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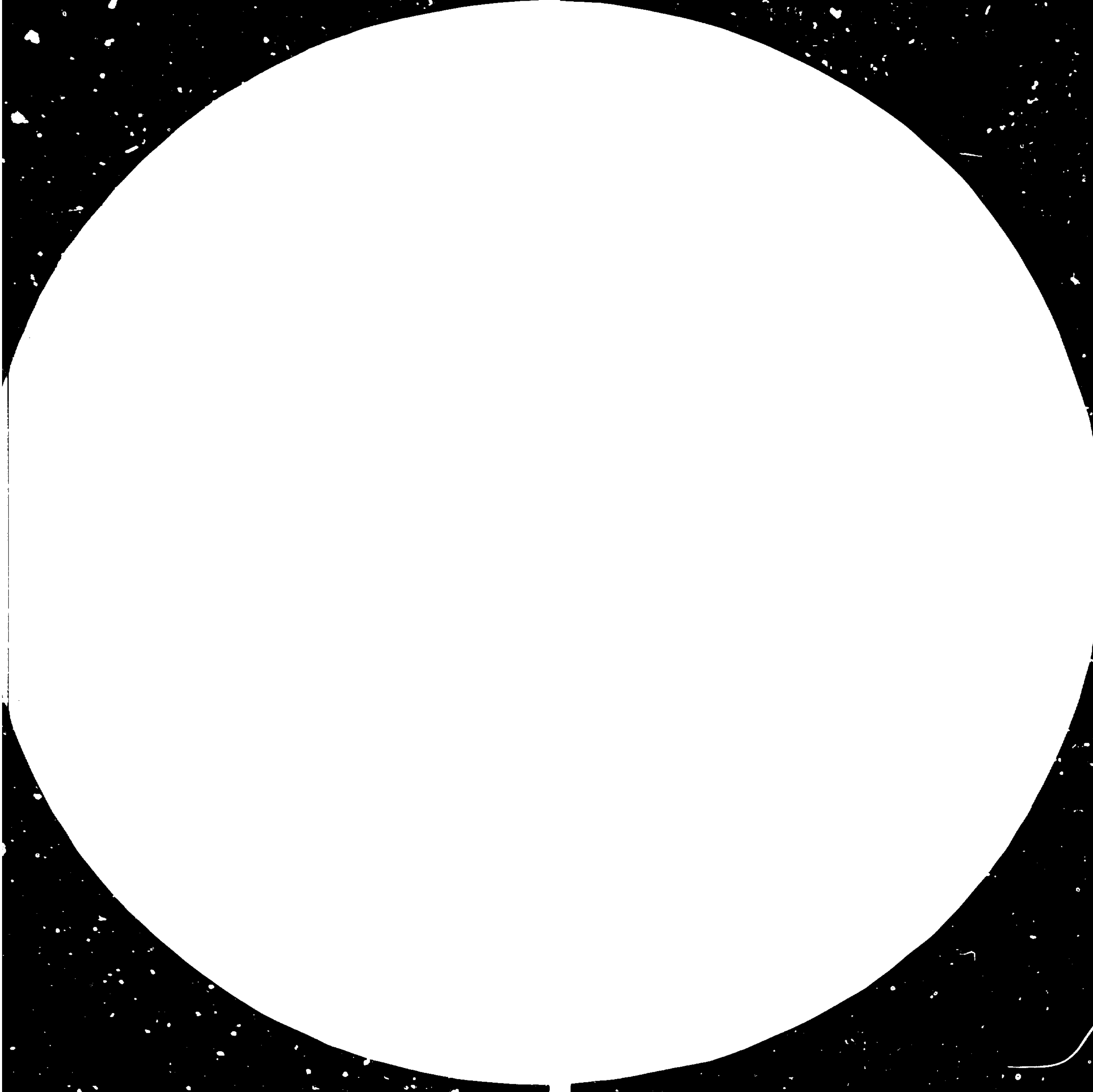

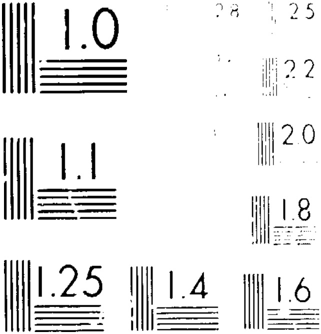
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Distr.
LIMITED
UNIDO/IS.278
13 January 1982

English

UNITED NATIONS
INDUSTRIAL DEVELOPMENT ORGANIZATION

A CONCEPTUAL MODEL FOR PROJECTING INDUSTRIAL ENERGY USE IN DEVELOPING COUNTRIES *

prepared by

Global and Conceptual Studies Branch
Division for Industrial Studies

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V.82-20426

TABLE OF CONTENTS

I. INTRODUCTION

The future rate of growth of energy consumption in developing countries will have a major impact both on their development prospects and on global supply and demand balances for energy. The industrial sector, which is the largest user of energy in most developed countries, can be expected to play a dominant role in determining future energy use in developing countries. This paper presents a conceptual model for projecting industrial energy consumption in developing countries, including the countries classified by UNIDO as least developed.

The model yields country-specific estimates of final consumption of commercial energy by the industrial sector. Projections of aggregate industrial energy consumption by groups of countries classified by region or level of development, or for developing countries as a whole, are obtained by summation of the projections for individual countries.

Previous models of energy consumption in developing countries can be categorized as either end-use models or reduced-form models. End-use models (also referred to as systems analysis or engineering models) attempt to incorporate explicitly all of the major structural determinants of energy consumption. The parameters of these models are generally determined from engineering data, rather than estimated using statistical techniques. In using the models to project future energy use, the values of the models' parameters, as well as of the variables to which they are applied, may be varied to reflect the assumptions of alternative scenarios. Examples of end-use models are discussed by Lapilione (1978) and Parikh (1981).

Reduced-form models (also referred to as econometric models) contain much less detail on the structural determinants of energy use, usually relying on a single basic equation containing relatively few explanatory variables. The parameters of these models are usually estimated using statistical techniques. In using the models to project future energy use, the parameters of the models are generally assumed either to be constant, or to change according to historically observed relationships. Examples of reduced-form models are discussed by Strout (1979 a).

Both types of models have useful roles to play in analyzing energy use in developing countries. For example, the greater structural detail of end-use models makes them more suitable than reduced-form models for simulating the effect on energy use of alternative possible economic or technological developments. On the other hand, reduced-form models are more suitable than end-use models for predicting the most probable level of future energy use, because the simplicity of reduced-form models makes it possible to estimate their parameters with more precision and also reduces the number of variables for which future values have to be predicted. Thus the two types of models should be thought of as complementary, rather than competitive.

Because the emphasis of the present study is on projecting the most probable level of future energy consumption, and also because the data required for end-use models are not available for a number of the countries of interest, the model developed here is of the reduced-form type. The following section describes the model in detail, and section III compares the model to previous reduced-form models of energy consumption in developing countries. Section IV discusses the data available for estimating the model and Section V discusses procedures for using the model to project industrial energy use.

