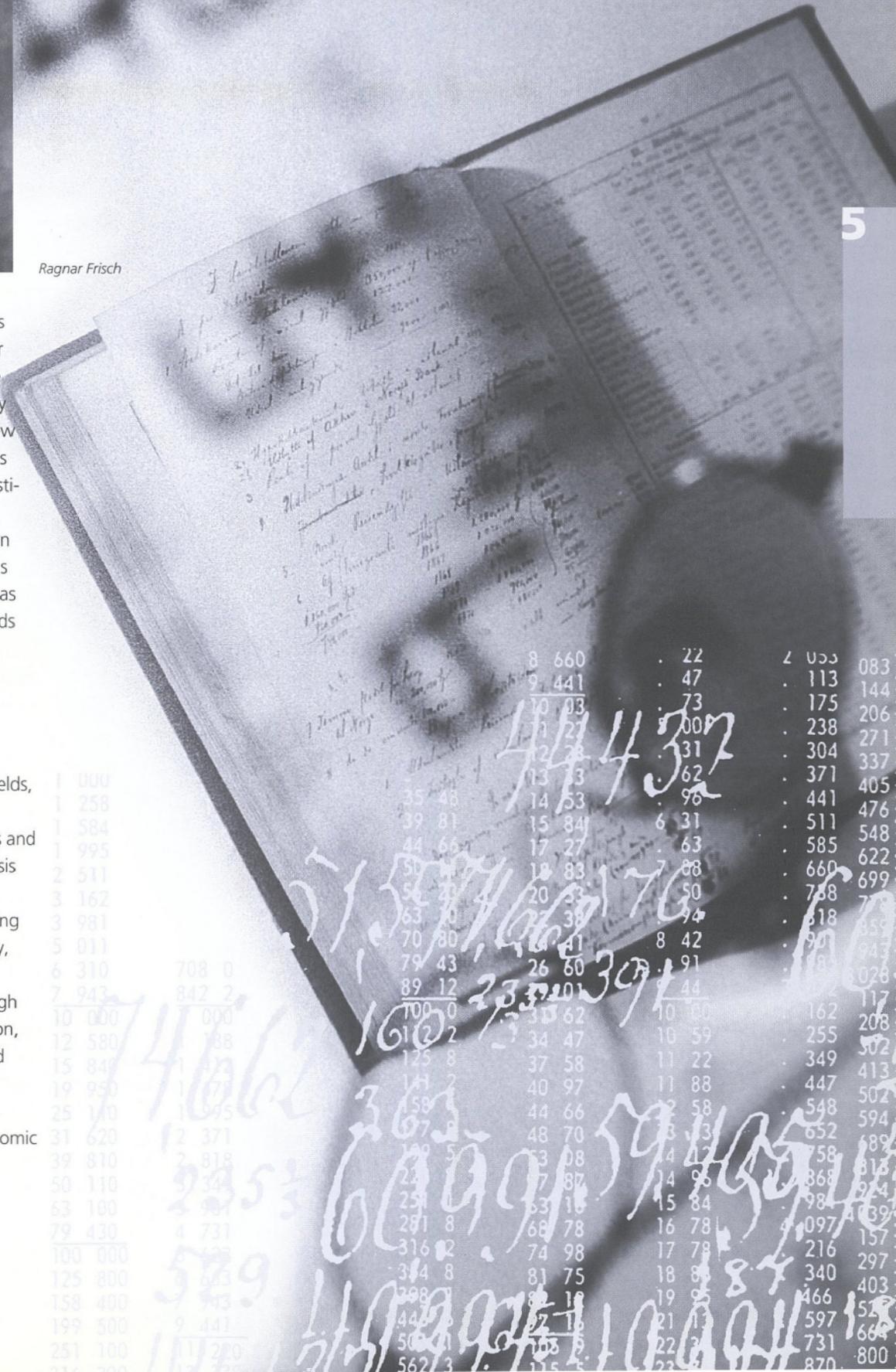
Petter Jakob Bjerve



Ragnar Frisch

Throughout the 1960s and 1970s models of the MODIS family, ever increasing in size continued to be developed and used intensively by policy makers. Around 1980 a new breed of macroeconomic models were finally taking over, and constituted the family of models used today. The 1960s also initiated an era of computer based tax models run by the Research Department as a service directed primarily towards the Ministry of Finance and the Storting (Parliament).

In the 1970s natural resource accounts and energy economics became new adopted research fields, later on after 1980 petroleum economics followed. In the 1980s and up to the current a major emphasis has been placed on developing microsimulation models, combining advances in computer technology, econometric methods, and data availability. These models, although far from having reached perfection, have been extremely versatile and useful vehicles for the analysis of societal change as a result of demographic development, economic growth, and government policy.



1 000		8 660	22	2 000	083
1 258		9 441	47	2 113	144
1 584		10 03	73	2 175	206
1 995		11 21	31	2 238	271
2 511		12 78	62	2 304	337
3 162		13 3	96	2 371	405
3 981		14 53	6 31	2 441	476
5 011		15 84	63	2 511	548
6 310		17 27	88	2 585	622
7 943		18 83	50	2 660	699
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125 800	2 818	48 70	4 12	3 572	1802
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199 500	3 712	57 87	15 84	3 722	2002
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316 200	4 606	68 78	17 78	3 872	2202
	5 053	74 98	18 88	3 947	2302
	5 500	81 75	19 95	4 022	2402
	5 947	89 16	21 13	4 097	2502
	6 394	97 16	22 3	4 172	2602
	6 841	105 9	23 2	4 247	2702
	7 288	115 5		4 322	2802

## General research objectives



*Directors of Research: Ådne Cappelen, Knut H. Alfsen, John K. Dagsvik, Olav Ljones and Assistant Director General: Olav Bjerkholt*

The general objectives of the Research Department's function within Statistics Norway are fourfold:

### **Enhanced empirical knowledge**

Statistics alone is an insufficient source of information for understanding the social and economic development. Analysis of statistical data by means of relevant theory and analytical methods and the use of models when appropriate may give enhanced empirical insight and deeper understanding of the phenomena under consideration. Such analytic knowledge beyond what can be derived from data alone, is inherent in many of the published results of the Department on the state of the economy, the environmental situation etc. Key parameters, such as the interest sensitivity of household saving or of the relation between economic growth and environmental deterioration, are examples of embodiments of empirical knowledge beyond the realm of statistics.

### **Analytical tools for monitoring economic and environmental development or government planning**

An important use of empirical insight gained is embodied in the design of tools for government planning, usually in the form of simulation models. Modelling activities are carried out in

close contact with user interests and with emphasis on government planning needs. Signals concerning needs will generally be channelled through research council programmes and direct contact with ministries. Analytical tools will often involve substantial operational commitments. In order to avoid an accumulation of operational tasks in the Research Department, continual attempts is made to make operation of existing models more efficient, and assessing the society's need and willingness to pay for continued operation.

### **Feed-back to the statistics**

Researchers in the Statistics Norway have a unique position close to the sources of data. The Statistics Act clearly states that this position should not be utilized to monopolize access to data. The proximity with the statistical work provides special opportunities for exploitation of the data expertise in the Statistics Norway, for special organization of data material and links to other sources, and for influencing the methods of collection of primary data. The analytic use gives feed-back effects to statistical work and may serve to improve the quality of the official statistics.

### **Cumulating competence**

Adequate expertise and scientific competence are obvious prerequisites for successful performance of research tasks. The research activity shall give results that can be utilized in the Norwegian society and provide documentation that high scientific standards in the analyses have been maintained. Good contact with research institutes and universities abroad and at home is necessity. Competence building and the maintenance of a high scientific level demands considerable resources.

<i>Department</i>	<i>Section</i>	<i>Division</i>
<b>Department of Economic Statistics</b>	<b>National Accounts Section</b>	<b>Administration Division</b>
	<b>Natural Resource Accounts and Environmental Statistics Section</b>	<b>Computer Processing Division</b>
	<b>Manufacturing and External Trade Statistics Section</b>	
	<b>Section for Economic Indicators</b>	
	<b>Public Finance and Credit Market</b>	
	<b>Labour Market Section</b>	
<b>Department of Statistics on Individuals and Households</b>	<b>Demography and Living Conditions Section</b>	<b>Administration Division</b>
	<b>Population, Education and Regional Statistics</b>	<b>Computer Processing Division</b>
	<b>Health and Social Welfare Section</b>	
	<b>Sample Surveys Section</b>	
<b>Department of Industrial Statistics</b>	<b>Business Registers Section</b>	<b>Administration Division</b>
	<b>Incomes and Wages Statistics</b>	<b>Computer Processing Division</b>
	<b>Primary Industries Section</b>	
	<b>Section for Transport, Communication, Construction and Private Services</b>	
	<b>Data Registration Section</b>	
<b>Research Department</b> Olav Bjerkholt	<b>Division for Public Economics</b> Olav Ljones	<b>Unit for Administration</b> Otto Gerhard Vaagen (from 1 June 1994)
	<b>Natural Resources Division</b> Knut H Alfsen	
	<b>Macroeconomic Division</b> Ådne Cappelen	
	<b>Microeconomic Division</b> John K Dagsvik	
<b>Department of Administrative Affairs</b>	<b>Budgeting and Accounts Section</b>	<b>Joint Services Division, Oslo</b>
		<b>Joint Services Division, Kongsvinger</b>
		<b>Personnel Development</b>
<b>Department of Coordination and Development</b>	<b>EDP Systems Development Section</b>	
	<b>Methods and Standards Section</b>	
<i>Other Sections</i>	<b>Information and Publishing Section</b>	
	<b>Computer Services Section</b>	

**Board**  
Åge Danielsen

**Director General**  
Svein Longva

**Age structure of the Research Department** (including personnel on leave)

11	10	21	20-29 years
29	21	50	30-39 years
18	13	31	40-49 years
3	1	4	50-59 years
		61	Men
		45	Women

**Distribution according to Occupational Group**

6	17	51	25	7	106	The Department
6	7	3	2		18	Head of Dep./ Unit for Adm.
4	11	3	1		19	Division for Public Economics
1	16	9	1		27	Natural Resources Division
5	16	8	2		31	Macroeconomic Division
5	5	1			11	Microeconomic Division

■ Office personnel	■ Academic staff
■ Administrative positions/ Executive officers	■ Research Fellows
	■ Executive positions

**Personnel in Research Department** (by February 1994)

Division/ Unit	Government Budget	Project	Total
Head of Department	1		1
Division for Public Economics	13	9	22
Natural Resources Division	14	12	26
Macroeconomic Division	15	11	26
Microeconomic Division	6	5	11
Unit for Administration	8.5	5	13.5
Research Department	57.5	42	99.5

**Current organization**

The Research Department is divided into four divisions, each led by a Director of Research.

