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PROCEDURES AND PROGRAM FOR THE ECONOMETRIC ANALYSIS OF A GROUP OF DEVELOPED MARKET ECONOMY COUNTRIES

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PREFACE

This paper is part of the Energy Demand Publication Series. The Series reflects the work on this broad subject that forms a major line of the IIASA Energy Project's activities. A first step in the econometric analysis of energy demand was achieved with the Workshop on Energy Demand held in May 1975. This Conference and its subsequent Proceedings were prepared by Prof. W.D. Nordhaus of Yale University and with the support of the Ford Foundation.[1] The plan for our econometric studies was outlined by P. Tsvetanov on the occasion of the Status Report of the Energy Project in October 1975.[2]

Following these publications, a number of Research Memoranda and Reports that highlight and serve to complete the presentation of the various aspects of energy demand as it is dealt with at IIASA have been started.[3]

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[1] See Proceedings of the Workshop on Energy Demand, May 22-23, 1975, CP-76-1 (International Institute for Applied Systems Analysis, Laxenburg, Austria, 1976).

[2] See P. Tsvetanov, "Econometric Analysis of Energy Demand at IIASA, in Second Status Report of the IIASA Project on Energy Systems, RR-76-1 (International Institute for Applied Systems Analysis, Laxenburg, Austria, 1976).

[3] See Claire Doblin "Data Provided for the W.D. Nordhaus Study, 'The Demand for Energy: An International Perspective'" (International Institute for Applied Systems Analysis, Laxenburg, Austria, forthcoming).

ABSTRACT

The econometric analysis of energy demand of a group of developed market economy countries is part of a series of international econometric analysis studies now underway in the Energy Project at IIASA. Detailed results of this study were presented by Professor Nordhaus at the "Workshop on Energy Demand" held May 22-23, 1975.

The goal of this paper is to complete the presentation of the study and deal with the set of variables, the size of the time-series samples, procedures of data-transformation for the analysis of individual countries, pooling of data for an overall analysis and the main characteristics of the computer program used. We think that these procedures and the program described also could be useful for other econometric applications at IIASA.

A brief résumé concerning the scope, problems and status of international energy demand analysis at IIASA is included in the Annex.

Procedures and Program for the Econometric Analysis of a Group of Developed Market Economy Countries

1. GENERAL REMARKS

The econometric analysis of the energy demand of a group of market economy countries is part of a series of international econometric analysis studies now underway in the IIASA Energy Project. The second part of these studies will be an econometric analysis of the energy demand of countries with a planned economy. Both studies have two steps: first, the analysis of the individual countries and, second, the cross-sector analysis for countries with the same kind of economy. A further step would be an international analysis of energy demand of countries with planned and market economies. More details concerning the scope, problems and status of this international analysis are given in the Annex.

2. DATA

The data collected consist of raw data (ALL), transformed data (N) and pooled data (POOL). (Names in parentheses are file names in the Computer Center.)

2.1 Original Data

Three sets of variables are compiled for the econometric study: macroeconomic data, energy consumption and energy price data. The macroeconomic data include population, gross domestic products in constant and current prices, GDP deflators, capital goods deflators, consumer price indexes, wage rates (salary per hour) and weather statistics (temperature deviation from the mean temperature per year and for the first quarter of the year). The economic data are given in national currencies.

Consumption and price data are for four types of energy (solid, gaseous and liquid fuels and electricity) and four sectors of the economy (domestic or household, transportation, industry and energy). Consumption data are in natural units (1,000 metric tonnes for coal and liquid fuels, millions m^3 at 4,200 kcal for gaseous, millions kwh for electricity). All price data are in national currencies; prices for solid, liquid and gaseous fuels are converted from natural untis to Btu (per 10^6 Btu); electricity prices are per kwh.

2.2 Notation for the Time Series in the Computer Center

The data are stored as time series, one time series at a time. The mean length of the time series is 1955 to 1972. The time series are distributed over three files (ALL, N and POOL respectively).

The notation for the time series is the following. Each time series is identified by a label. The labels consist of three to six characters with a fixed and a variable part. The fixed part consists of one or two letters; the variable part is an index for countries, sectors and energy-type, as described below:

(LL) Two character abbreviation for countries:

- GE Federal Republic of Germany,
- IT Italy,
- NE Netherlands,
- FR France,
- US United States,
- UK United Kingdom,
- BE Belgium;

(M) One character abbreviation for sector:

- I Industry,
- T Transport,
- D Domestic,
- N Energy,
- O Other (Industry less Energy),
- A Aggregate;

(K) One character abbreviation for energy:

- H Hard Coal,
- G Gas,
- L Liquid Fuel,
- E Electricity.