II. THE MODEL

The quantity of energy used in an industry is assumed to be a function of the quantity of output produced by the industry, the price of energy, the prices of other inputs, the degree of technical and economic efficiency, and government policies affecting energy use. The basic relationship can be expressed in mathematical form as

$$E_j = E_j(X_j, PE_j, PK_j, PL_j, PR_j, T_j, G_j) \qquad (1)$$

$$j = 1, 2, \ldots, m$$

where

E_j = energy used in industry j,

X_j = output of industry j,

PE_j = price of energy to industry j,

PK_j = price of capital services to industry j,

PL_j = price of labour services to industry j,

PR_j = price of raw materials to industry j,

T_j = degree of technical and economic efficiency in industry j,

G_j = government policies that affect energy use in industry j.

Equation (1) can be interpreted as the reduced-form equation of a general equilibrium model that incorporates both technological and preference relationships.[1] Because adequate data on energy consumption by each industry are not available for developing countries, it is necessary to aggregate over industries to obtain an expression for aggregate energy consumption by the industrial sector. The aggregate energy-use function can be written as

$$EI = EI(X_1, X_2 \ldots X_m, PE, PK, PL, PR, T, G) \qquad (2)$$

where EI is aggregate energy consumption by the industrial sector.

The output levels of the individual industries, $X_1, \ldots, X_m$, are retained in the aggregate function because energy intensities are known to vary substantially across industries, so that the composition of total industrial output has an important effect on total energy consumption.[2] The absence of subscripts from the remaining variables indicates that these variables are measured at an aggregate, rather than industry by industry, level. While it would be desirable to take account of differences across industries in these variables as well, this is generally not feasible because of data limitations. The use of aggregate input-price variables will not introduce serious distortions into the estimation results if input prices do not vary substantially across industries, or if the responsiveness of energy consumption to input prices does not vary substantially across industries. The use of the aggregate variables T and G will not introduce serious distortions if these influences on energy consumption tend to be uniform across industries.

Sufficient data exist to estimate equation (2), or simplifications of it, for at least some developing countries.[3] However, when constructing a model for the purpose of projecting industrial energy demand, it is desirable to

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[1] For an explicit derivation of a relationship similar to equation (1) from a general equilibrium model see Nordhaus (1977).

[2] See Strout (1976).

[3] Hoffman and Mors (1980) use a variation of equation (2) to estimate total, rather than industrial, energy consumption for a large number of developing countries. Their specification omits the variables T and G as well as all input-price variables except PE.

express energy use as a function of a smaller number of more fundamental, and more easily projected, determinants. For example, Chenery and his collaboraters have demonstrated that the composition of output in a country can be explained using just two variables, per capita income, Y, and population, N.[4/] Therefore, the output of each industry, X_j, can be expressed as a function of Y and N,

$$X_j = X_j\ (Y, N) \qquad j = 1, 2, \ldots, m \tag{3}$$

and the set of m output variables in equation (2) can be replaced by a suitably general expression in Y and N.

Similarly, as Nordhaus (1977) demonstrates, the price of labour, PL, can be expressed as a function of per capita income,

$$PL = PL\ (Y). \tag{4}$$

The price of capital will be determined by the composition of output, which in turn is a function of Y and N, as well as by government policies, G, and the level of technical and economic efficiency, T. Therefore, the price of capital can be expressed as the function

$$PK = PK\ (Y, N, T, G). \tag{5}$$

Similarly, the price of raw materials, PR, can be expressed as a function of the variables in (5) together with the resource endowment of the country, R, so that

$$PR = PR\ (Y, N, T, G, R). \tag{6}$$

Substituting in equation (2) using the relationships (3), (4), (5), and (6), the reduced-form relationship for total industrial energy use can be written,

$$EI = EI\ (Y, N, PE, T, G, R) \tag{7}$$

[4/] See Chenery (1960), Chenery and Taylor (1968), Chenery and Syrquin (1975). For other applications of this approach in analyzing the development of the industrial sector, see United Nations (1963, 1976b). This approach has also been used by Strout (1976, 1979b) to analyze energy consumption in developing countries.

Because (7) is a reduced-form relationship, its functional form cannot in general be specified on theoretical grounds. Instead, the choice of functional form can be based on considerations of data availability, statistical properties of the estimates, and convenience in interpreting the results and performing projections.

The limited number of developing countries for which adequate data are available, and the limited number of observations available for each country, restrict the number of parameters that can be estimated with an appropriate degree of precision. Also, the unavailability of adequate data for some of the variables in equation (7) requires the use of some proxy relationships. With these considerations in mind, it is useful to specify the right-hand side of equation (7) as the product of three sub-functions,

$$EI = S(Y, N) \cdot P(PE) \cdot Z(T, G, R) \qquad (8)$$

where the sub-function S(Y, N) represent the direct and indirect influences of a country's basic economic structure on industrial energy use, P represents the effect of energy price, and Z represents the influences on energy use of a country's resource endowments, level of technical and economic efficiency, and government policies.

Equation (8) can be expressed in logarithmic form as

$$\ln EI = \ln S + \ln P + \ln Z \qquad (9)$$

The specification of the basic estimation equation is then completed by specifying the functional forms for each of the sub-functions S, P and Z.

In specifying the form of the economic structure sub-function, ln S, it is desirable to employ a form that imposes minimal a priori restrictions on the estimated relationships. This can be done by using a form that approximates any general functional form. The form used here is a second-order Taylor's series approximation to the logarithmic function, ln S(ln Y, ln N),

$$\ln S = a_0 + a_1 \ln Y + a_2 (\ln Y)^2 + a_3 \ln N + a_4 (\ln N)^2 + a_5 \ln Y \ln N. \qquad (10)$$

This functional form, which was named the translog form by Christensen, Jorgenson, and Lau (1973), has received numerous applications in other contexts in which it has been desired to impose minimal a priori restrictions on economic relationships.[5/]

The specification of the energy-price-effect sub-function should allow for the possibility that the responsiveness of energy use to price depends on the absolute level of energy price. The specification used here is

$$\ln P = b \ln PE + c(\ln PE)^2 \qquad (11)$$

With this specification of the energy-price-effect sub-function the price elasticity of energy use is equal to

$$b + 2c \ln PE$$

The common assumption of a constant price elasticity can be tested empirically by determining whether the estimate of the parameter c is statistically significant.

Because the availability of data on energy prices is still limited for developing countries, an alternative specification of the energy-price-effect sub-function based on more widely available data will be estimated as well. The price of energy to the industrial sector can be approximated by a weighted average of the prices of each type of energy

$$PE = \sum_i w_i PF_i$$

where PF_i is the price of energy type i and w_i is the share of that type of energy in industrial energy use. If data were available on the prices and shares for all types of energy, the overall price of energy could be calculated directly. This is in fact how the PE variable appearing in equation (11) was calculated.[6/] Where adequate data are not available to calculate the price of energy directly, partial information on prices and shares can be used as proxies for the price of energy.