*Division for Public Economics*  
*Natural Resources Division*  
*Macroeconomic Division*  
*Microeconomic Division*

Each division has its own responsibilities and research tasks. On an ad hoc basis the divisions join forces to cooperate on major studies or special investigations. A staff unit deals with personnel, finances, publication, and computer resources. (Until the end of 1993 there existed a separate staff unit for computer resources.)

**Personnel and budget**

The total staff in 1993 was roughly 100 persons. The distribution by division is given by the adjoining table. A complete list of persons employed by the Department is given on p. 10.

The financial resources of the Research Department stem partly from the government budget as allocated within Statistics Norway. About 40 per cent of total expenditures in 1993, or approximately Nkr 14 million are project financed.

The bulk of the project revenues comes from research grants from the Norwegian Research Council and from contracts with Ministries, primarily the Ministry of Environment, the Ministry of Finance, the Ministry of Industry and Energy, the Ministry of Local Government and Labour, and the Ministry of Foreign Affairs.

**Publications**

Most of the research results are published in the publication series of Statistics Norway, but often also in other contexts. Monographs are published in the series Social and Economic Studies, and other research reports in the Report series. Preprints, i.e. articles intended for book or journal publications, are published in the Discussion Papers series. There is also a Reprint series to make available journal articles and book chapters by staff employees. The Research Department publishes two periodicals: *Økonomiske analyser*, in Norwegian with 9 issues a year, and *Economic Survey*, in English with 4 issues a year. A complete list of all publications in 1993 starts at p. 33.

# 10 Persons employed

Staff of the Research Department as of 1 February 1994

## Head of Research Department

Bjerkholt, Olav,  
Assistant Director General

## Division for Public Economics

Ljones, Olav, *Director of Research*

Aslaksen, Iulie, *Research Fellow*  
Brunborg, Helge, *Sen. Research Fellow*  
Stølen, Nils Martin,  
*Sen. Research Fellow*  
Sørensen, Knut Ø., *Research Fellow*

Aarbu, Karl Ove (*Economist*)  
Andreassen, Leif (*Economist*)  
Arneberg, Marie W. (*Economist*)  
Fjærli, Erik (*Economist*)  
Fredriksen, Dennis F. (*Economist*)  
Hansen, André H., *Executive Officer*  
Hansen, Kirsten, *Senior Exec. Officer*  
Ivås, Eva, *Executive Officer*  
Langørgen, Audun (*Economist*)  
Lian, Bård, *Adviser (EDP)*  
Moe, Ann Synnøve, *Clerical staff*  
Mohn, Klaus (*Economist*)  
Stambøl, Lasse S. (*Demographer*)  
Thoresen, Thor Olav (*Economist*)

## Natural Resources Division

Alfsen, Knut H., *Director of Research*

Brekke, Kjell Arne, *Sen. Research Fellow*  
Bye, Torstein, *Sen. Research Fellow*  
Frenger, Petter, *Sen. Research Fellow*  
Gjelsvik, Eystein, *Research Fellow \**  
Glomsrød, Solveig, *Research Fellow*  
Johnsen, Tor Arnt, *Research Fellow*  
Vennemo, Haakon, *Research Fellow*

Aaserud, Morten (*Economist*)  
Bartlett, Sarita (*Economist*)  
Brendemoen, Anne (*Economist*)  
Brubakk, Leif (*Economist*)  
Bruvoll, Annegrete (*Economist*)  
Hansen, Mona Irene, *Exec. Officer*  
Johnsen, Torgeir (*Economist*)\*  
Katz, Alexandra (*Economist*)  
Larsen, Bodil Merethe (*Economist*)  
Lurås, Hilde (*Economist*)  
Malo, Solfrid, *Exec. Officer*  
Mysen, Hans Terje (*Economist*)  
Nesbakken, Runa (*Economist*)\*  
Nyborg, Karine (*Economist*)  
Rosendahl, Knut Einar (*Economist*)  
Spurkland, Gina, *Computer Scientist*

## Macroeconomic Division

Cappelen, Ådne, *Director of Research*

Bowitz, Einar, *Research Fellow*  
Eika Torbjørn, *Research Fellow*  
Holmøy, Erling, *Sen. Research Fellow*  
Holtsmark, Bjart, *Research Fellow*  
Magnussen, Knut, *Research Fellow*  
Moum, Knut, *Sen. Research Fellow*  
Olsen, Øystein, *Director of Research*  
Skjerpen, Terje, *Research Fellow*  
Swensen, Anders Rygh,  
*Sen. Research Fellow \**

Bjørnland, Hilde (*Economist*)  
Bye, Brita (*Economist*)  
Drzwi, Wenche, *Sen. Exec. Officer*  
Fæhn, Taran (*Economist*)  
Grünfeld, Leo Andreas (*Economist*)  
Holm, Inger, *Sen. Exec. Officer*  
Hove, Stein Inge (*Economist*)  
Haakonsen, Laila, *Executive Officer*  
Johansen, Per Richard, *Adviser*  
Lerskau, Lisbeth, *Sen. Exec. Officer*  
Lindquist, Kjersti-Gro (*Economist*)  
Naug, Bjørn (*Economist*)  
Nordén, Gunnar [*Conscientious objector*] (*Economist*)

Ouren, Jørgen, *Planning Officer (EDP)*  
Rolland, Mette (*Economist*)  
Storm, Erik (*Economist*) \*  
Strøm, Birger, *Sen. Exec. Officer*  
Svendsen, Ingvild (*Economist*)

## Microeconomic Division

Dagsvik, John K., *Director of Research*

Aaberge, Rolf, *Sen. Research Fellow*  
Aasness, Jørgen, *Sen. Research Fellow*  
Klette, Tor Jakob, *Sen. Research Fellow*  
Simpson, Margaret,  
*Visiting Research Fellow*

Johansen, Frode (*Economist*)  
Kornstad, Tom (*Economist*)  
Vatne, Bjørn Helge, *Adviser (EDP)*  
Wennemo, Tom, *Sen. Exec. Officer (EDP)*  
Wetterwald, Dag (*Economist*)  
Wikestad, Renée H.P.,  
*Computer Scientist*  
Zhu, Yu (*Economist*)

## Unit for Administration

Otto Gerhard Vaagen, *Head of Administration* (from 1 June 1994)

Bjørnstad, Knut, *Computer Scientist*  
Dihle, Anne Kari, *Sen. Exec. Officer* (Personnel)  
Rambøl, Hanne, *Sen. Exec. Officer* (Finances)  
Vågdal, Marit, *Exec. Officer* (Publications)

Fjeld, Ole Henrik [*Conscientious objector*] (*EDP*)  
Gundersen, Marit Berger, *Clerical staff*  
Johansen, Rune, *Computer Scientist*  
Karlsen, Anne Strandli., *Exec. Officer \**  
Kronlund, Tone, *Clerical staff \**  
Lysell, Kari Anne, *Clerical staff*  
Salvesson, Sigmund G., *Clerical staff*  
Skoglund, Anne, *Clerical staff*  
Veiby, Tone, *Clerical staff*  
Vogt, Yngve, *Computer Scientist*  
Vonheim, May Synnøve, *Clerical staff \**

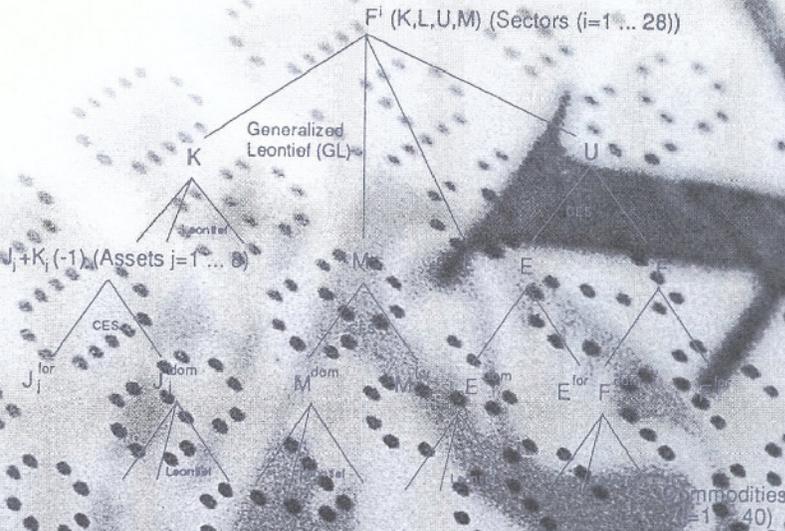
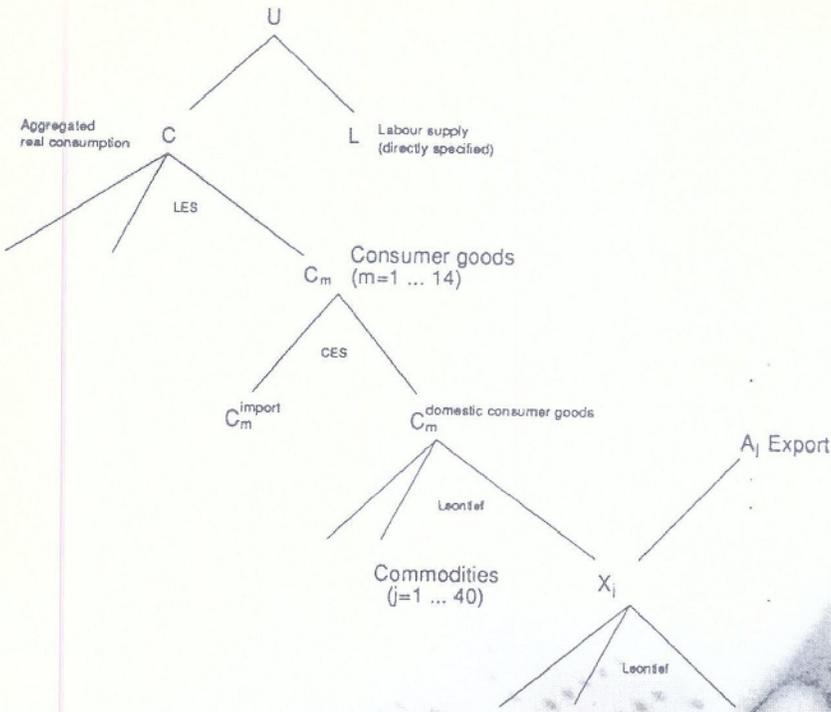
\* on leave

