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ENERGY IN THE PORTUGUESE ECONOMIC MODEL

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CONTENTS

PREFACE

This report contains considerations and asessments about the possibilities to link energy more directly to the Portuguese economic planning model MODEP. This model has been developed in a Portuguese - Norwegian cooperation project. The Norwegian work in this project is financed by the Norwegian Agency for International Development (NORAD), and the report presented here also serves as a report to NORAD from the author's work in Lisboa during a two weeks stay.

The conclusions are those of the author and do not necessarily represent those of the Central Bureau of Statistics.

1. INTRODUCTION

The Portuguese economic planning model MODEP has been developed in a Portuguese - Norwegian cooperation project[1]. The model is used by the Central Planning Department (DCP) in the short and medium term macro-economic planning.

The formulation of the model framework of MODEP is close to that of the Norwegian planning model MODIS. The Portuguese model is, however, more aggregated and simplified, comprising 22 production sectors compared to about 140 MODIS sectors.

During the last years, there has been developed a system of resource accounts in Norway. These accounts, including the most important natural resources, are being presented in physical units in a way that is analogous to the (monetary) national accounts. The purpose of this is to link the information regarding the natural resources to the economic models and planning routines which are based on the national accounts, and thereby studying the impacts of macro-economic planning on use and supply of the natural resources. The resource accounts may provide a basis for resource budgets in a similar way as the national accounts provide a basis for (economic) national budgets (up to 4 years plans).

Energy has been the main natural resource in the Norwegian work on resource budgeting until now. Considering a continuation of the Portuguese - Norwegian cooperation on economic models, linking energy to MODEP is therefore one issue. This paper discusses the possibilities for a such extension of the model. It has to be stressed, however, that work in this field should not be considered independently of other improvements and extensions of the model, for instance up-dating the model structure.

2. ENERGY ACCOUNTS AND BUDGETS IN NORWAY

The Norwegian energy accounts contain information on reserves, extraction and use of energy. The use of energy is distributed by the sectors of MODIS, thus giving a basis for technical projections of the energy accounts (reference paths). This is done outside the model, and in the first step by assuming a set of fixed energy coefficients being defined as the ratios between the energy use and the gross domestic product (GDP) in the base year.

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[1] MODEP is described in "A simple Input-Output Model for the Portuguese Economy". Lorents Lorentsen, May 1977.

In the next step the coefficients have to be adjusted by competent authorities, to take political decisions, as well as substitution and saving of energy into account. After such a process of adjusting the reference path, the projection of the energy accounts may be looked upon as a probable projection or a forecast. The political part of the budgeting process, however, is not necessarily finished. This process may also include feedbacks to the macro-economic assumptions, considerations about how to link supply and use of energy and at last considerations about the desirability of the projected development.

For a more extensive description of the Norwegian energy accounting and budgeting system, see [1] and [2].

3. THE AIM OF LINKING ENERGY TO MODEP

An extension of MODEP concerning energy, should be looked upon as a step by step process. The first step would be to establish figures for the consumption of the most important energy goods for each of the 22 production sectors, public services (civil and military) and private households. An assumption of fixed energy coefficients will then enable us to achieve a rough impression of the energy impacts of currently economic revaluations.

In the next step the coefficients should be changed due to knowledge of competent authorities, taking into account the changes expected in the 4-5 years to come. Concerning the household sector, the consequences of price changes should be accounted for already in the first step by help of price and cross-price elasticities. The changes in energy coefficients may be due to technological changes, and may also affect the distribution of energy goods for each sector. The result of this procedure will be an improved projection of energy consumption compared to that of the first step.

The third step consists of considerations about the relation between demand and supply of energy. It might be necessary to take into account feedbacks of the energy projections upon the model assumptions. We will then have an iterative process.

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[1] "Energy accounts and budgets, the Norwegian experience". Note submitted by the Government of Norway to a seminar on modelling studies and their conclusions on energy conservation and its impact on the economy. U.N., Washington D.C., 15-19 October 1979. The paper has been prepared by Arild Hervik.

[2] "Energy accounts in Norway". Paper written by Hans Viggo Sæbø (8/10 1981).