For example, since hydro-electric power is generally cheaper than other forms of energy, one important determinant of energy price is the share of

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[5/] The functional form used in the studies referred to in footnote 4 are similar to the translog form, but omit the interaction term, ln Y ln N.

[6/] See Choe (1978). In calculating the energy price index Choe used the share of each type of energy in total, rather than industrial, energy use.

hydro-electric power in total energy use. Therefore the share of hydro-electric power can be used as a proxy for cross-country differences in energy price. Similarly, the world price of petroleum will have an important effect on energy price, and can be used as a proxy for differences over time in the price of energy. Thus, the proxy energy-price-effect sub-function can be written as a function of the share of hydro-electric power, WH, and the world price of petroleum, PP,

$$P = P(WH, PP)$$

A convenient functional form for the proxy energy-price-effect sub-function is

$$\ln P = b \ln WH + c \ln PP \qquad (12)$$

The choice of specification for the remaining sub-function, $\ln Z$, is severely constrained by the unavailability of adequate data on the variables T, G, and R. The specification used here allows the effects of these variables on energy demand to vary both across countries and over time,

$$\ln Z = f + g D_k + ht \qquad (13)$$

where D_k is a dummy variable that has a value of unity if an observation is for country k and a value of zero otherwise, and t is time.[7]

Substituting equations (10), (11), and (13) into equation (9), and adding a disturbance term, the basic equation to be estimated is

$$\ln EI_{kt} = a + a_1 \ln Y_{kt} + a_2(\ln Y_{kt})^2 + a_3 \ln N_{kt} + a_4(\ln N_{kt})^2$$

$$+ a_5 \ln Y_{kt} \ln N_{kt} + b \ln PE_{kt} + c(\ln PE_{kt})^2 + g D_k + ht + u_{kt} \qquad (14)$$

where $a = a_0 + f$, the subscript k indicates the country, the subscript t indicates the year, and the disturbance term, u_{kt}, is assumed to satisfy the usual Gauss-Markov conditions. The alternative specification of the energy-use equation, incorporating the proxy energy-price-effect sub-function,

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7/ In estimating the energy-use equation, the dummy variable for one of the countries is omitted, and cross-country differences are estimated relative to this country.

equation (12), is

$$\ln EI_{kt} = a + a_1 \ln Y_{kt} + a_2(\ln Y_{kt})^2 + a_3 \ln N_{kt} + a_4(\ln N_{kt})^2$$
$$+ a_5 \ln Y_{kt} \ln N_{kt} + b \ln WH + c \ln PP + g D_k + ht + u_{kt} \qquad (15)$$

The energy-use equations are estimated with pooled cross-section and time-series data. Data sources for estimation of the model are discussed in section IV.

III. COMPARISON WITH PREVIOUS MODELS OF ENERGY CONSUMPTION IN DEVELOPING COUNTRIES

As noted in the introduction, previous studies of energy consumption in developing countries have used either end-use models or reduced-form models. Because the model developed in this study is a reduced-form model, only studies based on this type of model will be discussed. Although the previous studies have generally focussed on total, rather than industrial, use of commercial energy, they provide a useful basis for evaluating the features of the model developed here, especially since this model could also be adapted to project total use of commercial energy.

Five previous reduced-form models of energy consumption in developing countries are summarized in Table 1. All of these studies except the WAES study used econometric methods to estimate the parameters of the models.

The models differ with respect both to the choice of explanatory variables and the choice of functional form for the energy-use equation. The only explanatory variable appearing in all of the models is the level of income, measured by the GDP. The first four models express per capita energy consumption as a function of per capita income, whereas the WAES model expresses total energy consumption as a function of total income. As a result, the first four models constrain the elasticity of energy use with respect to population to be equal to unity, while the WAES model constrains the population elasticity to be equal to the per-capita-income elasticity.

TABLE 1: SELECTED MODELS OF ENERGY CONSUMPTION IN DEVELOPING COUNTRIES

Hoffmann and Mors (1980)*	$\ln(E/N)_{kt} = a + b \ln Y_{kt} + c \ln PE_{kt} + d_1 \ln U_{1kt} + d_2 \ln U_{2kt} + d_3 \ln U_{3kt} + d_4 \ln U_{4kt}$
Strout (1979b)	$\ln(E/N)_{kt} = a + b \ln Y_{kt} + c\, IM_{kt} + d\, W_k$
Strout (1976)	$\ln(E/N)_{kt} = a + b \ln Y_{kt} + c(\ln Y_{kt})^2 + d \ln N_{kt} + f(\ln N_{kt})^2$
Choe (1978)	$\ln(E/N)_{kt} = a + b \ln Y_{kt} + c \ln PE_{kt} + f \ln (E_{kt-1}/N_{kt-1})$
WAES (1977)	$\ln E_{kt} = a + b \ln (YN)_{kt}$
This Study	$\ln EI_{kt} = a + a_1 \ln Y_{kt} + a_2(\ln Y_{kt})^2 + a_3 \ln N_{kt} + a_4 \ln (N_{kt})^2 + a_5 \ln Y_{kt} \ln N_{kt} + b \ln PE_{kt} + c \ln (PE_{kt})^2 + g D_k + ht$

where:

E = total consumption of commercial energy,
N = population,
Y = per capita GDP
PE = index of price of energy,
U_i = share of sector i in GDP,
IM = index of importance of energy-intensive commodities,
W = index of winter temperature,
EI = commercial energy use by the industrial sector.

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* Country dummy variables are also included in one version of the Hoffmann-Mors model.

Because the models are all expressed in logarithmic form, the elasticity of energy use with respect to each variable is given by logarithmic differentiation of the energy equations.[8] For example, for the Choe model, the (short-run) income elasticity of energy use is equal to

$$\frac{\partial \ln(E/N)}{\partial \ln Y} = b$$

Thus this model implies that the income elasticity does not depend on either the level or composition of GDP. Since there is strong reason to believe that the effect of income on energy use changes as a country develops, the implicit assumption of a constant income elasticity of energy use has to be considered a weakness of the Choe model. By contrast, the income elasticity for the Strout (1976) model is equal to

$$\frac{\partial \ln(E/N)}{\partial \ln Y} = b + 2c \ln Y$$

and thus varies with the level of income.

The characteristics of the income and price elasticities for each model are summarized in Table 2. The Hoffmann-Mors and Strout (1979b) models both imply constant income elasticities of energy use. However, both of these models also include variables representing the composition of GDP, so that the assumption of a constant income elasticity is not as restrictive as in the Choe model. The WAES model also involves a constant income elasticity, but in calculating projections of energy use the income elasticity is varied judgementally to reflect alternative assumptions concerning future energy prices.[9]

The income elasticity of energy use for the model developed in this study is equal to

$$\frac{\partial \ln EI}{\partial \ln Y} = a_1 + 2a_2 \ln Y + a_5 \ln N$$

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[8] Since the energy-use equations are most appropriately interpreted as reduced-form equations, reflecting both demand and supply influences on energy use, the elasticities will also reflect both types of influence. Therefore, the elasticities are referred to throughout as energy-use elasticities rather than demand elasticities.