# Programmes

$$y_{p_j} = \frac{e^{X_j \beta_j}}{1 + e^{X_j \beta_j}}$$

22	300	---	MODAG
26	600		
27	670		
28	500		
30	500		
31	500		
32	500		
33	500		
34	500		
35	500		
44	600	1	30 31 32 33
53	800		
70	100		
71	80		
87	100		
101	200		

390



12

## Macroeconomic analysis

13

### Business cycle analysis

As in earlier years the Research Department in 1993 published – parallel editions – Økonomiske analyser (in Norwegian, nine issues)/ Economic Survey (in English, four issues) comprising the annual Economic Survey of the preceding year and three quarterly economic surveys. In addition to presenting the quarterly national accounts and other short term indicators the quarterly business cycle surveys also provide a brief presentation of the main international economic trends and a forecast of the macroeconomic development of the Norwegian economy. The forecast is undertaken by means of the quarterly macro-econometric model KVARTS (see below). The KVARTS model is also used to provide alternative scenarios for the Government appointed Expert Committee for Income Settlements in connection with the annual wage and income negotiations.

**The objective of the macroeconomic analysis within Statistics Norway is to analyze the state, functioning, and development of the Norwegian economy by exploiting internal and external data sources and by developing and utilizing macroeconometric models other analytical approaches.**

In the third quarterly survey of 1993 a study of possible effects of lower interest rates in Europe was presented using the Global Econometric Model (NIGEM) of the National Institute of Economic and Social Research (United Kingdom). One conclusion from the study was that a lowering of the short-term interest rates alone is not sufficient to improve economic conditions very much, as for most countries it is mainly the long-term interest rates that affect private sector demand. If long-term rates are considered determined by forward-looking expectations of short-term rates, then the market will have to believe in a more permanent change in monetary policy with regard to short-run rates if long-term rates are also to come down. With forward-looking expectations also with respect to exchange rates, the initial exchange-rate changes will be stronger.

Without a substantial and lasting decline in German short-term rates, the analysis shows that it is necessary to have a clearly signalled and coordinated change in monetary policy in the other main European countries if monetary policy is to contribute to higher growth.

Project leaders: *Knut Moum and Øystein Olsen*

### **Business cycle history**

This project aims at analyzing Norwegian business cycles since the early 1970s. Previous studies have analyzed earlier periods after World War II. The purpose of the project is partly to isolate different "shocks" to the economy. Such shocks are e.g. demand and supply shocks coming from abroad, shocks of domestic origin such as the build-up of the oil sector which had both supply and demand effects, and finally, policy shocks. Another part of the project is to relate model based simulations with theories of business cycles. During 1993 most of the work on the project consisted in creating and checking the quarterly database for the KVARTS model and preparing historical simulations to study the model's ability to reproduce the history. One study REP 93/23 analyzing factors behind the increase in unemployment from 1987 to 1991 has been published. Different filtering techniques have been compared and analyzed in order to derive some stylized properties of Norwegian business cycles. A real business cycle model for the Norwegian economy is also being developed as an alternative to the traditional econometric modelling strategy of the Department.

Project leader: *Per Richard Johansen*

### **Macroeconometric models**

The Research Department possesses two major macroeconometric models, the quarterly KVARTS model and the annual MODAG model. The further development of these two models is regarded as a joint programme. During 1993 both models were reestimated. Most econometric equations change little in the annual reestimation. The quarterly model has been equipped in 1993 with a labour supply block quite similar to that of MODAG. Aggregate labour supply is quite inelastic with regard to the after-tax consumer real wage but quite responsive to changes in labour market conditions and thus contains a strong discouraged-worker effect. The wage equations have not been changed much and imply quite strong wage-wage spirals between sectors on top of the traditional wage-price spirals. The equations are based on a standard bargaining framework with wedges due to income taxes, employers' taxes and differences between producer and consumer prices.

Work are in progress to improve the specification of the labour market including wage formation in the macro models by disaggregating labour into different groups using education as the main criterion. A report REP 94/2 describing the data base and a simple model that presents gaps between supply and demand for different categories has been published. Research on possible

substitution effects between different labour groups is underway. One object of this research is to establish the responsiveness of labour demand to more wageflexibility with regard to relative wages.

A major research activity for some years has been to explain consumer behaviour in a better way. One concern, preoccupying many Norwegian economists for some time, has been to uncover the factors behind the dramatic changes in the household savings ratio from 1984 to 1992. Our research so far concludes that the deregulation of the domestic credit market in the mid-1980s is a major factor. However, changes in household wealth partly induced by swings in housing prices which also may have been influenced by credit market deregulation, are also important. Changes in after-tax real interest rates have some effect too, partly due to income effects but also through effects on housing investment.

A project on inventory investment in manufacturing has compared the traditional production smoothing model with the sS-model of inventory behaviour. The results indicate that no model seems to dominate the other in the sense that inventory behaviour seems to vary between different sectors. There are some interest rate effects in the specified

## Macroeconomic models

All of the Statistics Norway's macroeconomic models have been built up on the basis of the account system of the national accounts. The core of the models is input-output connections for supply and utilization of specified goods and services. Linked to this core are behaviour relations etc. for different sectors of the economy.

The MODAG model has an input-output core with 41 goods and 33 production sectors. This model is particularly suitable for analysis in the medium term. The behaviour relations cover production, consumption, investment, imports-exports, prices, interest rates, and wages and the labour market. The Ministry of Finance is an important user of the MODAG model for forecasts and economy policy analyses.

The KVARTS model is a quarterly model which contains largely the same type of behaviour relations as MODAG, but is more aggregated. The input-output core has 24 goods and 18 production sectors. In the model great emphasis is placed on dynamic short-term contexts, meaning that much of the progress is determined by developments in previous quarters. The model is used in business cycle analyses and for work in the Expert committee for Income Settlements.

The MSG model is an applied general equilibrium model which describes an economy characterized by perfect competition, flexible prices and full utilization of labour and capital. The aggregation level and input-output structure in the official version of the model, MSG5, are identical to the MODAG model. The model is particularly suitable for studies of changes in industry structure along a growth path for the economy and for analyses of policies that affect the economy's supply side. The Ministry of Finance is an important user of the MSG model.

equations that was not included in the models before. This leads to an increased interest rate sensitivity of demand in our models compared to earlier versions.

A study comparing stochastic simulation properties of KVARTS with traditional deterministic simulations was completed in 1993. The basic result is that the differences between point forecasts are small, which is the usual conclusion in the literature. The study also shows that combining simulations of error terms with those of parameters does not widen confidence intervals very much, see REP 93/20.

Project leader MODAG: *Einar Bowitz*  
Project leader KVARTS: *Torbjørn Eika*

### General equilibrium models

The Research Department has for 20 years developed and used successive versions of the Multi-Sectoral Growth (MSG) model which originated in Leif Johansen's doctoral thesis of 1959.