The labels for the raw data are as follows:

Macroeconomic data

(LL)MGDS GDP Const.,

- MGDR GDP Current,
- MCPI Consumer Price Index,

MPOP Population,
MEXR Exchange Rate US - ...,
MWAR Wage Rate,
MCDG Capital Good Deflator,
MWEY Weather Year,
MWEQ Weather Quarter,

(LL) 1...7 available;

Quantity data

(LL) QG(M) (K)
(LL) 1...7 available,
(M) 1...4 "
(K) 1...4 "

Price data

(LL) PR(M) (K)
(LL) 1...7 available,
(M) 1...4 "
(K) 1...4 " .

2.3 Transformation of Data for the Analysis of Individual Countries

Macroeconomic data

Real per capita GDP:

$$Y(LL) = (LL)MGDS/(LL)MPOP .$$

GDP deflator:

$$P(LL) = (LL)MGDR/(LL)MGDS .$$

Quantity and prices

The study considers the total net consumption of fuel in each sector and ignores the composition of the total consumption between fuels. This is based on the hypothesis that within each sector there is a subclass of fuels which are perfect substitutes, and for equal levels of nonfuel cost interfuel competition will be determined by the relative net price of fuels. To make the definition operational we need to convert the quality of each fuel from natural units into a universal calorific power (10^6 Btu) and to assess the efficiency of each fuel in each sector. The estimated conversion coefficients CONV(K) and efficiency constant VEFF(M) (K) are as follows:

M \ K		H	G	L	E
VEFF	I	.7	.85	.8	1.
	T	.044	.22	.22	.4
	D	.2	.7	.6	.95
	N	.7	.85	.8	1.
	O	.7	.85	.8	1.
CONV		.0278	.0167	.0326	.00341

efficiency constants

set equal to Industry

(M) = 1-5 (for (M) = A, see below).

Then the:

net energy consumption for each fuel in each sector is

$$QN(LL)(M)(K) = (LL)QG(M)(K) \cdot VEFF(M)(K) \cdot CONV(K) \quad ;$$

price per unit net energy is

$$PN(LL)(M)(K) = (LL)PR(M)(K)/VEFF(M)(K);$$

sectorial aggregate net quantity is

$$SQN(LL)(M) = \sum_{K=1}^{4} QN(LL)(M) \quad ;$$

sectorial net price is

$$SPN(LL)(M) = \sum_{K=1}^{4} ZQ(LL)(M)(K) \cdot PN(LL)(M)(K)$$

where

$ZQ(LL)(M)(K)$ = the share of the fuels in the aggregate consumption of a sector ;

$$ZQ(LL)(M)(K) = QN(LL)(M)(K)/SQN(LL)(M) \quad .$$

Sectorial prices are corrected by the GDP deflator:

$$RSP(LL)(M) = SPN(LL)(M)/P(LL) \quad .$$

Special Case: Sectors O and A (and N)

- Quantity

Energy Consumption in Sector Other:

$$(LL)QGO(K) = (LL)QGI(K) - (LL)QGN(K) \quad .$$

Energy Consumption in Aggregate:

$$(LL)QGA(K) = \sum_{M=I,T,D} (LL)QG(M)(K)$$

$$QN(LL)A(K) = \sum_{M=I,T,D} QN(LL)(M)(K) \quad .$$

- Prices

For Energy and Other, price is set equal to Industry:

$$(LL)PR(M)(K) = (LL)PRI(K)$$

$$M = O,N \quad .$$

For Aggregate, price is equal to weighted average of Industry, Transport and Domestic prices:

$$ZS(LL)(M)(K) = QN(LL)(M)(K) / \sum_{M=I,T,D} QN(LL)(M)(K)$$

$$PN(LL)A(K) = \sum_{M=I,T,D} ZS(LL)(M)(K) \cdot PN(LL)(M)(K) \quad .$$

- Efficiency for Aggregate Only

$$(LL)VEFFA(K) = QN(LL)A(K)/(LL)QGA(K) \quad .$$

2.4 Pooling of Data

The approach to pooling is given briefly in the Annex. The data from several countries are put together and treated as if they were sequential observations. The goal is to obtain a larger number of observations for the regression analysis. The effects on the country are represented by dummy variables. These dummy variables have the form:

$$DUM(LL) = \begin{Bmatrix} 0 \\ 1 \end{Bmatrix} \quad .$$

Ones are for the observations of the country considered, and zeroes are for all other countries. Before pooling, the macroeconomic data and price data used for the analysis of the individual country are translated into a "universal" standard of value (dollars) for a given year (1960):