[9] The income elasticity is varied inversely with the assumed level of energy price to reflect the effects of energy price on conservation of energy.

TABLE 2: ELASTICITIES OF ENERGY USE

	Income Elasticity	Price Elasticity
Hoffmann and Mors (1980)	Constant, equation includes variables for composition of GDP	Constant
Strout (1979b)	Constant, equation includes variable for composition of GDP	Not included
Strout (1976)	Varies with level of income	Not included
Choe (1978)	Constant*	Constant*
WAES (1977)	Constant, but effectively varies with energy price	Not included explicitly
This Study	Varies with level of income and with population	Varies with level of price

* The Choe study yields estimates of both the short-run and long-run elasticities of energy use.

Thus the income elasticity is allowed to vary both with the level of income and with population size.

Although not included explicitly in all the models reviewed here, energy price has been generally recognized to be an important determinant of energy use. The Hoffmann-Mors and Choe models both include an energy price variable in the energy-use equation. In both cases the form of the equation implies that the price elasticity of energy use is constant and equal to the coefficient of the energy price variable. The WAES model reflects the effects of price on energy use indirectly through adjustments to the income elasticity of energy use. Neither of the Strout models summarized in Table 1 includes an energy price variable but Strout (1979a) has emphasized the importance of including a price variable in future models of energy use in developing countries.

None of the models reviewed here allow for the possibility that the price elasticity of energy use depends on the level of energy price. However, it is plausible a priori that the price elasticity is a positive function of the level of energy price, since higher energy prices increase the incentive to find substitutes for energy use. Also, Mittlestadt (1981) presents empirical results indicating that the price elasticity of energy use is positively related to energy price for developed countries. Therefore it is desirable for a model of energy use in developing countries to allow for this possibility. As noted above, the model developed in the present study does allow for the price elasticity to be a function of energy price.

The Hoffmann-Mors and Strout (1979b) models allow for the effects of economic structure on energy use by including variables for the composition of GDP. As discussed in section II, the present study allows for the effects of economic structure on energy use through the inclusion of the economic structure sub-function, $\ln S(\ln Y, \ln N)$.

The only other variable included consistently in any of the previous models summarized in Table 1 is winter temperature, which is included in the Strout (1979b) model.[10/][11/] Winter temperature can be expected to be a less

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[10/] Strout (1979b) also presents results for the Strout (1976) model modified to include a winter temperature variable.

[11/] Hoffmann and Mors (1980) also include country dummy variables in one version of their model.

important determinant of industrial energy use than of total energy use and is not included explicitly in the model developed here. However, to the extent that winter temperature does affect industrial energy use, this effect should be captured by the country dummy variables, η_K, included in the present model.

The country dummy variables also allow for the effects of other variables that differ across countries, such as government policies and the degree of technical and economic efficiency. As noted by Gregory and Griffen (1974), the inclusion of country dummy variables is important to avoid biases in the application of cross-sectionally estimated parameters to explain changes in the dependent variable over time.

IV. DATA FOR MODEL ESTIMATION

The conceptual model described in the previous section is designed to incorporate the principal determinants of industrial energy consumption in a way that requires only the most widely available data. Nevertheless, the inadequate quantity and quality of energy data for developing countries severely restrict the sample of countries for which the model can be estimated.

The most serious data problem is with respect to the dependent variable, energy consumption by the industrial sector. Although data are now available on total commercial energy use for most countries, data on sectoral energy use are not generally available. The only major effort to provide such disaggregated data for developing countries is by the International Energy Agency (1978). Unfortunately, this publication does not contain data for any of the countries classified by UNIDO as least-developed.[12] Also, for a number of the countries for which data are provided, total final consumption is only partially allocated to end-use sectors.

The procedure used in the present study was to include only those observations from the International Energy Agency (1978) study for which at least 75 per cent of total final consumption of commercial energy was allocated to end-use sectors.[13] The portion of total consumption that was listed as "not included

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[12] Procedures for adapting the estimation results to project industrial energy consumption by the least-developed countries are discussed in the following section.

[13] The average per cent of total final consumption allocated to end-use sectors was 92 per cent for the observations included in the sample.

elsewhere" was then assigned to end-use sectors in the same proportions as the originally-allocated portion. The countries for which data on industrial energy consumption were obtained from the International Energy Agency (1978) study are Argentina, Brazil, India, Jamaica, Kenya, Mexico, Nigeria, Thailand, and Venezuela.

The sample size can be expanded by using comparable data on sectoral energy consumption that have been published for the OECD countries (International Energy Agency 1981, Organization for Economic Co-operation and Development 1976). These data are of higher quality than the data in the International Energy Agency (1978) publication in that all of total final consumption is allocated to end-use sectors for all countries. In order to obtain a sufficiently large sample for estimation of the model, it was decided to include twelve lower-income OECD countries in the sample. Four of these countries are classified by the World Bank (1980b) as developing countries; Greece, Portugal, Spain, and Turkey. The other countries included in the sample are Australia, Austria, Finland, France, Ireland, Italy, the Netherlands, and New Zealand.[14/]

The data on final consumption of commercial energy by the industrial sector for the countries in the sample are shown in Table A1. The time period chosen for the study, 1967-1977, includes all the years for which the International Energy Agency (1978) publication provides data. The model is to be estimated by pooling the time-series data for each country. The largest number of degrees of freedom is obtainable by including data for all individual years. However, since the data for individual years may reflect short-run cyclical disturbances, as well as errors of measurement, experiments [illegible] also be performed using data averaged over more than one year.

Data on constant market price GDP in national currency units are shown in Table A2. One approach that can be used in converting GDP in national currency units to GDP measured in US dollars is to divide the GDP in national currency units by the official exchange rate for the base year used in calculating constant market price GDP. However, this procedure has encountered increasing criticism in recent years on the grounds that official exchange rates do not adequately reflect the purchasing power of a country's currency.

[14/] The basic criterion for inclusion in the sample was that 1977 per capita GNP be less than $7500. However, two countries that met this criterion, the United Kingdom and Japan, were excluded from the sample because their growth rates, and hence the presumed average ages of their capital stocks, are atypical.

Kravis, Heston, and Summers (1978) have estimated alternative measures of GDP in US dollars indicating that the approach using official exchange rates understates the relative levels of income in the poorer countries.

Until this issue is resolved, it is appropriate to experiment with both procedures in estimating the energy-use equations. The official exchange rates for the base year of 1970 are shown in Table A3, together with two sets of purchasing power conversion factors calculated from the Kravis, Heston, and Summers (1978) study.[15] The column labeled D70 shows the conversion factors based on their preferred equation, while the column labeled A70 shows the conversion factors based on a simpler equation that yields results for a broader sample of countries, including most of the least-developed countries.

Table A4 shows the total midyear population for each country. The per capita income variable, Y, appearing in the energy-use equation is calculated by dividing GDP in 1970 US dollars by total midyear population. The population data also appear directly in the energy-use equation as the variable N.