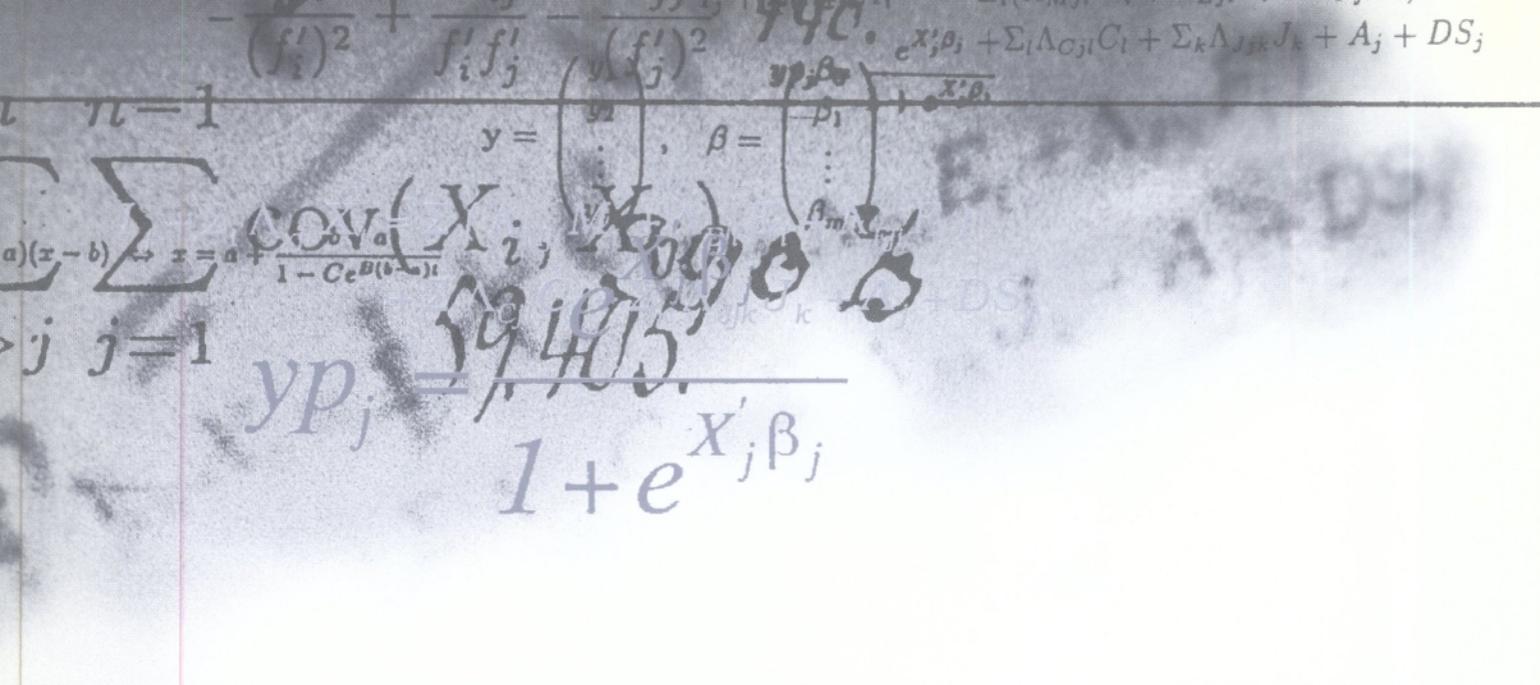
The MSG model was used intensively in preparation of the Government Long Term Programme 1994-97 published in April 1993. The model has been adapted to be more suitable for energy and environmental studies. A detailed submodel of electricity supply, including both hydro and potential gas power production, has been included. Changes in the consumer demand block improving

the modelling of demand for cars, petrol and public transport have been carried out. Finally, a detailed modelling of environmental taxes that affect producer and consumer behaviour as well as government revenue, has been included.

The data base of the model has been extended to analyze "effective rates of assistance" (ERA) of 18 industries. A report REP 93/31 from this project discusses both conceptual, methodological and empirical problems related to the ERA approach. The calculations consider the partial and joint effects of i) taxes and subsidies, ii) tariffs and non-tariff barriers to trade, iii) price discrimination in the market for hydro power electricity and iv) capital income taxation. The study is part of a more general analysis of economic consequences of industrial policies.

While the current MSG model is based on assumptions of perfect competition and myopic decision rules, the development of a revised model embodying imperfect competition and perfect foresight started in 1993. As the model is quite disaggregated in terms of sectors, there may be severe difficulties in simulating such a large model with leads in many variables. That remains to be studied in 1994.

Project leader: *Erling Holmøy*



## 16 Microeconomic research

**A long tradition within the Research Department is econometric analyses of micro-data collected by Statistics Norway and application of estimated behavioural relations and welfare measures in policy simulation experiments. The overall aim has been to establish a micro-based system of structural behavioural relations for households and firms. Adequate theory and methods for econometric analysis is developed and adapted for this purpose. The micro-econometric research activity within Statistics Norway emphasize empirical studies and the application of findings from these in the Department's inventory of macroeconomic models and microsimulation tools.**

### Discrete choice

The activity within this field includes the development of theory and methodology for structural analysis of discrete data, with particular reference to:

- (i) Characterization of transition probabilities for individual choices that take place over time,
- (ii) Modeling two-sided search/matching behaviour in markets with flexible contracts and limited information,
- (iii) Characterization of models for discrete and continuous choice.

Work on these topics is reported in DP 79, DP 80 and DP 94.

Project leader: *John K. Dagsvik*

### Labour supply

The labour supply studies are focused on estimating empirical models that account for nonstandard budget constraint (such as kinked and nonconvex tax systems), and non-pecuniary job attributes (such as type of work). Currently, much effort is spent on revising and extending empirical work to allow preferences to depend on pecuniary and non-pecuniary job attributes, and to account for unemployment.

Project leader: *John K. Dagsvik*



### **Consumer behaviour**

Studies on consumer demand are concentrated on estimating and implementing consumer demand systems into macroeconomic and microsimulation models. The implementation of results from micro-econometric consumer demand studies, see Reprint 68, DP 89 and DP 105, includes a consumer demand system in the general equilibrium model MSG, in the macro model MODAG (including detailed and updated rules for indirect taxation), and in the microsimulation model LOTTE (with detailed and updated rules for direct taxation). This system of models can be applied to study implications for the distribution of welfare from changes in direct and indirect taxes. A typical application carried out last year was to compare the welfare effects of child allowances and food subsidies. As a first step towards refining the models of demand for durables, analyses of household demand for automobiles and potential demand for alternative-fuel-cars (such as electric cars) were started in 1993.

Project leaders: *Jørgen Aasness and John K. Dagsvik*

### **Producer behaviour and productivity analyses**

Studies are conducted on investment, foreign ownership, patents, market power, R&D and productivity. Currently, the relationship between R&D-investment and firm performance, such as profits and productivity, is under investigation. Other topics where work is in progress are: The relationship between physical investment and the financial condition of the firm, the possibility of using patents as an indicator of R&D activity, and the pattern of entry and exit of firms, see DP 93.

Project leader: *Tor Jakob Klette*

### **Welfare and inequality**

The aim is to establish a theoretical foundation for partial and complete welfare measures and measures of inequality, as well as applying these measures for empirical analyses. Typical empirical applications which were carried out last year included analyses of trends in the distribution and inequality of income during 1973-90 in Norway, and variations (mobility) in households' incomes during 1986-1990. Some of these results are reported in REP 93/17.

Project leader: *Rolf Aaberge*



## 18 Taxes, transfers and income distribution

**The Research Department have for many years had the responsibility for tax simulation models used both by the Ministry of Finance and the Storting (Parliament). The models are also used for other analytical purposes. The present model strategy is concentrated on microsimulation models, both static and dynamic.**

### **Tax-benefit models – LOTTE and ODIN**

LOTTE is a static tax-benefit model, the first version of which originated in the early 1970s. The model is based on data from the Norwegian Income Survey, i.e. a sample of individual tax returns. The income definitions are mostly derived from the income concepts defined by the tax code. Some income components are extracted from administrative registers (government transfers). Household characteristics are recorded by interview.

The sample used in 1993 was based on tax returns for 1991. The sample size varies from year to year. For 1991 the sample included approximately 24 000 individuals (8 000 households). The sample data are updated to 1994.

Sophisticated calibration methods are applied to force the estimates for some income components to match totals from the tax register. The individual records can be aggregated to households, married couples and weighted in terms of consumption units. The model includes income distribution calculations, e.g. Gini coefficients.

The basic model includes only direct taxes but has been extended in 1993 by a module for econometric simulation of consumption. The new module (LOTTE KONSUM) allow calculation also of indirect taxes and simulation of policy mixes with both direct and indirect taxes. The model will be further extended in 1994 with a module for social security benefits using data from the solid security registers and social security compensation rules.

An important element in the recent Norwegian tax reform was to split by imputation the income of unincorporated businesses in labour remuneration and capital income. The tax reform will be evaluated in 1994 using a specially adapted version of LOTTE.

The data sets in the microsimulation models LOTTE and MOSART (see page 20) will be made available as anonymized micro datasets – model populations – in 1994.

Staff: *Karl Ove Aarbu, Marie W. Arneberg, Kirsten Hansen, Bård Lian and Thor Olav Thoresen.*

ODIN is a "law model" that calculates taxes and benefits for stylized defined households. The model simulates taxes (marginal and average rates) and disposable income for given household characteristics such as family composition, pension status, and income components. The model includes time series from 1980 and can be run on PC or work station. Simulations are run on request; the model is also installed with external users, e.g. ministries .

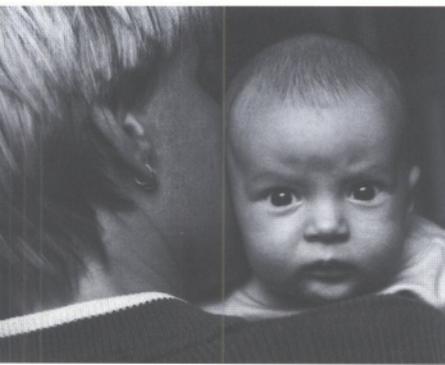
Staff: *Marie W. Arneberg, Kirsten Hansen, Bård Lian and Ann Synnøve Moe.*

**Transfers to children**

The aim of this project is to analyze the distributional results of transfers to parents with children. Descriptions of the actual influence from transfers to children on the income distribution are given. The project uses data and simulation modules from the tax-benefit model LOTTE with additional simulation procedures established for this project.

The measurement of income distribution and poverty for different household types raises many problems, e.g. the choice of unit (household/ individual) and equivalence scale. The project has tried to show how the distributional conclusions depend upon the measurement definition.

A new module, for simulation of the birth benefit is recently established within the LOTTE tax-benefit model. A simulation module for child care subsidies will be completed in 1994. The latter module also includes behavioural effects of changes in child care subsidies and, hence explicitly considers labour supply effects of changes in taxes and transfers.



REP 93/26 shows the distributional effect of child allowances and child-related tax deductions. Results from this study have also been used by a government appointed committee to recommend reductions in public transfers, see [30]. The project has been supported by the Norwegian Ministry of Children and Family Affairs.

Staff: *Thor Olav Thoresen*

**Corporate taxation and behaviour**

The project tries to shed light on the utilization of accelerated depreciation and tax exempt funds, a field of growing international interest. The first part of the project was completed in 1993, see [25]. The plan for 1994 is to extend [25], by developing a better theoretical foundation and using a richer data set in pursuance of ideas embedded in the Södersten/Kanniainen model of why corporations may not utilize accelerated depreciation fully. The work will be a cooperative effort with Jeffrey K. MacKie-Mason, University of Michigan and Diderik Lund, University of Oslo.