Sectorial prices in "universal currency":

$$SPD(LL)(M) = SPN(LL)(M)/EXRT(LL) \quad .$$

Income in "universal currency":

$$YD(LL) = Y(LL)/EXRT(LL) \quad .$$

The conversion constant EXRT has the following values:

GE	3.53	FR	4.22
IT	497	US	1. (basis)
NE	2.7	BE	41.2 .
UK	.312		

Corresponding to the specification (see Annex), the following data are used for pooling:

a.	SQN(LL)(M)	lag	0,-1
b.	SPD(LL)(M)	lag	0,...,-4
c.	YD(LL)	lag	0,-1
d.	(LL)MWEY	lag	0 ,

and stored under the following labels as time series with 82 observations:

a.	AGG(M)Q0	last digit of the label identifies the lag of the variable. (M) = 1-6
	AGG(M)Q1	
b.	AGG(M)P0	
	AGG(M)P1	
	AGG(M)P2	
	AGG(M)P3	
	AGG(M)P4	
c.	AGG(M)Y0	
	AGG(M)Y1	
d.	AGG(M)W0	

Q stands for SQN
P stands for SPD
Y stands for YD
W stands for MWEY

All income data are independent of (M).
All weather data are independent of (M).

3. PROGRAM USED TO PERFORM THE ECONOMETRIC ANALYSIS

The program system used is called IAS (Interactive Simulation System); it was developed at the Institute for Advanced Studies, Vienna, and has been in use since January 1974. Nearly all computations in the area of econometric work and forecasting done at the department of economics of this institute and at the Austrian Institute for Economic Research, Vienna, were performed with this programming system on a UNIVAC 1106 owned by both institutes.

The IAS System was designed to make econometric analysis as convenient as possible and thus more attractive to economists who refrain from empirical work because of the technical problems involved. Characterizing a time series by its spectral shape or testing a hypothesis with a regression is almost as easy as performing operations with a desk calculator. IAS has the following main capabilities:

- file system (DATABASE) for time series and cross-sectoral data,
- file system for model equations,
- model simulation language,

- parameter estimating techniques (all standard techniques used in econometric work),
- time series analysis (also spectral analysis),
- deterministic and stochastic simulation,
- various input, output, transformation, and documentation routines.

The output of the program is self-documenting and can be used directly for publication.

One of the program's major drawbacks has turned out to be the price factor. Computing time on the UNIVAC 1106 is rather expensive and IAS performs many input/output operations. More details of the IAS system are given in the User Handbook of IAS, which is available in the IIASA computer center.[4]

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[4] See K. Plasser and S. Schleicher, "Benützer Handbuch IAS-SYSTEM LEVEL 2.3," mimeographed manuscript (Institute for Advanced Studies, Vienna, July 1975).

ANNEX

International Econometric Analysis of Energy Demand

Plamen Tsvetanov

1. GENERAL REMARKS[5]

1.1 Scope of the Work

- A series of studies to cover some characteristic countries--mainly the countries with developed market economies and the Eastern European countries with planned economies.

- The work covers the aggregate energy demand and the energy demand in the domestic, transportation, industrial (nonenergy) and energy sectors.

- The third remark on scope which I should like to make is that the first step of these studies would be the analysis of the individual countries. The second, would be the cross-section analysis for countries with the same kind of economy, and the third step would be an international analysis of the countries with planned and market economies.

1.2 Problems

This international approach causes some problems:

- Gathering of adequate data is one of the most crucial and difficult tasks. For a number of countries some of these data are not complete.

- In many empirical studies, a constant elasticity model is specified. For the purposes of cross-section analysis a variable elasticity model would allow some degree of heterogeneity between countries. In the VEM the value of the elasticity for a particular factor depends on the level of the factor.

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[5]For more information see P. Tsvetanov and W.D. Nordhaus, "Problems of Energy Demand Analysis,""in Proceedings of the Workshop on Energy Demand, May 22-23, 1975, CP-76-1 (International Institute for Applied Systems Analysis, Laxenburg, Austria, 1976).