It should be stressed that a system of making energy projections in connection with MODEP, will not take the place of working out other energy forecasts. MODEP will only reflect the economic development in a period of 4-5 years, a period which is shorter than the planning period for most systems providing energy (for instance hydro power plants). Energy demand has, however, consequences for imports of oil and thereby for the payment balance, which is an important issue in the Portuguese economy and planning.

Besides being used for projection purposes, energy figures linked to the MODEP sectors can be used to analyze roughly the energy content in the final goods and services being consumed, invested or exported (energy cost analyzes). This may also turn out to be useful when analyzing the (indirect) effects of changes of energy prices on prices of other goods and services.

4. THE FLOW OF ENERGY IN PORTUGAL

Portugal is producing primary energy from two sources: Hydro electricity power plants and some minor coal mines. Hydro electricity provides about 2/3 of the electricity demand in a normal year, but only about 10 per cent of the total Portuguese demand for energy.[1)] In a dry year the production of hydro electricity may be considerably less. Practical all the residual energy has to be imported, mostly as crude oil to be refined in Portugal. Table 1 shows some major figures regarding the supply and use of energy in Portugal in 1979.

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1) Gross demand. The energy goods are assumed aggregated by the help of their calorific values. No conversion factors are taken into account regarding electricity.

Table 1. Production, conversion and use of energy in Portugal. 1979

	Total	Coal and coke	Crude oil, oil products and gases	Electricity
	PJ	1 000 t	1 000 t	TWh
Extraction	43	180	-	11,2
Imports	423	490	9 690	0,9
Exports, sales for ocean transport etc.	-74	-	-1 670	-1,1
Stocks {+ Decrease / - Increase	-36	60	-870	.
Primary supply	356	720	7 140	11,0
Conversion	-59	-300	-1 640	4,3
Losses	-9	-	-50	-1,8
Use outside the energy sectors[1]	288	420	5 440	13,4
(PJ)	(288)	(12)	(228)	(48)

1) Ocean transport is excluded.

Note: Numbers may not add due to roundoff.

Source: The energy balance.

To handle energy in connection with the MODEP model, it will be adventageous to consider the sectors extracting an converting energy in particular. This is because the production in these sectors is partly dependent on the demand from the other sectors or on conditions which should be dealt with exogenously compared to the model. Dealing with the energy sectors in particular will also simplify the framework when working in this field. The energy sectors in Portugal are:

- Extraction sectors
  - Coal mines
  - Hydro electric power plants
- Conversion sectors
  - Coke oven plants
  - Petroleum refineries
  - Gas works
  - Thermal power plants

None of these sectors are constituting own sectors in MODEP, but both hydro electric power plants, thermal power plants and gas works belong to the electricity, gas and water supply sector (number 19). As long as energy is

handled outside the model, there are no problems with just dividing the sectors including energy sectors. When estimating the use of energy outside the energy sectors, it must be remembered to subtract the consumption figures for the energy sectors.

A table showing the sector definitions in MODEP is given in annex 1, whereas a definition of the energy sectors is given in annex 2.

The flow of energy into the Portuguese economy may be described by help of a table showing the energy extraction, imports, exports, stock changes, inputs and outputs of the energy sectors, ending up with a distribution of the energy goods by the MODEP sectors (except for the energy sectors), public services and private households. The first part of such a table may be worked out merely by a rearrangement of the energy balance. The problem is the distribution by the MODEP sectors.

5. DATA SOURCES

As metioned in the last paragraph, the supply and conversion of energy are satisfactorily described in the energy balance. This balance comprises all energy goods and is worked out by the Energy Department (DGE), though published by the Bureau of Statistics. However, the frame in which it is published is not adequate for our purpose. It will be necessary to rearrange it, so that it is more easy to follow the energy flow from extraction through conversion to the use outside the energy sectors. Given the energy demand, it will then be possible to estimate the supply by going back through the conversion sectors.

An example of a possible rearrangement of the energy balance is given in annex 4. Here the energy goods are somewhat aggregated compared to the balance, the aggregation chosen being accounted for in annex 3. The example also comprises a trial of distributing the use of electricity by the MODEP sectors.