Staff: *Karl Ove Aarbu*

**Tax incentives and corporate financing behaviour**

The project investigates the effects of tax asymmetries on financing behaviour in Norwegian corporations, using panel data for the period 1986-1991. Differences across firms, stemming from different probabilities of tax-exhaustion, as well as differences over time from changes in the personal tax code, are studied. The empirical findings indicate that firm-specific tax incentives clearly have significant effects on financing behaviour, while the effects of changes in the personal tax code are ambiguous. Special attention is paid to the role of tax incentives when firms face limited financial flexibility and tax effects are most likely to occur in the firm's retention policy, as the most flexible source of financing. For preliminary results, see [36].

Staff: *Erik Fjærli*

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Land Districterne

## 20 Labour force, population and regional models

**The aim of the projects under this heading is to provide microsimulation model tools for the projections of the labour force, including education status and attainment, and social security rights and status, as well as appropriate model tools for studying the development of regions (grouping of counties) and the municipal sector.**

### **Projections of labour force, education and social security**

MOSART is a dynamic, cross-sectional, stochastic microsimulation model, that projects population size and composition, labour force, educational level and future pension benefits. It projects demographic events such as immigration, emigration, death, births, marriages, and divorces, and the individual incidence of education, disability, retirement, labour force participation and labour market earnings. The current version of the model simulates life histories for a one per cent sample of the Norwegian population above 15 years, i.e. a model population of 30-35 000 individuals in each simulation year, see REP 93/6.

MOSART is a discrete time model with one year intervals and has a recursive structure. The simulation is sequential, simulating all events that occur for all individuals during one year, with later events to a large degree dependant upon earlier events. Transition probabilities have been estimated as conditional probabilities. MOSART is mainly a demographic model where educational transition probabilities, the transitions into disability, labour

force participation rates and labour market earnings depend in the model only upon demographic variables. The impact of economic variables can be introduced by exogenously changing the relationships between the above variables and the underlying demographic variables. The initial population is large with no synthetically generated variables. Data registers covering the whole population are utilized in the estimation of the transition probabilities.

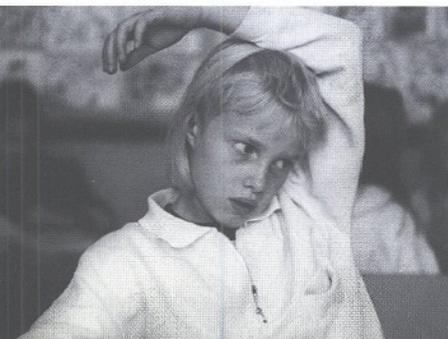
For each year the model supplements the model population with new 16-year-olds and immigrants, and simulates emigration and mortality for the existing population. Births are simulated, followed by marriages and divorces. Changes in marital status are female dominant, by the use of female marriage rates. The model simulates educational activity, disability and retirement. Labour force participation and the resulting earnings are simulated last and depend upon the other events. The probability for entering disablement status is estimated from register data with covariates as sex, age, education and labour market experiences.



The simulation period in the current version of the model is from 1990 to 2050. MOSART was used extensively during 1993 to analyze the long run development in disability and old-age pensions covered by the Norwegian National Insurance System, see REP 93/78 and [30]. The number of pensioners will increase relative to the number of workers, leading to a growing tax burden on future generations.

An extension of the model to cover household formation and dissolution will be completed in 1994. The modelling of transitions through the educational system will also be improved in 1994 by the inclusion of unemployment and the capacity of the education system as explanatory variables for choice of education. The future sectoral labour market balances will be reported upon under a project financed by the Directorate of Labour.

Staff: *Leif Andreassen, Helge Brunborg, Dennis Fredriksen and André Hvaal Hansen.*



### **Regional analysis**

REGARD is a regional model system for the Norwegian economy based on regional national accounts and other statistical sources. The core model for production is based on 7 regions and 28 industrial sectors. A demographic model block take care of internal migration and labour force participation. The model system as a whole provides projections of the labour market balance in the regions. The model gives a link between demographic and economic trends in the regions. There is a strong link to the macroeconomic model MODAG. The REGARD model replaces the earlier REGION model.

The REGARD model was completed in 1993. Preliminary results from applying the model, giving regional breakdowns of the Long Term Programme of the government, have been published in [36].

In 1993 this project cooperated with several statistical divisions of Statistics Norway about regional data needed in the accession negotiations with EC, and took part in the planning of the next regional national accounts.

Staff: *Eva Ivås, Klaus Mohn, Lasse Stambøl and Knut Sørensen.*

### **Analysis of the municipal sector**

MAKKO is a macro model for municipal sector at the aggregate level, with a link to the macro-econometric models. The model contains submodels for the municipal service sectors as preschool institutions, schools, health care, social care and old age care with data for the population that will be covered by the service and the use of resources within the sectors. Important parameters in the model are description of the coverage of the services (per cent of population that receives the service) and the standard (a crude measure is man-hours per client). MAKKO describes how municipal employment and production of services depend on population changes. The model is used to project number of clients, manhours performed and cost on municipal administration.

The MAKKO model has obtained a revised sector structure and data according. A method for disaggregation of man-hours by sectors has been developed. Results from simulations of the revised and updated model will be reported in 1994.

Results from econometric time series modelling of local public spending behaviour will be published in 1994. The model endogenizes local public consumption, the capital stock and net financial wealth in Norway at aggregate national level, assuming that local public disposable income is exogenous.

Staff: *Audun Langørgen*

## Natural resources and environmental management

**The primary objective of this research area is to provide models and analytical capacity able to shed light on the interactions between the management of the environment and the natural resources, and economic development. The main user groups are governmental bodies, although informing the general public is also emphasized. The work is organized around three main projects: one on the domestic aspects of energy use and the associated environmental impacts, one on international aspects of energy supply and demand, and one on methodological problems related to the integration of economic, environmental and natural resource issues within a national or international management context.**

### **The SAMMEN project**

SAMMEN is a Norwegian acronym for Society, Environment and Energy. The project is part of a larger Norwegian research programme aiming at improving the knowledge and modelling tools necessary for the authorities to formulate and carry out a rational energy policy with due regard to the environmental impacts of energy use.

Much of the project is related to the management of the extensive hydro power resources of Norway. The deregulation of the domestic energy market and the liberalization of international trade in electricity have potentially large ramifications both for energy policy, e.g. through proper pricing of the energy resources, and

for environmental policy through the impact on emission of greenhouse gases. The question of the impact of delivered effect and the peak load on the optimal pricing structure will be studied in 1994. The focus of our effort is the macroeconomic model MSG-EE (see box).

The SAMMEN project also analyses issues related to fossil fuel use, and the associated air pollution. Particular emphasis is put on the benefits of controlling future emission of local air pollutants, and how these benefits will affect the cost-benefit ratio of policy proposals in particular climate policies. In recognition of the central role of transport, greater emphasis has been put on studies of the linkages between investment in transport infrastructure, use of cars and environmental impacts. Other external effects of transport, such as traffic accidents and congestion costs are also covered.

## **Multisectoral Growth – Energy and Environment: MSG-EE**

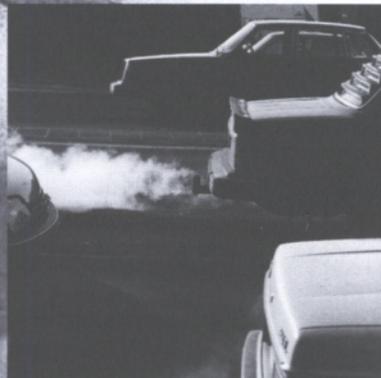
*MSG-EE is a variant of the official version of the MSG-model MSG5, distinguished by a more detailed modelling of transport activities. Domestic commercial transport is produced in five sectors covering road, rail, air and boat transport as well as post and telecommunication services. Transport is also produced in other producing sectors for own consumption (own transport). In MSG-EE transport is treated as a separate input factor in production, in addition to the usual capital, labour, energy and materials set of input factors. Finally, the households have a choice of consuming own or public road transport.*

The impact of road transport on the economy and the environment will be further studied in 1994. While the effort in previous years has concentrated on clarifying the impact of road transport on air quality, accidents, congestion, etc., the plan in 1994 is to focus on the role of investments in transport infrastructure (roads), in particular whether the considerable investments made in the transport sector over the years have paid a reasonable dividend in terms of economic growth.

Earlier estimates of the economic productivity losses due to air pollution will be updated. While previous estimates were to a certain extent based on subjective assessments by experts, the work in 1994 will aim at incorporating physical damage functions in economic models, and thereby assess the economic value of the ensuing productivity losses.

The Research Department has a strong tradition in integrating studies of economic growth, energy use and air pollution problems. In 1994 the experiences from this work will be applied to the issue of waste generation and handling. The aim is to be able to analyze waste generation and economic growth in a consistent manner within a unified modelling framework.

Project leader: *Torstein Bye.*



### **International energy and environmental issues**

The project on international energy and environmental issues has as its main objective to analyze problems related to Norway's considerable oil and gas resources. As most of the oil and gas resources are exported, the demand for these products requires an understanding of international, in particular Nordic and European, oil and gas markets. Demand side models covering the Western European and Nordic energy markets have been developed, as well as a game theoretic model for the supply of natural gas to the European market.

The use of fossil fuels in Europe have a strong impact on the Norwegian state of the environment through deposition of transboundary pollutants, thus, the European energy demand model SEEM (see box) is linked to the RAINS model developed by IIASA, making it possible to analyze national emissions, transport and depositions of acid compounds due to changes in for instance the taxation of energy in Western Europe.