- The lagged response of energy demand effects the relationships between the use of fuel and the existing stocks of equipment and appliances. Two main difficulties arise in these studies: First, the time response is quite long (5-10 years) with respect to the sample periods for an individual country (15-20 years). Second, the choice of the lag structure is a difficult problem connected with the lag of all variables, the autocorrelations between the errors, relationships between the length of the lag and the degree of polynomial to be investigated, etc.

1.3 Purposes of the Studies

- Analysis of factors and methods of forecasting.
- Choice of structure of models for different economies.
- Short-run and long-run elasticities for different sectors and countries and groups of countries.
- Recommended models for short-run and medium-run forecasting of energy demand for different groups of countries.
- International analysis of the energy demand in planned and market economies.

A future step would be to combine the determinant of energy demand with the models of economic growth of these countries.

1.4 What is the Status Now?

From the beginning, we have been able to obtain preliminary results from data mainly for countries with market economies. For the countries of Eastern Europe, including the USSR, we have started collecting available data and making a preliminary analysis of the factors and the methods of forecasting. This work is in progress.

2. ECONOMETRIC ANALYSIS OF A GROUP OF WESTERN COUNTRIES

2.1 General Framework

Countries included: Belgium, France, the Federal Republic of Germany, the Netherlands, Italy, the United States and the United Kingdom.

- The study considers the net aggregate and consumer sector's energy consumption.
- Income, prices and population are the determinative factors of the energy consumption.

- Two levels of investigation: individual countries' analysis and pooling of the seven countries' data.

2.2 Individual Countries' Analysis

Two specifications are tested: a geometric lag and two variants (B_1 and B_2) of an equation with polynomial lag structure:

$$(A) \quad Q_t = e^{a_o} P_t^{a_1} Y_t^{a_2} Q_{t-1}^{a_3} ,$$

$$(B) \quad Q_t = e^{b_o} \prod_{T_o}^{T_1} W_i P_{t-i}^{b_1} Y_t^{b_2}, \ \Sigma W_i = 1 ,$$

where

$$(B_1) \quad : T_o = 0, \ T_1 = 3, \ W_i \text{ quadratic}, \ W_4 = 0 ,$$

$$(B_2) \quad : T_o = 0, \ T_1 = 5, \ W_i \text{ quadratic}, \ W_6 = 0 ,$$

and

Q_t = per capita net energy consumption,

P_t = relative net price of energy,

Y_t = per capita real GDP.

Detailed results for the short-run and long-run elasticities are given in a paper of Professor Nordhaus.[6] We focus only on the long-run elasticities of the specification B_1, which gave the lowest standard errors. Before turning to the results, I would like to remark that the long-run elasticity is defined as percentage change in net energy demand per year after the entire lag is included, divided by the percentage change of the explanatory factor during the current year. Since the LRE's characterize the final response of the energy demand to the change of a determinative factor, they are the main task of the investigation. If a sector has an absolute value of LRE for a factor (for example, income or price) greater than unity, we will say that the energy consumption of this sector is income (or price) elastic--if less, inelastic.

Let us now proceed to the results. These results for the

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[6]This work was headed by Professor Nordhaus. Detailed results are given in W.D. Nordhaus, "The Demand for Energy: An International Perspective," in Proceedings of the Workshop on Energy Demand, May 22-23, 1975, CP-76-1 (International Institute for Applied Systems Analysis, Laxenburg, Austria, 1976).

aggregate (for the economy of a country as a whole) and for the four consumer sectors are given in Table 1.

We will not analyze the results in detail. A general assessment and conclusions are easier to make with the aid of a graphical presentation (Figure 1). These figures show that for the aggregate, three countries have rather high income elasticities and another three have rather low elasticities. There is no clear indication as to whether energy tends to grow faster or slower than income.

The price elasticities are highly variable and not well determined: three countries (Italy, the Netherlands and the United States) are price elastic, two (France and the Federal Republic of Germany) have incorrect signs.

Domestic sector. The income elasticities are positive, but show some irregularity across the samples. The price elasticities are consistently (except for France) negative. The composite statistics--greater than unity--indicate that the sector is price elastic.

Transport. Highly income elastic: all six countries have income elasticity greater than unity. (For high income countries--the United States and the Federal Republic of Germany--the income elasticity is very close to unity, while the medium and low income countries--especially Italy and the United Kingdom--have very high income elasticities.) The overall impression is that transport demand is quite price inelastic.