As discussed in the previous section, the model allows for two alternative specifications of the energy-price-effect sub-function. In one specification, an index of energy price appears directly. The data for this index are from a study by Hoffmann and Mors (1980) and are shown in Table A5. Unfortunately, the price index data are not available for 1976 and 1977, so that a truncated sample has to be used in estimating the energy-use equation incorporating this specification of the energy-price-effect sub-function.

The alternative specification of the energy-price-effect sub-function incorporates data on the share of hydro and geothermal electric power and on the world price of petroleum. Data on hydro and geothermal electric power generation are shown in Table A6. The share of this type of energy for a country is calculated by dividing by total energy requirements, Table A8. An index of the world price of petroleum is shown in Table A7.

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[15] For the majority of the countries in Table A2, the base year used in calculating constant market price GDP is 1970. For the countries for which the GDP data are reported using other base years, the data will first be converted to a 1970 base using each country's GDP deflator.

V. USING THE MODEL TO PROJECT INDUSTRIAL ENERGY USE

Once the model has been estimated, it can be used to project industrial energy use in individual countries. For the countries appearing in the sample, as well as for any other developing countries for which base-year data on industrial energy consumption are available, the projection procedure is straight-forward.

From equation (14), the ratio of industrial energy consumption in any projection year, T, to consumption in the base year, B, is

$$\frac{EI_T}{EI_B} = \exp\Big\{ a_1(\ln Y_T - \ln Y_B) + a_2\left[(\ln Y_T)^2 - (\ln Y_B)^2\right] + a_3(\ln N_T - \ln N_B) + a_4\left[(\ln N_T)^2 - (\ln N_B)^2\right] + a_5(\ln Y_T \ln N_T - \ln Y_B \ln N_B) + b(\ln PE_T - \ln PE_B) + c\left[(\ln PE_T)^2 - (\ln PE_B)^2\right]\Big\} + h\,(T - B) \tag{16}$$

where the country subscript, k, has been suppressed for simplicity. Thus, industrial energy consumption in any year can be projected by calculating the value of the right-hand-side of equation (16) using the estimated coefficients and the projected values of the variables Y, N, and PE for that year and then multiplying base-year consumption by the result. An analagous procedure can be used for the alternative specification of the energy-use equation, (15).

Unfortunately, this procedure cannot be used directly for the least-developed countries, because base-year data on industrial energy consumption are not available for them. Therefore a less direct (and less accurate) method is required to project industrial energy consumption by the least-developed countries.

The recommended procedure is to first estimate base-year industrial energy consumption using a modified version of equation (15). The modified equation incorporates data on two variables, total energy consumption, E, and the share of manufacturing in total output, SM, for which historic data are available for the least-developed countries as well as for the countries in the sample. The equation for estimating base-year industrial energy consumption is

$$\ln \frac{EI_{kt}}{E_{kt}} = a + a_1 \ln Y_{kt} + a_2(\ln Y_{kt})^2 + a_3 \ln N_{kt} + a_4(\ln N_{kt})^2$$

$$+ a_5 \ln Y_{kt} \ln N_{kt} + b \ln WH + c \ln PP + g \ln SM + ht \qquad (17)$$

Equation (17) is first estimated using the data for the countries in the sample. The value of the right-hand-side of equation (17) for a least-developed country is then calculated using the estimated coefficients and the base-year values of the variables Y, N, WH, PP, and SM for that country. The estimate of base-year industrial energy consumption is then calculated by multiplying the antilog of the calculated value of the right-hand-side of (17) by the base-year value of total energy consumption in the least-developed country. The base-year data for the least-developed countries are shown in Table A10.

Once the base-year industrial energy consumption has been estimated for a least-developed country, the projected value for any year can be calculated using equation (16). The difficulty with this procedure is that the projected values of industrial energy consumption will include any errors in estimating base-year industrial energy consumption, as well as the usual projection errors. An alternative procedure, which yields estimates of the future rates of growth of industrial energy consumption, but not its absolute values, is to calculate the right-hand-side of equation (16) for a least-developed country for some future year, and then calculate the compound growth rate implied by the resulting estimate of EI_T/EI_B.

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TABLE A1: FINAL CONSUMPTION OF COMMERCIAL ENERGY BY THE INDUSTRIAL SECTOR

(millions of tons of oil equivalent)

	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977
Argentina	4.715	5.018	5.469	5.894	5.962	5.752	6.210	5.955	6.686	6.720	5.256
Australia	10.76	11.48	12.58	13.36	14.11	14.02	15.15	16.51	17.37	19.79	19.88
Austria	4.77	5.36	5.68	5.95	6.35	6.14	7.53	7.70	6.74	7.32	6.60
Brazil	8.013	8.784	10.155	10.003	11.261	13.265	16.053	17.417	18.413	21.089	n.a.
Finland	5.42	5.75	6.28	6.57	6.62	7.60	8.10	8.00	7.42	7.67	6.80
France	39.96	42.76	46.06	49.83	46.69	46.27	48.94	49.56	47.75	50.77	50.88
Greece	1.60	1.54	1.93	2.20	2.49	2.65	3.01	3.07	3.41	3.70	3.83
India	25.377	27.770	27.505	28.673	29.531	31.730	33.035	35.728	38.160	39.516	n.a.
Ireland	1.05	1.03	1.28	1.47	1.67	1.55	1.49	1.99	1.44	1.43	1.74
Italy	29.53	33.35	35.83	38.85	37.01	40.15	43.15	43.66	46.43	48.89	47.52
Jamaica	n.a.	.650	.807	.859	1.049	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Kenya	n.a.	n.a.	n.a.	.158	.198	.154	.183	.238	.247	.296	.31[illegible]
Mexico	16.724	17.565	19.032	19.604	20.138	22.517	24.184	27.212	29.002	29.195	37.[illegible]
Netherlands	8.68	9.91	10.86	11.88	11.45	13.54	14.47	15.40	18.25	19.97	20.8[illegible]
New Zealand	1.41	1.17	1.18	1.26	1.34	1.52	1.65	1.72	2.50	2.52	2.64
Nigeria	.602	.395	.423	.465	.727	.756	.908	1.145	1.912	n.a.	n.a.
Portugal	1.21	1.12	1.20	1.31	1.65	1.72	1.90	2.15	2.57	2.73	2.99
Spain	11.61	12.78	14.44	14.87	16.30	18.02	20.74	22.90	21.04	22.12	22.93
Thailand	.654	.913	1.053	1.329	1.440	1.813	1.928	1.745	1.981	2.236	2.471
Turkey	2.16	2.09	2.31	2.39	2.64	2.94	3.12	3.31	4.26	4.[illegible]	5.49
Venezuela	4.519	4.988	5.211	5.352	5.318	5.815	7.615	7.593	7.697	7.982	8.460

Source: International Energy Agency (1978, 1981); Organization for Economic Co-operation and Development (1976).