The Department will take part in several international projects in 1994. A model for studying the supply of gas to the European market will be studied in co-operation with the CORE institute in Belgium. Scenarios for the use of natural gas in Europe will be analyzed in a cooperation with the Dutch ECN institute and Statoil, the SEEM model will be used, in conjunction with the RAINS model, to analyze scenarios of an integrated Europe and of an Europe marked by disintegration, respectively. The Department will also cooperate with the Battelle Northwest Pacific Laboratory in USA in development of a global economy-energy-carbon emission model.

Project leader: *Snorre Kverndokk*

### **International models**

#### **Nordic energy demand model**

*This model is a regionalised partial equilibrium energy model for the Nordic countries (Norway, Denmark, Sweden and Finland) covering the most important energy carriers in this region. Supply functions and an energy transport network is linked to a demand model comprising three manufacturing sectors, a service sector, four transport sectors and the households. The demand for energy in Iceland is covered in a separate model.*

#### **Sectoral European Energy Model (SEEM)**

*The Sectoral European Energy Model (SEEM) is a model for the calculation of future demand for fossil based energy in nine Western European countries given an economic development path, and price paths for oil gas and coal at the import level (cif). The model calculates end user prices including taxes and demand for solid, liquid and gaseous fossil fuels from manufacturing industry, services, transportation, power production and households. For given supply paths of non fossil electricity, the model computes equilibrium prices and quantities of electricity based on the average incremental cost of conventional power and relative energy prices. The model also comprises a routine for calculating emissions of CO<sub>2</sub> from fossil fuel use.*

**DYNOPOLY – a DYNAMIC  
OligoPOLY model for the  
European gas market**

*The game depicted by the model is essentially an investment game between dominant natural gas suppliers (Algerie, former USSR and Norway) facing a deregulated gas market with no intermediate barrier between suppliers and end users. The demand region is continental Western Europe. Each player possesses a bundle of strategic investment options. In the beginning of each five-year period they can make use of one or more of the remaining options, or none. The moves are made simultaneously, only previous investments are known. The investments are operative from the next period. The players maximize discounted cash flows over the remaining horizon. They have full information of demand, options and costs and can predict the other players' best moves. The model is solved by dynamic programming, and the solutions are perfect Nash equilibria. In equilibrium, the players balance the profits from discouraging the opponents' supplies by making an investment, against the profits from restricting supply by postponing the investment.*

**Methodological issues**

The methodological issues related to natural resources and environmental management cover such diverse topics as the selection of a useful and operational set of environmental indicators, including the issue of a "greening" of the GDP and the integration of the natural resource accounts and the national accounts, and welfare theoretical and ethical questions related to the monetary valuation of natural resources and environmental services. Also of concern are topics related to the modelling of the intertemporal nature of many natural resource and environmental problems.

Besides providing a forum for research on methodological and fundamental issues related to natural resources and the environment, a central objective of this project is to provide ideas for the future development of the inventory of models operated on a more or less permanent basis by the Department. For instance, a recent proposal is to use the macroeconomic models as a basis for projecting the long term waste generation in Norway.

Many, if not all, environmental and natural resource issues are of an intertemporal nature. In 1994 work on extending some of the macroeconomic models of the Norwegian economy to incorporate aspects of intertemporal optimization will be carried out. This work has, besides the formulation of the economic relations, also a computer science aspect, where the development of efficient algorithms is central.

Project leader: *Kjell Arne Brekke*

Traditionally the work of the Research Department has focused on aspects of the Norwegian society. In recent years there has been a small portfolio of research projects aimed at analyzing aspects of developing countries, often in contact with research institutions or government bodies in the respective countries. These projects are spin-offs from the domestic work in the sense that they draw heavily on the experiences and tools developed in a Norwegian context. Financial support is usually given by the Norwegian Council, government contacts, or international institutions. On an ad hoc basis senior staff also will occasionally take part in missions, research parties, project work, or studies organized by international organizations such as United Nations, the World Bank, the International Monetary Fund, Organization of European Cooperation and Development, etc on problems related to developing countries.

Under a general agreement between Statistics Norway and the Norwegian Ministry of Foreign Affairs and the Norwegian Agency for Development (NORAD) some means are allotted each year for special studies. In 1993 there has been work on the structural adjustment programmes for Africa and on the population problem and the incidence of AIDS in Africa. A report on Mozambique's macro-economic performance has been prepared, and also reports on the demographic and social consequences of AIDS in African countries.

Sponsored by the Norwegian Ministry of Environment the Research Department has in 1993 taken part in an ongoing cooperation project with the Indonesian Ministry of Environment on developing a general equilibrium model for environmental analysis in Indonesia.

A cooperation over several years with the State Statistical Bureau of China comprising two projects, one on analysis of Chinese household data and one on establishing a macroeconomic model of China was brought to a temporary halt in 1993 as the financial resources run out.



Studies have also been undertaken of structural adjustment, soil erosion and deforestation in Nicaragua. Emphasis in this project is on the general equilibrium effects of soil deprivation on both economic performance in the long run and social conditions as determined by migration and the economic conditions for different social classes. The aim is to provide an integrated analysis of the prospects for economic growth and its environmental impact and vice versa. Similar studies will be initiated in 1994 also for Tanzania. A study of integrated environment-economy modelling of Ghana will also be initiated in 1994, supported by the World Bank.

Some examples of

## Research Department projects in 1993

27

**Table 1.** Norwegian energy use. Percentage change from the reference scenario. Year 2010

	<b>Harmonization scenario</b>	<b>Increased tax scenario</b>
Hydro power capacity	+3	+10
Electricity demand	-1.5	-5.3
Fossil fuel demand	+0.7	-7.0

### **Climate policy, carbon emissions and international trade in electricity**

Opening up the electricity market for international trade will affect the Norwegian market mainly by linking the Norwegian price of hydro power to the international price of electricity from fossil fuel combustion or nuclear power. In this way an international treaty specifying a tax on carbon emissions will also imply an increase in the price of the carbon free hydro power. The consequences of this linkage between foreign and domestic electricity prices have been studied by linking the general equilibrium model MSG-EE with an engineering model describing the power systems in the Nordic countries and the northern part of Germany.

Three scenarios have been developed. In the reference scenario it is assumed that Norwegian CO<sub>2</sub> taxes are kept at the current level (Nkr 150 per tonne of CO<sub>2</sub>) until year 2010, while foreign carbon taxes are assumed to grow towards 50 per cent of the Norwegian tax rate in the final year. In the harmonization scenario, the Norwegian tax rate is set equal to the international level, both increasing so as to reach the Norwegian level in the reference scenario by 2010. Finally, in the increased tax scenario, accelerated growth in carbon tax rates from current levels is assumed both for Norway and even more abroad, so as to equilibrate the tax rates at Nkr 350 per tonne of CO<sub>2</sub> by 2010. The impact of these tax policies on Norwegian energy use are outlined in table 1.

**Table 2.** Total CO<sub>2</sub> emissions in the Nordic countries and Northern Germany. Change from the reference scenario. Million tonnes CO<sub>2</sub>. Year 2010

	Harmonization scenario	Increased tax scenario
Norway	0.1	-0.5
Other Nordic countries and Northern Germany	-5.0	-16.5
Total	-4.9	-17.0

Higher foreign demand for electricity increases the hydro power capacity in Norway in the alternative scenarios. At the same time, the increase in the price of electricity depresses the domestic demand for electricity. In the harmonization scenario part of the energy demand is met by an increased use of fossil fuels, which becomes relatively cheaper than electricity for heating purposes. In the increased tax scenario, the increased overall energy price makes the demand for fossil fuels even lower than in the reference scenario. Table 2 shows the aggregate effects on CO<sub>2</sub> emissions.

The CO<sub>2</sub> emissions follow closely the response in demand for fossil fuels. Even though the Norwegian emissions increase in the harmonization scenario relative to the reference scenario, the overall emissions are substantially reduced. This illustrates that national carbon emission targets may not be the best policy in the quest for a global reduction in carbon emissions.

Project workers: *Tor Arnt Johnsen and Bodil Merethe Larsen.*

Financial support: *Ministry of Industry and Energy, The Norwegian Petroleum Institute and the Ministry of Environment.*

Reference: *Article by Jarlset, T., T. A. Johnsen and B. M. Larsen in Økonomiske Analyser 7/93.*

### Marginal cost of funds when external environmental and transport effects are included

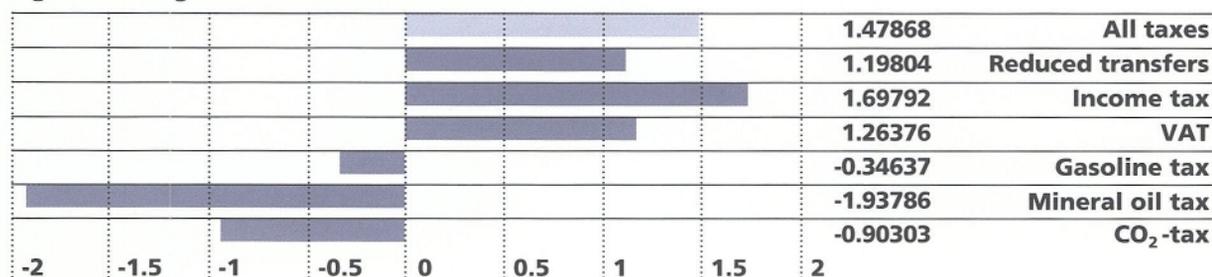
Tax policy and environmental policy are also linked in other ways than through the power market. In a study of the marginal cost of public funds, based on the Norwegian multi-sectoral general equilibrium MSG-5 model, some possible benefits of reduced fossil fuel use are taken into account. The benefits are mainly related to reduced health damage and less damage from road traffic (e.g. congestion, accidents, damage to roads, etc.) following a reduction in use of fossil fuels. While the marginal cost of income taxation is found to be of the order of 1.70, i.e. 1 Nkr additional income from income taxation imposes a total cost on the economy of Nkr 1.70, raising 1 Nkr by way of taxing mineral oil benefits the economy by Nkr 1.94, see figure 1. The marginal benefit of environmental taxation is likely to be decreasing when the tax rate is increased. Still, the study provides strong arguments for increasing the tax on fossil fuels and decreasing the income tax level.