The energy balance is published in the energy statistics. Besides, some data (especially data concerning extraction and conversion of energy) can be found in the industrial statistics, volume 1. As for the sectors other than the energy sectors, the background material for the energy balance is more detailed than the figures published here.

The statistics on oil products originate from the petroleum companies, and it is very disaggregated regarding products. As for sectors, it is fairly good for the manufacturing sectors (3-digit level according to the International Classification for Industrial Statistics (ISIC or CAE)).

The same concerns the sector division of the electricity consumption.

The MODEP sectors are mainly defined by 1, 2 or 3 digits according to CAE, and it should therefore be reasonable to use the background material for the energy balance when distributing energy by these sectors.

The Energy Department has compared their material regarding energy use in manufacturing with the industrial statistics, and the agreement is fairly good. For the MODEP sectors defined by help of the 5-digit level (sector 14 and 15, see annex 1), it should be possible to use the industrial statistics or distribution keys established on the basis of this statistics.

One adventage of using the energy balance background material is that data here are more up to date than the data of the industrial statistics (for sectors other than mining and energy sectors). Another point is that using the data of the Energy Department, we would benefit from their work in separating fuels used for self-generated electricity in the sectors. In the energy balance this electricity production is handled along with the production in central thermal power plants. Ideally, self-generation should be accounted for in each sector (input of fuel, output and input of electricity), but as this generation only accounts for about 10 per cent of consumption in the manufacturing sectors, it is more convenient to choose the same solution as in the energy balance. One should, however, be some careful about the pulp and paper-sector, covering most of its requirement for electricity by self-generation (sector 10 in MODEP).

To conclude the energy balance background material seems to provide satisfactorily data for the energy sectors, agriculture, mining, manufacturing and construction. The main problems concerning the remaining sectors are:

1) Oil products used for transport

1.1) A division between use in the transport sector (7 according to CAE), other industrial sectors (for instance services) and private households has to be done. The transport sector in the energy balance comprises the transport purposes, while the MODEP sectors comprise the economic activities. It would especially be important to isolate the gasolines used for private cars. This consumption should be linked to the private consumption when forecasting the effect of economic development.

1.2) The transport sector according to MODEP comprises both land, air and sea transport. If ocean transport contributes heavily to the GDP of this sector, it would not be of much sense to project the use of energy for land and air transport by a linkage to the total GDP. There are no data available for the energy purchased and consumed by the Portuguese ocean transport abroad. Even if it is possible to make a rough estimate of these purchases, it would be adventageous to divide the transport sector when projecting energy use. Such a division has been done in the national accounts. For the time being the use of energy for ocean transport is excluded from the energy balance.

The problem of purchases abroad concerns also to some extent the fishing sector.

2) Distribution of energy use by service sectors and households

The background material for the energy balance provides data for domestic energy use (except for energy used for transport purposes). One should, however, be careful about the reliability of these data. There is not always a clear distinction between private and industrial activities. Besides, using MODEP requires a further distribution by trade, other private services and public services (both civil and military). If there are no surveys giving possibilities for a such distribution, a rough method would be to assume that energy use in these sectors is proportional to the number of people occupied (or adjusting this assumption using some weights eperienced by other countries).

Data will of course never be perfect, and effects to improve them will have to be considered in relation to the resources available. It should be pointed out, however, that several authorities dealing with energy planning would benefit from improvements in the data base.

6. CONCLUSIONS

The first step of linking energy to MODEP by establishing energy consumption figures for the sectors, should not require unreasonable efforts or time. An exceptation might be the work on distributing oil used for transport by economic sectors and households. However, in this field it should be possible to make some rough estimates, whereas a more reliable data base might require new surveys.

The work of collecting, evaluating and linking (mostly existing) energy data to MODEP should in the first round be done during 3-4 months, for instance by two persons working half day on the project. It would be adventageous to combine this work with the work on up-dating the model, eventually doing other improvements.

It is planned to up-date MODEP with 1977-structure early in 1982. At the same time the model can be run with 1980 as a starting year. Linking energy to the model should therefore be done within the first months of 1982. If the Energy Department has finished their work on an energy balance for 1980 early next year, 1980 should also be used as a first year as for estimating the energy coefficients.