TABLE A2: CONSTANT MARKET PRICE GDP IN 1970 NATIONAL CURRENCY UNITS
(billions)

	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977
Argentina [a]	12.959	13.516	14.670	15.459	16.198	16.705	17.727	18.874	18.626	18.086	18.933
Australia	27.268	29.649	31.332	33.100	34.540	35.837	37.810	38.410	39.378	40.859	41.645
Austria	315.9	330.1	350.8	375.7	396.9	420.8	442.9	461.9	454.9	483.1	501.1
Brazil	157.600	175.700	192.700	208.301	237.100	264.000	298.7	332.3	351.2	382.7	400.5
Finland	35.606	36.459	40.264	43.592	44.642	47.774	50.872	53.039	53.516	53.678	53.895
France	663.5	691.8	740.1	782.6	824.9	873.6	920.4	950.2	953.3	997.4	1,027.9
Greece	236.2	251.9	276.9	298.9	320.2	348.6	374.2	360.5	382.4	406.0	420.2
India	345.4	357.1	378.1	404.6	413.8	410.7	426.5	425.8	464.8	472.1	504.3
Ireland	1.369	1.480	1.570	1.620	1.686	1.783	1.864	1.904	1.926	1.982	2.091
Italy	49,113.3	52,216.9	55,177.5	57,936.9	58,831.2	60,684.4	64,900.0	67,654.5	65,314.9	69,066.6	70,220.6
Jamaica [b]	1.614	1.696	1.792	2.020	2.069	2.260	2.259	2.265	2.244	2.094	2.011
Kenya [c]	10.016	11.334	12.042	12.923	13.747	14.423	15.434	16.094	16.198	17.090	18.418
Mexico [c]	377.1	407.0	432.4	461.9	477.7	512.3	551.7	582.8	605.9	615.6	633.3
Netherlands	94.802	100.885	107.371	114.573	119.461	123.544	130.592	135.212	133.992	139.998	143.328
New Zealand	5.040	5.149	5.408	5.609	5.752	6.006	6.437	6.697	6.809	6.814	6.610
Nigeria [b]	6.734	6.733	8.551	10.834	12.191	12.487	13.159	14.437	14.277	15.882	16.744
Portugal [d]	113.5	123.5	126.2	138.1	143.9	156.4	175.7	178.3	170.6	182.3	192.0
Spain	2,130.7	2,252.6	2,428.4	2,574.6	2,697.6	2,927.4	3,173.0	3,341.8	3,363.6	3,432.7	3,514.1
Thailand [c]	117.1	127.0	137.1	146.0	157.9	164.6	180.2	190.0	204.1	221.3	236.5
Turkey [e]	105.2	112.2	118.2	123.9	135.2	144.1	150.4	163.2	177.8	192.8	201.3
Venezuela [f]	41.679	44.580	46.034	50.072	51.819	53.380	56.955	60.285	63.416	68.353	73.002

Source: World Bank (1980b)

a/ 1960 units
b/ 1974 units
c/ 1972 units
d/ 1963 units
e/ 1965 units
f/ 1968 units

TABLE A3: EXCHANGE RATES AND PURCHASING POWER CONVERSION FACTORS

	Country Code	1970 Exchange Rate	A70 Purchasing Power Conversion Factor	D70 Purchasing Power Conversion Factor
Argentina	1	3.775	1.79	1.91
Australia	2	0.892	1.23	1.13
Austria	3	26.000	1.46	1.29
Brazil	4	4.593	2.21	2.23
Finland	5	4.200	1.37	1.34
France	6	5.554	1.26	1.23
Greece	7	30.000	1.75	1.04
India	8	7.500	2.89	2.93
Ireland	9	0.416	1.66	1.53
Italy	10	625.000	1.52	1.35
Jamaica	11	0.833	2.03	1.88
Kenya	12	7.142	2.78	2.45
Mexico	13	12.500	2.05	1.88
Netherlands	14	3.620	1.33	1.23
New Zealand	15	0.892	1.38	1.38
Nigeria	16	0.714	2.77	2.46
Portugal	17	28.750	2.02	1.82
Spain	18	70.000	1.78	1.75
Thailand	19	20.800	2.69	2.46
Turkey	20	11.500	2.38	2.41
Venezuela	21	4.498	1.75	1.78

Sources: Kravis, Heston, and Summers (1978); World Bank (1980b).

TABLE A4: TOTAL MIDYEAR POPULATION

(thousands)

	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977
Argentina	22,787	23,101	23,419	23,741	24,060	24,382	24,709	25,041	25,377	25,704	26,036
Australia	11,822	12,046	12,275	12,507	12,701	12,898	13,098	13,301	13,507	13,788	14,074
Austria	7,323	7,357	7,391	7,426	7,445	7,465	7,484	7,503	7,523	7,515	7,506
Brazil	87,377	89,908	92,512	95,191	97,934	100,755	103,659	106,645	109,718	112,864	116,100
Finland	4,581	4,589	4,598	4,606	4,626	4,646	4,666	4,687	4,707	4,720	4,732
France	49,552	49,954	50,359	50,768	51,166	51,567	51,972	52,379	52,790	52,920	53,051
Greece	8,646	8,695	8,744	8,793	8,843	8,893	8,944	8,995	9,046	9,138	9,231
India	510,583	522,625	534,952	547,569	559,168	571,012	583,107	595,459	608,072	619,786	631,726
Ireland	2,905	2,920	2,935	2,950	2,985	3,020	3,055	3,091	3,127	3,162	3,198
Italy	54,624	52,967	53,313	53,661	54,084	54,510	54,940	55,373	55,810	56,138	56,468
Jamaica	1,803	1,825	1,847	1,869	1,903	1,937	1,972	2,007	2,043	2,072	2,101
Kenya	10,151	10,510	10,881	11,265	11,686	12,122	12,574	13,044	13,531	14,062	14,614
Mexico	45,713	47,203	48,741	50,330	51,995	53,716	55,493	57,329	59,226	61,238	63,319
Netherlands	12,577	12,727	12,873	13,032	13,154	13,277	13,401	13,526	13,653	13,758	13,864
New Zealand	2,700	2,736	2,773	2,811	2,861	2,912	2,964	3,016	3,070	3,109	3,148
Nigeria	61,449	62,985	64,560	66,174	67,856	69,581	71,350	73,163	75,023	76,977	78,982
Portugal	9,095	9,078	9,061	9,044	9,119	9,195	9,271	9,348	9,426	9,501	9,577
Spain	32,647	33,020	33,397	33,779	34,135	34,494	34,858	35,225	35,596	35,945	36,298
Thailand	32,589	33,609	34,660	35,745	36,803	37,893	39,015	40,170	41,359	42,331	43,326
Turkey	32,756	33,590	4,445	35,321	36,222	37,146	38,094	39,066	40,063	40,995	41,949
Venezuela	9,717	10,034	10,362	10,700	11,065	11,442	11,832	12,236	12,653	13,076	13,513

Source: World Bank (1980b)

TABLE A5: INDEX OF ENERGY PRICE

(1970 = 1.000)