Project workers: *Haakon Vennemo and Anne Brendemoen*

Financial support: *The Norwegian Research Council.*

Reference: *DP 99*

Figure 1. Marginal costs of taxes. Nkr



### The EC carbon/energy tax and its implication for transboundary pollution

Introducing a carbon/energy tax in the European Union (EU) along the lines proposed by the European Commission (i.e. a 10\$/barrel tax on fossil fuels in year 2000), will not only reduce the carbon emissions, but also emissions of transboundary pollutants such as sulphur and nitrogen.

Sulphur and nitrogen emissions are presently regulated by the Helsinki and Sofia protocol, which stipulates that sulphur emissions should be reduced by 30 per cent relative to the emission level in year 1980 before 1993, and nitrogen emissions should be stabilised at the 1987 level before 1997. Reduced sulphur and nitrogen emissions due to a carbon/energy tax will make it cheaper for the community as a whole to fulfill these targets.

In a study based on the Sectoral European Energy Model (SEEM), developed by Statistics Norway, and IIASA's RAINS model, we estimate that the carbon/energy tax will reduce the annual cleaning costs for nitrogen in Western Europe from 4 billion 1991-DM to less than 2 billion DM. With the carbon/energy tax, further cleaning of sulphur emissions may not be necessary. In the study it is also shown that a deregulation of the thermal power sectors in the Western European countries may have a beneficial effect of future sulphur and nitrogen emission levels.

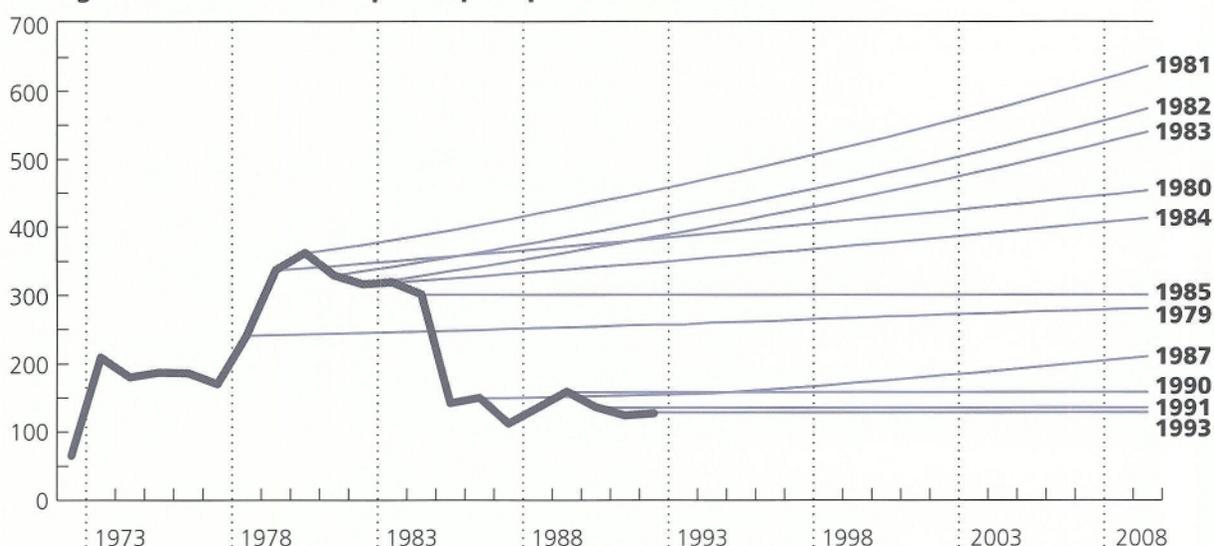
It is important to consider the current renegotiations of the Helsinki and Sofia protocols and initiatives to formulate an international climate policy simultaneously. In particular one should avoid committing large investments in cleaning equipment for sulphur and nitrogen emissions, before one has ascertained the effect of climate policy on future emission levels of these compounds. Similarly, one should ideally also take the future energy policy of the EU into account.

Staff: Knut H. Alfsen, Morten Aaserud, Hugo Birkelund, Eystein Gjelsvik

Financial support: Ministry of Environment

Reference: DP 81, DP 104, Birkelund et al. in ES 3/93

**Figure 2. Observed and expected price paths. 1993-Nkr/barrel**



### **Erosion in Nicaragua and Tanzania**

While energy resources like oil, gas and hydro power are of prime importance for Norway, soil is an important natural resource in many of the less developed countries. Current agricultural practice with nutrient mining and erosion losses are highly unsustainable in many cases. In a study of soil erosion in Nicaragua, based on a model of the Nicaraguan economy and incorporating the productivity effects of soil erosion in the agricultural sectors, it is estimated that soil erosion represents a loss of GDP by almost 15 per cent after 10 years. In a study of the soil wealth of Tanzania, it is concluded that if erosion and soil mining are taken into account, the

present reporting of the income of agricultural activities in Tanzania overestimates the "true" (Hicksian) income by approximately 20 per cent.

Project workers: *Marion A. De Franco, Solveig Glomsrød, Henning Høie, Torgeir Johnsen, Eduardo Marin Castillo, Kjell Arne Brekke, Vegard Iversen*

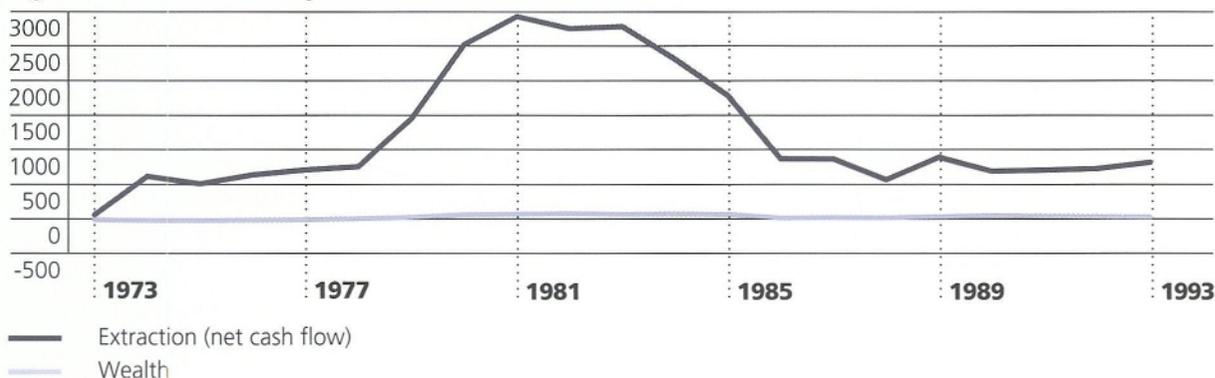
Financial support: *NORAD, The Norwegian Research Council*

References: *Notes 93/22 and Brekke, K. A. and V. Iversen (1994): Soil wealth in Tanzania, to be published as Discussion Papers.*

### **Green GDP, oil wealth and Hicksian income**

Sustainable development is often characterized as a development where coming generations are not "worse off" than the present generation. It is highly problematic to give precise and operational meaning to the term "worse off". Not only will one have to decide how to compare the welfare of different individuals, also comparison over time is necessary. A pragmatic approach could be to replace the measurement of welfare with a more limited measure of economic resources. In this case Hicks' definition of income as what could be spent in one period and being as well off in the next period, has at least the flavour of sustainable development.

**Figure 3. Extraction and petroleum wealth. Bill. 1993-Nkr**



An important component of national income in Norway comes from the exploration of the offshore petroleum reserves. A natural question is whether Norway today exploits the petroleum reserves at the cost of future generations. The petroleum income can be viewed as a rate of return from a petroleum wealth. Defining the petroleum wealth as the present value of expected future net cash flow, it is obvious that the conceived wealth depends upon expectations of future oil and gas prices, as well as on extraction and cost paths. The expectations have shown considerable variability over time. Figure 2 depicts a number of expected price paths as found in official documents at different times.

When changes in price expectations and new information on reserves and costs are translated into changes in petroleum wealth, we get the picture in figure 3.

The variability in the estimated petroleum wealth is formidable. One consequence of this is that it has little meaning to "correct" the traditional GDP measure for extraction of oil and gas. Such a correction would virtually destroy the traditional GDP measure.

Comparing the spending of petroleum revenues in Norway with the expected rate of return from the fluctuating petroleum wealth, we find that by and large the spending has not been excessive, i.e., Norway has so far avoided to spend on behalf of future generations, when current expectations on the development of the petroleum wealth is taken as the informational basis.

Project workers: *Tor Arnt Johnsen, Torstein Bye*

Financial support: *The Norwegian Research Council.*

Reference: *REP 94/1 and Brekke, K. A. (1994): "National wealth and Hicksian income in the debate on green GDP", to be published as Discussion Papers.*



When the models relate to different countries, it is added to the comparability problem, since differences arise from an economic approach or from different national characteristics.

This follows a similar comparative analysis of the models by Lybeck et al. (1984) although their sample overlaps in only one case, and covers three rather than four different countries. The present study adds to the comparative analysis of the models by examining the properties of four of the models analyzed here, and modelling that one might realistically expect to observe for a later vintage of the same models.

They are ADAM from the Danish Ministry of Budget, Denmark; KOSMOS from the National Institute of Economic Research, Sweden; MODAG from the Central Bureau of Statistics, Finland; and those of the Ministry of Finance (KESSU) in Finland (BOFA). In the period between completion of the models several revisions have taken place to the models.