Industry (nonenergy) sector. Income elasticities scattered around demand unity are well-determined. Price elasticities show a pattern of instability.

Energy sector. It should be noted that this sector has a rather different character from the other sectors. Energy consumption is in reality energy consumed in the transformation of one energy form into another, or in the extraction or upgrading of fuels. The energy sector exhibits very low income elasticities. The price elasticities are quite mixed.

The results obtained from the analysis of individual countries are not entirely encouraging. This is largely owing to the fact that price and income are highly colinear for an individual country and therefore the data cannot determine the coefficients with great precision. The next step consists in combining or pooling the data into a single relationship.

2.3 Pooling of Countries' Data

Briefly, the approach is based on the following assumptions:

- The countries have similar preference and production functions.

Table 1. Individual countries, long-run elasticities, β_1 specification.

Sectors	Factors	ELASTICITIES						
		F	FRG	I	NL	UK	USA	Comp.
Aggregate	Income	1.17 (.09)	1.15 (.13)	1.25 (.13)	-.48 (.34)	.67 (.09)	.32 (.10)	.84 (.11)
	Price	.10 (.26)	.70 (.32)	-1.30 (.21)	-1.20 (.25)	-.26 (.25)	-1.73 (.36)	-0.66 (.26)
Domestic	Income	2.34 (.52)	1.55 (.28)	.49 (.29)	.00 (.63)	1.10 (.32)	.27 (.08)	.44 (.17)
	Price	.22 (.34)	-.68 (.35)	-1.40 (.25)	-1.30 (.33)	-.30 (.45)	-1.75 (.21)	-1.14 (.29)
Transportation	Income	1.32 (.08)	1.19 (.11)	1.65 (.11)	1.52 (.20)	2.11 (.06)	1.01 (.15)	1.68 (.10)
	Price	-.15 (.13)	-.87 (.18)	-.60 (.40)	-.37 (.40)	-.15 (.21)	.13 (.47)	-.36 (.22)
Industry (except energy)	Income	.57 (.16)	1.24 (.17)	1.15 (.19)	1.72 (.70)	.06 (.15)	.99 (.13)	.78 (.17)
	Price	-.38 (.16)	1.03 (.25)	-.96 (.22)	.02 (.48)	-.73 (.31)	-.35 (.23)	-.30 (.23)
Energy	Income	.32 (.19)	-.13 (.27)	.25 (.30)	-.01 (.89)	-.94 (.17)	.36 (.07)	.18 (.14)
	Price	-.30 (.12)	.89 (.50)	-1.19 (.35)	-.52 (.49)	1.28 (.73)	-.71 (.44)	-.33 (.25)

Notes: Comp. = composite estimate of coefficients.

Upper figures = estimated coefficients.

Lower figures in parenthesis = standard errors.

Underlined figures = elastic coefficients (absolute value > unity).

On the individual country level, results for Belgium are not complete.