In addition to benefit from the work going on in the Energy Department, the work in DCP should be considered in connection with that of GEBEI (Basic Economic Unit). This group is among others analyzing the energy input/output structure of the Portuguese economy. Other institutions working in this field will of course also be oriented, for instance through the cooperation going on within the frame of the National energy plan.

Cooperation with other institutions and experts will be even more important when doing the next steps in the MODEP-energy linkage: Correcting the energy coefficients when projecting the energy consequences of the medium term economic development. As mentioned in paragraph 3, even using fixed coefficients should give some rough impression of these consequences. Still it would be desirable to work with the aim of improving the energy projections also at an early stage of the project. Especially this concerns the household sector, where price and cross-price elasticities have to be established. It seems reasonably to link the private consumption of electricity and oil used for non-transport purposes to the housing sector of the consumption, whereas oil used for transport might be linked to the residual sector.

The needs for human resources and time doing the correction of coefficients, linkage of energy demand and supply (including imports) and eventual feedbacks to the model, are difficult to estimate. When established as a routine, this will not require much resources. It is, however, important to realize that it is not a matter of "all or nothing", and the activities in the field should be considered not only as a part of the Departments work on economic models, but as a part of the joint efforts of improving the energy planning system in Portugal as well.

The major conclusion is that starting working out the energy data base now, it would be possible to have a link to MODEP within the first

months of 1982. Further priorities and efforts improving the data base, correcting the energy coefficients and taking energy more directly into account in the economic planning, should then be considered.

Annex 1

SECTORS IN MODEP

Production sectors No.	ISIC (CAE)	Sector name	Price exogenous
1	11, 12	Agriculture and forestry	x
2		Cattle	x
3	13	Fishing	x
4	22	Petroleum	x
5	21, 23, 29	Mining	x
6	311, 312	Manufacture of food	x
7	313, 314	Manufacture of beverages and tobacco	x
8	321, 322, 324	Manufacture of textiles, clothes and shoes	
9	33	Manufacture of wood and cork products	
10	34	Manufacture of pulp and paper, printing etc.	
11	323, 355, 385, 39	Manufacture of leather and products of rubber, other price endogeneous manufacturing	
12	351, 352, 353, 354, 356	Manufacture of industrial chemicals, chemical products and products of oil, coal and plastic	x
13	36	Manufacture of mineral products	x
14	37, 38194, 38195	Manufacture of basic metals	x
15	381 ÷ 38194, 38195	Manufacture of various metallic products	
16	382, 383	Manufacture of machines and electrical equipment	x
17	384	Manufacture of transport means, building of ships	x
18	5	Construction	
19	4	Electricity, gas and water supply	x
20	6	Trade etc.	
21	7	Transport and communications	
22	Δ8, Δ9	Other private services	

	ISIC (CAE)	Sector name
Public sectors		
1.	Δ8, Δ9	Civil
2.	Δ9	Military
Private consumption sectors		
1.		Food
2.		Non durables
3.		Semi durables
4.		Durable goods
5.		Housing
6.		Residual
Investment sectors		
1.		Non-productive
2.		Productive/public
3.		Private

Annex 2

ENERGY SECTORS

ISIC (CAE)		Part of MODEP sector no.
Extraction sectors:		
21	Coal mines	5
Δ4101	Hydro electric power plants	19
Conversion sectors:		
	Coke ovens	
353	Petroleum refineries	12
4102	Gas works	19
Δ4101	Thermal power plants	19

The use of energy in these sectors have to be subtracted from the consumption figures when estimating the use of energy outside the energy sectors.

Annex 3

CLASSIFICATION OF ENERGY GOODS

In the following the energy goods in the energy balance are aggregated in a way convenient for a linkage to the MODEP model. Several levels of aggregation are possible, also aggregating all energy goods. Such a aggregation might be problematic, especially regarding which conversion factors to use for electricity. The principle for the aggregation proposed here is to distinguish the oil products used for transport and feedstocks and the products mainly used for heat purposes. The latter may be substituted by electricity or solid fuels.

Compared to the energy balance, "briquets" and "gas de alto forno" are not included in the proposed aggregation and in the table in annex 4. These energy goods are insignificant compared to the others.