	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977
Argentina	1.146	1.086	1.062	1.000	1.028	1.022	.998	1.075	1.233	n.a.	n.a.
Australia	1.058	1.059	1.043	1.000	.967	.946	.890	.864	.907	n.a.	n.a.
Austria	1.000	.991	.977	1.000	1.019	.997	.982	1.035	1.101	n.a.	n.a.
Brazil	1.147	1.134	1.108	1.000	1.049	1.141	1.158	1.455	1.546	n.a.	n.a.
Finland	.953	.943	.932	1.000	1.102	1.068	1.045	1.319	1.274	n.a.	n.a.
France	.984	.986	.998	1.000	1.011	.979	.949	1.147	1.107	n.a.	n.a.
Greece	1.044	1.054	1.037	1.000	.967	.936	.865	1.004	1.031	n.a.	n.a.
India	.873	.987	1.032	1.000	1.163	1.104	.987	1.014	1.163	n.a.	n.a.
Ireland	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Italy	1.092	1.065	1.014	1.000	.991	.938	.853	1.020	.928	n.a.	n.a.
Jamaica	.976	.936	.969	1.000	1.002	1.029	.964	1.134	1.020	n.a.	n.a.
Kenya	.945	.934	1.000	1.000	1.026	1.066	1.022	.949	.952	n.a.	n.a.
Mexico	1.057	1.037	1.001	1.000	1.042	1.205	1.129	1.209	1.114	n.a.	n.a.
Netherlands	1.014	.998	.985	1.000	.995	.960	.928	.970	1.051	n.a.	n.a.
New Zealand	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Nigeria	1.049	1.071	1.001	1.000	.831	.833	.688	.620	.838	n.a.	n.a.
Portugal	1.220	1.150	1.057	1.000	.924	.835	.783	.756	.718	n.a.	n.a.
Spain	1.022	1.006	.995	1.000	.993	.972	.938	.972	.979	n.a.	n.a.
Thailand	1.043	1.024	.999	1.000	1.042	1.004	.968	1.430	1.406	n.a.	n.a.
Turkey	1.008	1.097	1.052	1.000	1.013	1.189	1.155	1.026	.888	n.a.	n.a.
Venezuela	1.064	1.050	1.026	1.000	.969	.942	.904	.835	.763	n.a.	n.a.

Source: Hoffmann and Mors (1980)

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n.a. = not available

TABLE A6: HYDRO AND GEOTHERMAL ELECTRIC POWER GENERATION

(millions of metric tons of oil equivalent)[a]

	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977
Argentina	.365	.443	.394	.458	.455	.441	.889	1.516	1.572	1.515	1.748
Australia	2.75	2.64	2.81	2.93	3.64	3.81	3.67	4.13	4.50	4.71	4.11
Austria	4.60	4.50	3.96	5.13	4.03	3.98	4.39	5.10	5.58	4.82	5.84
Brazil	8.961	9.379	10.036	12.238	13.285	15.793	18.054	20.125	22.668	25.011	28.534
Finland	2.86	2.58	2.15	2.27	2.61	2.54	2.58	3.05	2.99	2.30	2.95
France	12.06	13.08	12.39	13.78	12.22	11.44	11.47	13.29	14.17	11.41	18.78
Greece	.55	.42	.64	.77	.83	.80	.70	.76	.51	.49	.49
India	5.728	6.362	7.075	7.751	8.603	8.349	8.894	8.558	10.224	10.689	11.404
Ireland	.29	.28	.19	.25	.15	.20	.17	.28	.19	.23	.25
Italy	11.21	11.14	10.50	10.60	9.79	10.13	9.41	9.16	10.18	9.70	12.94
Jamaica	.047	.039	.035	.037	.039	.043	.030	.037	.040	.045	.049
Kenya	.061	.077	.088	.097	.098	.117	.119	.160	.193	.173	.224
Mexico	3.332	3.809	4.084	4.561	4.416	4.680	4.990	5.082	4.753	5.400	5.814
Netherlands	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
New Zealand	2.91	2.91	2.75	3.06	3.46	3.58	3.57	3.51	4.30	3.80	3.71
Nigeria	.043	.039	.276	.419	.483	.444	.570	.601	.719	.775	1.100
Portugal	1.43	1.29	1.50	1.40	1.49	1.65	1.69	1.78	1.51	1.15	2.35
Spain	5.85	6.00	7.26	6.75	7.88	8.41	6.77	6.91	6.22	5.29	9.57
Thailand	.420	.431	.321	.549	.629	.530	.577	.751	1.043	1.117	1.996
Turkey	.64	.75	.81	.73	.60	.74	.60	.68	1.39	1.97	2.02
Venezuela	.482	.826	.965	1.246	1.649	1.861	1.896	2.189	2.732	3.231	3.830

Source: International Energy Agency (1978, 1981); Organization for Economic Co-operation and Development (1976).

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[a] Calculated equivalent of thermal power plant input assuming 28% efficiency.

TABLE A7: INDEX OF WORLD PRICE OF CRUDE PETROLEUM[a]

Year	Current Dollar Price[b]	Constant Dollar Price[c]
1967	1.33	1.38
1968	1.30	1.45
1969	1.28	1.41
1970	1.30	1.30
1971	1.65	1.53
1972	1.90	1.60
1973	2.70	1.90
1974	9.78	5.52
1975	10.72	5.26
1976	11.51	5.55
1977	12.40	5.56

Source: World Bank (1980a)

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a/ Realized price of Saudi Arabian light crude oil, 34° - 34.9° API gravity, F.O.B. Ras Tanura.

b/ U.S. dollars per barrel.

c/ 1970 U.S. dollars. Deflated using the unit value index of exports of manufactured goods for developed market economies.

TABLE A8: TOTAL ENERGY REQUIREMENTS

(millions of metric tons of oil equivalent)