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- 82 **Rolf Aaberge and Tom Wennemo:** *Inntektsulikhet og inntektsmobilitet i Norge 1986-1990* (Income inequality and income mobility in Norway 1986-1990). 1993.
- 83 **Ingvild Svendsen:** *Empirical Tests of the Formation of Expectations. A Survey of Methods and Results*. 1993.
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- 93/1 *Naturressurser og miljø 1992*
- 93/1A *Natural resources and the environment 1992*.
- 93/2 **Anne Brendemoen:** *Faktoreterspørsel i transportproduserende sektorer*. (Demand for inputs in the transport sectors)
- 93/5 **Audun Langørgen:** *En økonomisk analyse av lønnsdannelsen i Norge*. (An econometric analysis of wage formation in Norway).
- 93/6 **Leif Andreassen, Truls Andreassen, Dennis Fredriksen, Gina Spurkland and Yngve Vogt:** *Framskrivning av arbeidsstyrke og utdanning. Mikro-simuleringsmodellen MOSART*. (Labour force and education projections - using the microsimulation model MOSART).
- 93/7 **Dennis Fredriksen and Gina Spurkland:** *Framskrivning av alders- og uføretrygd ved hjelp av mikrosimuleringsmodellen MOSART*. (Projections of old age and disability pensions - using the microsimulation model MOSART).
- 93/9 **Erling Holmøy, Bodil M. Larsen and Haakon Vennemo:** *Historiske brukerpriser på realkapital*. (Historical user prices on real capital)
- 93/10 **Runa Nesbakken and Steinar Strøm:** *Energiforbruk til oppvarmingsformål i husholdningene*. (Energy use for space heating in households)
- 93/11 **Bodil M. Larsen:** *Vekst og produktivitet i Norge 1971-1990*. (Growth and productivity in Norway 1971-1990)
- 93/14 **Kyrre Aamdal:** *Kommunal ressursbruk og tjenesteyting. Makromodellen MAKKO*. (Municipal use of resources and supply of services. The MAKKO macro model).
- 93/15 **Olav Bjerkholt, Torgeir Johnsen and Knut Thonstad:** *Muligheter for en bærekraftig utvikling. Analyser på World Model*. (Prospects for sustainable development. Analyses on the World Model)
- 93/16 **Tom Andersen, Ole Tom Djupskås and Tor Arnt Johnsen:** *Kraftkontrakter til alminnelig forsyning i 1992. Priser, kvantum og leveringsbetingelser*. (Electricity sale contracts 1992. Prices, quantities and specifications).
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- 93/18 **Kjersti-Gro Lindquist:** *Empirical Modelling of Export of Manufactures: Norway 1962-1987*.
- 93/19 **Knut Røed:** *Den selvforsterkende arbeidsledigheten. Om hystereseeffekter i arbeidsmarkedet*. (Self reinforcing unemployment, on hysteresis in the labour market).
- 93/20 **Dag Kolsrud:** *Stochastic Simulation of KVARTS91*.
- 93/21 **Sarita Bartlett:** *The Evolution of Norwegian Energy Use from 1950 to 1991*.
- 93/22 **Klaus Mohn:** *Industri-sysselsetting og produksjonsteknologi i norske regioner*. (Industrial employment and production technology in Norwegian regions).
- 93/23 **Torbjørn Eika:** *Norsk økonomi 1988-1991: Hvorfor steg arbeidsledigheten så mye?* (Norwegian economy 1988-1991: Why did the unemployment rise?).
- 93/25 *Skatter og overføringer til private. Historisk oversikt over satser mv. årene 1975-1993*. (Taxes and public transfers. Historical overview: 1975-1993).
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- 79 **John K. Dagsvik:** *Discrete and Continuous Choice, Max-Stable Processes and Independence from Irrelevant Attributes.* January 1993.
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- 94/2 **Wenche Drzwi, Lisbeth Lerskau, Øystein Olsen and Nils Martin Stølen:** *Tilbud og etterspørsel etter ulike typer arbeidskraft.* (Supply and demand for different types of labour).
- 94/3 **Hilde-Marie Branæs Zakariassen:** *Tilbud av arbeidskraft i Norge. En empirisk analyse på kvartalsdata for perioden 1972 til 1990.* (Supply of labour in Norway. An empirical analysis using quarterly data from 1972 to 1990).
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## Notes

93/3 **Klaus Mohn, Lasse S.**

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**Sørensen:** REGARDs formelle struktur. (The formal structure of the regional model REGARD).

93/16 **Kjell Wettergreen:**

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93/19 **Erik Storm:** Offentlige utgifter og inntekter i MODAG.

(Government expenses and income in MODAG).

93/22 **Mario A. De Franco, Solveig**

**Glomsrød, Henning Høie, Torgeir Johnsen and Eduardo Marín Castillo:** Soil Erosion and Economic Growth in Nicaragua.

93/24 **Bjart Holtsmark:** Folketrygdens alderspensjoner. Dokumentasjon av en modell for fremskrivning av utgiftene og for analyse av regelendringer. (The old age pensions in the social security system - documentation of a model).

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93/33 **Harald Koch-Hagen and Bodil Larsen:** TRAN. Dokumentasjon av en ettermodell for transportetterspørselen i MSG-EE. (TRAN. Calculating the demand for transport in MSG-EE)

93/35 **Tom Eek, Jan Erik Sivertsen, Tor Skoglund and Knut Ø.** **Sørensen:** Economic Accounts at Regional Level: Methods and Data for Norway.

93/39 **Knut H. Alfsen:** Demand for commercial and own transport services in production sectors.

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93/42 **Dennis Fredriksen:**

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93/46 **Jørgen Aasness and Bjart Holtsmark:** Consumer Demand in MSG-5.

93/47 **Stein Inge Hove:** Nedrustning av forsvaret. En modellbasert analyse. (Disarmament of the defence. A model based analysis).

### Økonomiske analyser (ØA)

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1/93: Økonomisk utsyn over året 1992.

2/93: Konjunkturbildet.

Revidert nasjonalregnskapsstatistikk for 1990 og 1991.

**Torbjørn Eika:** Faktorer bak økningen i arbeidsledigheten 1988-1991 (Causes underlying the unemployment growth 1988-1991).

**Hilde Lurås:** Miljøindikatorer. En generell oversikt over miljøtilstanden. (Environmental indicators. A general view of the state of the environment)

**Lasse S. Stambøl:** Utdanningsnivået er av stor betydning for flyttingene. (The level of education is very important with regard to internal migration).

**Nils-Øyvind Mæhle:** Kryssløpsdata og kryssløpsanalyse 1970-1990. (Input-output data and input-output analysis 1970-1990).

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**Bjart Holtsmark:** Eldrebølgen i neste århundre og konsekvenser for det private konsumet og de offentlige budsjetter. (Some consequences for the private consumption and the public deficit of the increasing number of elderly in the next century).

**Mette Rolland:** Økonomiske utsikter for Asia. Inntrykk fra vårmøtet i LINK-prosjektet. (Economic prospects for Asia. Impressions from the spring meeting with LINK-project). Grete Dahl: Ulikhet i inntekt for pensjonister. (Inequality of income for pensioners).

**Thor Olav Thoresen:** Overføringer, fordeling og ulikhet. (Transfers, distribution and inequality)

5/93: Konjunkturtendensene for Norge og utlandet.

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7/93: **Torbjørn Eika:** SSBs prognoser 1988-1992: Hvor gode var de? (Macroeconomic forecasts made by Statistics Norway: How well did they do?).

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**Knut Røed:** Den selvforsterkende arbeidsledigheten. (The self reinforcement of unemployment).

**Thore Jarlset, Tor Arnt**

**Johnsen and Bodil Larsen:**

Skatt på CO<sub>2</sub>-utslipp i Norden. Virkninger for norsk krafteksport og bruk av olje til oppvarming i Norge. (Taxation of CO<sub>2</sub> emissions in the Nordic countries. Effects on the Norwegian exports of hydro power and the use of oil for space heating in Norway).

8/93: **Tom Eek and Knut Ø.**

**Sørensen:** Jordbrukets regionale betydning i Norge. (The regional importance of agriculture).

**Dennis Fredriksen and Gina**

**Spurkland:** MOSART - en modell for alders- og uføretrygd fra folketrygden. (MOSART - a microsimulation model for old age and disability pensions).

**Dennis Fredriksen and**

**Charlotte Koren:** Kvinners forsørgelsesmønster og folketrygden. (Female labour force participation and public pension benefits).

**Anne Brendemoen, and**

**Haakon Vennemo:** Hva koster det å øke skattene? (What is the cost of increasing taxation?)

**Else Helene Flittig:**

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**Per Richard Johansen, Knut**

**A. Magnussen and Mette**

**Rolland:** Renteutviklingen og de økonomiske utsiktene for Vest-Europa. (The development og interest rates and the economic prospects for Western Europe).

**Mette Rolland:** Utviklingen i verdensøkonomien. (The prospects for the world economy).

**Jørgen Aasness:**

Fordelingsvirkninger av barne- trygd og matmoms - en analyse basert på LOTTE-KONSUM (Distributional effects of child allowances and VAT on food - an analysis based on the microsimulation model LOTTE-KONSUM)

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2/94 **Bodil Larsen:** Virkninger av CO<sub>2</sub>-avgifter på transportetter-spørselen i Norge fram til 2020. (Effects of CO<sub>2</sub> taxes on future demand for transport in Norway).

**Øystein Olsen and Nils**

**Martin Stølen:** Utviklingen fremover for ulike typer arbeidskraft. (The future development of different types of labour).

**Jon Ivar Røstadsand and**

**Johan Heldal:** Hva kan inntektsundersøkelsen for husholdningene fortelle oss?

Om bruk av utvalgsundersøkelser i nasjonalregnskapet. (How can household sample surveys on income be utilized? On the use of sample surveys in the National Accounts).

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**Quang:** Sesongjustering av detaljomsetningsindeksen. (Seasonal adjustment of the index for retail sales).

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1/93: *Economic survey 1992. Norway.*

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3/93: *Economic Trends.*

**Hugo Birkelund, Eystein**

**Gjelsvik and Morten Aaserud:**

Effects of an EC carbon/energy tax in a distorted energy market.

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