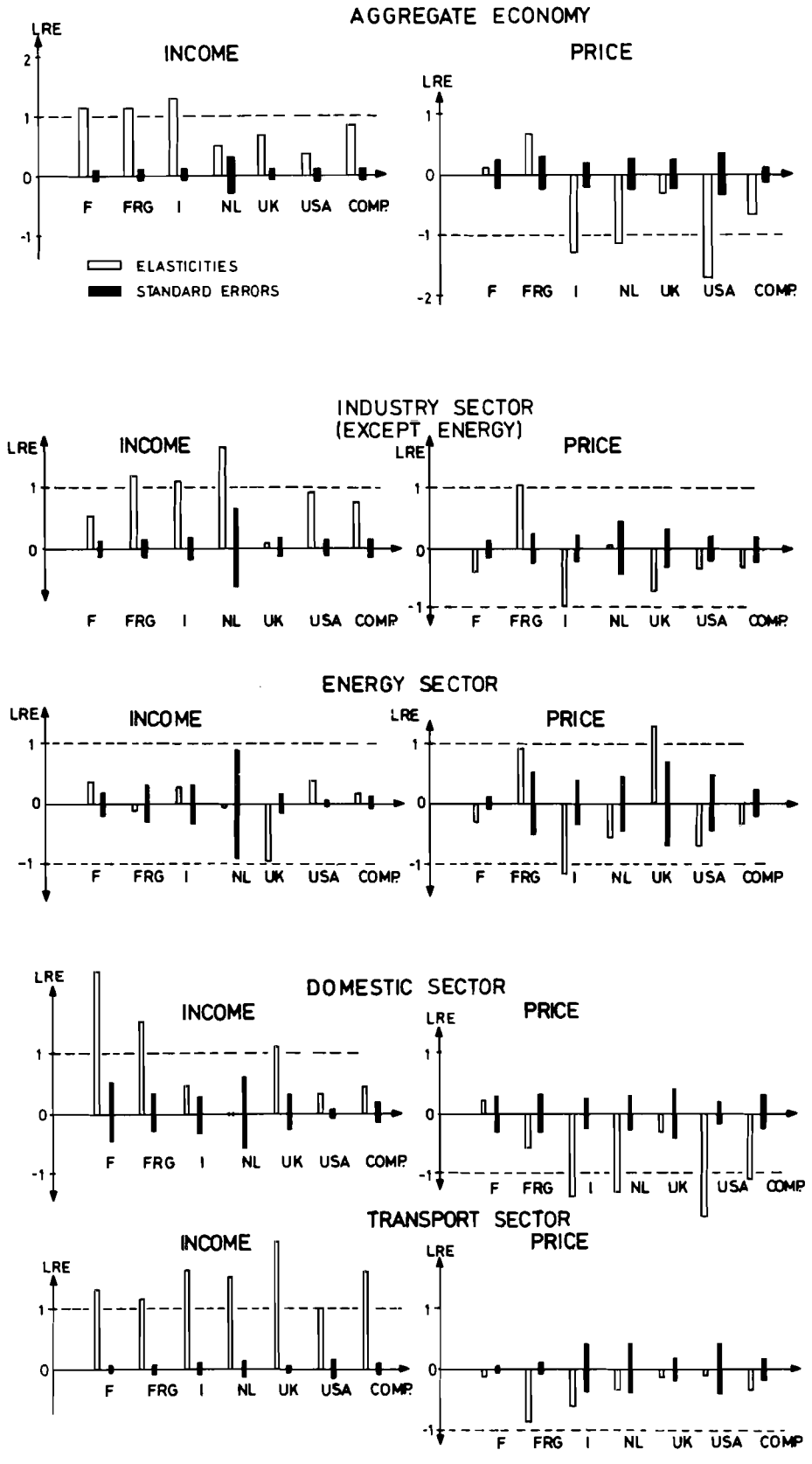

Figure 1. Individual countries, long–run elasticities, B1 specification.

- Countries have a different level of energy demand owing to the differences in income and relative prices but the elasticities of prices and incomes are the same.

- Other variables: weather, industrial structure, road network, etc. have country effects and could be represented by dummy variables.

- Short and long-run income elasticities--equal.

- Lag for price linear over a five year period.

The specification based on these assumptions is the following:

$$Q_{t,i} = e^{\alpha i} \cdot \prod_{\theta=0}^{4} P_{t-\theta,i}^{0.2\beta} \cdot \prod_{\theta=0}^{1} Y_{t-\theta,i}^{0.5\gamma}$$

where

$Q_{t,i}$ = per capita net energy consumption,

$P_{t,i}$ = relative net price of energy,

Y_{t},i = per capita real GDP,

α_i = individual countries' effects,

β = common long-run price elesticity,

γ = common long-run income elasticity.

The results for pooled data, the aggregate function, and the energy consumption functions for the four energy sectors are shown in Tables 2 and 3.

The aggregate consumption function concerns the energy demand for a country as a whole. The countries have common price and income long-run elasticities. The dummy variable indicates whether the country appears different from the United States. The price and income elasticities are moderate and well-determined. The ranking of economies by energy intensiveness is the following: Belgium, the United Kingdom, the United States, the Federal Republic of Germany, the Netherlands, France and Italy (the pattern of results varies for different sectors, however).

The energy consumption functions concern the four consumer sectors. The price and income elasticities vary from sector to sector and are all well-determined. The income elasticities for the transportation sector are very high. As the transport

Table 2. Results of pooled data: aggregate energy consumption functions.

$$q_{t,i} = \alpha_i - \underset{(.10)}{.85}\left[\sum_{\theta=0}^{4} 0.2p_{t-\theta,i}\right] + \underset{(0.08)}{0.79}\left[\sum_{\theta=0}^{1} 0.5y_{t-\theta,i}\right]$$

α_{USA}	D_i					
	UK	FRG	B	NL	F	I
4.70	.03	-.09	.13	-.25	-.35	-.35
(.18)	(.03)	(.03)	(.14)	(.03)	(.04)	(.04)

Notes:

$q_{t,i}$ = per capita net energy consumption.