	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977
Argentina	24.690	26.881	29.455	30.920	33.128	33.928	36.082	37.019	37.605	37.926	37.453
Australia	40.37	42.41	45.29	47.73	49.82	52.06	55.52	58.51	63.29	67.47	68.86
Austria	16.41	17.37	18.12	20.39	20.57	21.46	23.46	23.34	23.42	24.31	24.46
Brazil	31.227	35.711	38.278	41.548	46.038	53.593	65.831	69.791	71.477	78.553	83.617
Finland	16.21	17.05	18.38	19.38	19.97	21.20	22.64	21.98	21.88	22.84	23.55
France	123.35	130.13	137.75	150.16	156.96	163.88	182.25	178.25	168.05	177.74	179.55
Greece	6.36	6.76	7.76	8.47	9.90	10.99	12.77	13.25	12.11	13.11	14.26
India	62.929	67.541	68.808	72.069	73.886	80.144	83.439	85.228	93.175	97.808	102.863
Ireland	5.41	5.88	6.47	6.78	7.31	7.21	7.13	7.57	7.00	7.17	7.57
Italy	88.66	94.15	101.04	117.21	115.99	125.51	132.10	137.79	127.55	136.45	138.49
Jamaica	1.581	1.454	1.734	1.755	2.081	2.181	2.824	2.650	2.765	2.785	2.776
Kenya	.976	1.031	1.112	1.030	1.225	1.229	1.297	1.661	1.627	1.710	1.594
Mexico	37.737	40.314	43.877	46.016	47.714	52.359	57.109	61.998	66.327	70.194	75.879
Netherlands	35.44	39.47	43.35	49.22	50.82	58.58	61.83	61.54	59.09	65.03	63.15
New Zealand	7.24	7.42	7.54	7.97	8.24	8.92	9.75	9.86	10.63	10.94	11.42
Nigeria	1.765	1.608	1.622	2.143	2.667	3.164	4.521	5.117	6.608	6.303	8.328
Portugal	4.89	4.93	5.70	6.15	6.70	7.12	7.66	7.61	8.24	8.48	9.08
Spain	33.56	36.83	40.68	43.49	47.30	50.62	57.03	60.24	62.32	65.78	67.65
Thailand	3.681	5.436	4.461	5.868	7.132	7.496	9.027	8.517	9.240	10.134	12.134
Turkey	10.09	10.85	11.83	12.45	13.69	15.17	16.74	17.57	27.18	29.44	31.87
Venezuela	15.693	17.214	17.629	19.356	20.296	15.773	23.661	25.460	23.933	17.801	28.453

Source: International Energy Agency (1978, 1981); Organisation for Economic Co-operation and Development (1976)

TABLE A9: MANUFACTURING OUTPUT AS PER CENT OF GDP

	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977
Argentina a/	31.06	30.68	30.54	30.23	30.56	32.15	31.56	31.30	34.60	36.70	36.50
Australia b/	23.92	23.32	23.16	22.92	21.89	21.20	20.71	20.10	18.98	n.a.	n.a.
Austria b/	32.83	32.70	33.29	33.72	33.69	33.35	31.32	31.38	29.50	29.86	29.78
Brazil c/	24.30	26.18	26.82	27.39	27.70	28.56	29.52	30.55	30.21	29.63	28.04
Finland b/	22.70	23.35	25.76	26.86	25.71	26.62	27.39	29.87	27.57	27.67	27.18
France b/	27.68	27.83	28.93	28.75	28.54	28.22	28.33	27.90	27.30	27.43	27.49
Greece a/	16.56	17.13	17.82	19.11	19.34	18.76	20.13	20.22	19.91	19.55	19.09
India a/	13.03	13.65	14.39	14.40	14.84	14.96	14.25	15.64	16.10	16.58	16.38
Ireland	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Italy	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Jamaica b/	16.43	16.86	16.18	15.74	16.18	16.82	16.94	17.06	16.82	18.70	19.01
Kenya a/	11.16	11.30	11.93	11.98	12.57	11.85	12.78	13.30	12.36	13.26	12.68
Mexico b/	24.90	25.43	25.65	25.78	25.98	26.05	25.29	26.27	26.15	26.66	27.71
Netherlands b/	32.14	31.92	28.78	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
New Zealand	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Nigeria a/	7.05	7.48	7.94	7.16	6.25	7.11	7.99	6.55	7.43	8.82	8.78
Portugal a/	32.36	32.80	33.38	33.27	33.84	34.92	34.62	36.47	33.56	33.79	35.49
Spain a/	26.42	25.89	26.74	26.96	26.44	27.53	27.93	28.36	27.78	n.a.	n.a.
Thailand b/	15.33	15.32	15.63	16.02	17.22	16.95	16.44	18.20	18.27	18.81	19.00
Turkey a/	16.80	17.54	17.73	16.93	17.44	17.34	17.99	18.50	17.72	17.15	17.00
Venezuela b/	n.a.	15.96	15.69	15.92	16.52	17.14	17.69	19.53	16.20	17.24	16.34

Source: World Bank (1980b)

n.a. = not available

a/ GDP at factor cost

b/ GDP at market prices

c/ NDP at factor cost

TABLE A 1C: BASE YEAR (1977) DATA FOR LEAST DEVELOPED COUNTRIES

	1977 Constant Market Price GDP a/	1977 Total Midyear Population (thousands)	1970 Exchange Rate	Purchasing Power Conversion Factor b/	Consumption of Energy c/		Share of Manufacturing (%)
					Total	Hydro	
AFRICA							
Benin	90.1	3,229	277.710	2.95	135	18	9.38
Botswana	.167	728	.714	2.77	n.a.	n.a.	5.84
Burundi	26.117	4,156	87.500	2.98	36	7	9.48
Cape Verde	n.a.	300	n.a.	n.a.	27	0	n.a.
Cent. Af. Emp.	61.8	1,867	277.710	2.82	65	18	8.32
Chad	80.3	4,221	277.710	2.95	66	0	7.87
Comoros	n.a.	400	n.a.	2.89	13	0	n.a.
Ethiopia	5.444	30,245	2.500	2.97	450	111	9.77
Gambia	.142	554	2.083	2.89	38	0	2.69
Guinea	15.5	4,989	24.685	2.95	308	25	3.52
Lesotho	.088	1,250	.714	2.95	n.a.	n.a.	1.83
Malawi	.435	5,597	.833	2.95	249	89	14.87
Mali	215.3	6,129	555.420	3.00	129	11	12.07
Niger	119.8	4,862	277.710	2.92	132	14	10.67
Rwanda	29.988	4,379	100.000	3.00	84	43	14.81
Somalia	1.489	3,660	7.143	2.92	219	0	10.26
Sudan	1.323	16,919	.348	2.79	1,947	132	5.93
Uganda	10.519	12,049	7.142	2.80	560	128	4.72
U.R. of Tanzania	13.106	16,363	7.142	2.89	827	157	9.64
Upper Volta	87.4	5,465	277.710	3.00	100	0	13.59
ASIA AND PACIFIC							
Afghanistan	100.1	14,304	85.280	2.92	646	157	10.10
Bangladesh	34.764	81,219	6.460	2.98	2,298	157	8.14
Bhutan	n.a.	1,200	n.a.	3.03	n.a.	n.a.	n.a.
Laos	n.a.	3,200	n.a.	2.98	163	25	n.a.
Maldives	n.a.	100	n.a.	2.92	n.a.	n.a.	n.a.
Nepal	10.330	13,322	10.125	2.95	127	46	10.36
Samoa	n.a.	200	n.a.	2.70	16	0	n.a.
AMERICAS							
Haiti	2.605	4,749	5.000	2.91	220	50	12.78
WESTERN ASIA							
P.D.R. of Yemen	n.a.	1,700	n.a.	2.89	622	0	n.a.
" Arab R.	2.688	4,869	5.500	2.95	250	0	n.a.

Sources: United Nations (1979a); World Bank (1980b)

n.a. = not available

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a/ Billions of 1970 national currency units.

b/ Calculated using Kravis, Heston and Summers (1978) results for their equation A_{70}.

c/ Thousand metric tons of oil equivalent. Hydro is adjusted to reflect quantity of oil needed to produce same amount of electricity in thermal plant.