The energy goods which are aggregated differ only slightly in energy content (per ton or per m^3). The aggregated numbers will therefore express both mass and energy content.

Energy goods in Portugal. A rough aggregation

	Goods according to the energy balance
Coal	Coal and antracite
Coke	Coke
Crude oil	Crude oil
Oil products used for transport or feedstocks	Gasolines, carboreactores, naphtas, diesel oils
Other oil products	Kerosenes, fuel oils
Town gas etc.	Town gas, coke oven gas
LPG	Liquefied petroleum gases (propan and butan)
Refinery gas	Refinery gas
Electricity	Electricity

Annex 4

ENERGY FLOW IN PORTUGAL. 1979

Sector \ Energy good	Coal	Coke	Crude oil	Oil products: For transport and feedstocks	Oil products: Other	Town gas etc.	LPG	Refinery gas	Electricity
	1 000 t			1 000 t		Mill. m^3	1 000 t		TWh
Coal mines: Extraction	179	.	-	.	.	.	.	.	-
Coal mines: Use	-	-	-	-	-	-	-	-	-0,01
Hydro electric power plants: Extraction	-	.	-	.	.	.	.	.	11,25
Hydro electric power plants: Use	-	-	-	-	-	-	-	-	-0,05 (Pumping)
Imports	379	107	8 478	444	439	-	329	-	0,93
Exports	-	-	-	-496	-348	-	-1	-	-1,13
Supply to ocean transport and foreign air transport	-	-	-	-503	-324	-	-	-	-
Stocks: + Decrease / - Increase	52	7	-183	-368	-308	-	-23	7	.
Primary supply	610	114	8 295	-923	-541	-	305	7	10,99
Coke ovens: Input	-306	-	-	-	-	-38	-	-	-
Coke ovens: Output	-	223	-	-	-	90	-	-	-
Petroleum refineries: Input	-	-	-8 287	-3	-177	-	-5	-13	-0,22
Petroleum refineries: Output	-	-	-	3 694	3 844	-	173	34	-
Gas works: Input	-	-	-	-29	-	-	-1	-28	-0,02
Gas works: Output	-	-	-	-	-	147	-	-	-
Thermal power plants: Input	-219	-	-	-22	-1 053	-4	-	-	-0,48 [1]
Thermal power plants: Output	-	-	-	-	-	-	-	-	4,90
Losses	-	-	-8	-	-	-21	-2	-	-1,78
Use outside the energy sectors	86	338	-	2 717	2 073	174	471	-	13,39
Of which: MODEP 1	-	-	-	↑ Should be distributed by industrial sectors rather than by transport means	8	-	4	-	0,09
MODEP 2	-	-	-		-	-	-	-	-
MODEP 3	-	-	-		-	-	-	-	-
MODEP 4	-	-	-		-	-	-	-	-
Mining and manufacturing: MODEP 5	↑	↑	-		↑	↑	↑	-	0,09
MODEP 6			-					-	0,55
MODEP 7			-					-	0,10
MODEP 8			-					-	1,13
MODEP 9			-					-	0,30
MODEP 10			-					-	0,72
MODEP 11			-					-	0,54
MODEP 12	75	330	-		1 760	42	94	-	1,20
MODEP 13			-					-	1,10
MODEP 14			-					-	1,36
MODEP 15			-					-	0,34
MODEP 16			-					-	0,15
MODEP 17	↓	↓	-		↓	↓	↓	-	0,15
MODEP 18	-	-	-		6	-	1	-	0,05 [2]
MODEP 19	-	-	-		-	-	-	-	0,24 [2]
MODEP 20			-			25	104	-	- [3]
MODEP 21	4	-	-		1	-	-	-	0,24 [3]
MODEP 22			-			-	↑	-	2 [5]
Public services: Civil			-			5	269	-	
Public services: Miletary			-			-		-	-
Private households	7 [4]	7 [4]	-	↓	298 [4]	101	↓	-	3 [5]

1) Total use of electricity in power plants (hydro or thermal). 2) Elevation of water. 3) Railways, trams etc. In addition the uses for communications and services allied to transport should be included. 4) Includes the consumption in trade, private and public services. 5) Rough estimate.