$p_{t,i}$ = relative net price of energy.

$y_{t,i}$ = per capita real GDP.

$q_{t,i}$, $p_{t,i}$, $y_{t,i}$ -- in natural logarithms.

$\alpha_i = \alpha_{USA} + D_i$.

D_i = dummy country variables.

Upper figures = estimated coefficients.

Lower figures in parenthesis = standard errors.

Table 3. Results of pooled data: energy consumption functions.

$$q_{ti}=\alpha_i+\beta\left[\sum_{\theta=0}^{4} 0.2p_{t-\theta,i}\right]+\gamma\left[\sum_{\theta=0}^{1} 0.5y_{t-\theta,i}\right]$$

$\alpha_i=\alpha_{U.S.A.}+D_i$	β	γ	α_{USA}	D_i					
				UK	FRG	B	NL	F	I
Industry (except energy)	-.52 (.17)	.76 (.16)	<u>2.98</u> (.10)	.08 (.19)	.28 (.06)	.19 (.07)	-.34 (.05)	-.19 (.05)	-.11 (.08)
Energy	-.58 (.12)	.05 (.12)	<u>3.12</u> (.12)	-.37 (.06)	-.21 (.07)	-.60 (.06)	-.63 (.04)	-.91 (.07)	-1.41 (.06)
Transportation	-.36 (.12)	<u>1.34</u> (.80)	<u>1.84</u> (.23)	-.37 (.06)	-.63 (.05)	-.59 (.06)	-.44 (.05)	-0.74 (.09)	-.35 (.06)
Domestic	-.79 (.08)	<u>1.08</u> (.12)	<u>3.31</u> (.20)	.24 (.03)	-.05 (.07)	.11 (.03)	-.09 (.05)	-.39 (.04)	-.46 (.07)

Notes:

$q_{t,i}$ = per capita net energy consumption.

$p_{t,i}$ = relative net price of energy.

$y_{t,i}$ = per capita real GDP

$q_{t,i}$, $p_{t,i}$, $y_{t,i}$--in natural logarithms.

$\alpha_i = \alpha_{USA} + D_i$.

D_i = dummy country variables.

Upper figures = estimated coefficients.

Lower figures in parenthesis = standard errors.

Underlined figures = elastic coefficients (absolute errors value > unity).

sector is largely road transport, which is highly income elastic, the income elasticity for transportation is not surprising. The result for the energy sector indicates that the transformation processes of energy are not related to income.

Considering the price elasticities, it may be seen that in all of the four demand sectors the price elasticities have the right sign. The magnitudes of the elasticities indicate that the long-run response of energy consumption to price is moderate. They indicate that the most inelastic is the transport sector, which is plausible, since there is probably less possibility for technological substitution in this field.

2.4 Conclusion

I have presented here briefly the preliminary results of a study from the series of econometric studies on energy demand from an international perspective. The conclusion is that on the level of the individual country, the regression results show considerable lack of precision, as well as a certain number of contradictory conclusions.

The conclusion, when the data of the seven countries are pooled, is that the results mark considerable improvement over unpooled data. The second conclusion is that for the countries with market economy the net energy consumption of the aggregate economies, as well as different sectors, is relatively well explained by population, per capita income and relative prices (with country dummy variables 95 to 99 per cent of the variance of the sample).

The results show also that the income elasticities are relatively low and the price elasticities, all negative and moderate. These results are quite encouraging. An important application of the final results (this work is now under way) is the forecasting of the growth of energy demand over the short and medium run. Very preliminary projections were made for the United States. Emphasis was placed on the uncertainty of these results. It was concluded that the statistical uncertainty of the projection of energy demand at the end of the century is equally owing to uncertainties about price and income and to the uncertainty about the structure of the equation.

3. FUTURE WORK

- Special study on specific problems of the statistical analysis of energy demand data.
- Countries with planned economies: obtaining data and energy demand analysis.

- Comparison of the energy demand in planned and market economies.

A future step would be to dynamize the determinants of the econometric models integrating these models with the macro-economic models of these groups of countries--work which could be a part of a world energy model.