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ENERGY-ECONOMY INTERACTIONS IN JORDAN

by

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I. INTRODUCTION

The Government of Jordan has expressed serious concern regarding what it perceives to be the Jordanian economy's growing energy problem. The core of this problem is the dependence of the economy on imported oil. Jordan relies on imported oil for virtually all its primary energy and the oil import bill has swelled enormously, to the point where it now approximates total merchandise exports. The situation may continue to worsen since domestic energy resources are minimal (at least in the near-term) and energy demand is expanding very rapidly.

The principal concern is that increasing energy costs will seriously erode the rapid real growth rates which the economy has sustained for some years. Aggregate growth could be affected adversely either directly or indirectly. If energy import costs continue to rise more rapidly than exports, the Government would have to borrow more or divert foreign exchange resources which otherwise could have been used for economic development projects to pay for oil imports, thereby directly reducing aggregate growth. In addition, since a number of Jordan's largest development projects (particularly in the mining and minerals sector) are also large energy users, the higher implied production costs could make these activites less profitable, reduce exports, and indirectly lead to slower

growth.

In deciding how to cope with this basic energy problem, a number of specific questions arise. The more important of these for Jordan are the following :

--How rapidly will energy demand grow in the future? What forms of energy (electricity, gasoline, fuel oil, etc.) will be required? In which sectors will additional energy use be concentrated? Will transportation continue to dominate energy demand?

--What scope is there for using energy more efficiently? Are there significant possibilities for fuel substitution, from oil to alternatives such as coal? What are the most effective government policies for achieving greater efficiency?

--How sensitive is energy demand in different sectors to changes in domestic energy prices? What would be the effects of reducing or eliminating existing energy subsidies?

--How serious are the macroeconomic effects (e.g., on growth, inflation, balance of payments, employment, etc.) of oil imports? Do energy prices put a serious fiscal drag on the rest of the economy? To what degree is the economy vulnerable to uncertain future energy prices?

--Is it necessary for Jordan to re-think it's basic industrialization policy because of higher energy costs? Has comparative advantage shifted against Jordanian minerals or other industrial products?

--What are the prospects for domestic production of primary energy, viz. conventional or shale oil, geothermal, renewable energy? How far in the future will any of these be economic on a large scale?

--What changes in energy policy seem warrented? Which potential policy alternatives require more careful analysis? How should energy policy management be organized within the Jordanian Government?

This report has its roots in a request by the Government of Jordan to the US Government for assistance in analyzing analyzing these and other energy-related policy issues. After some discussions, it was agreed that USAID would provide consulting assistance to take a more careful look at few of the key questions, leaving for later the possibility of a more comprehensive energy sector study or master plan.

As part of this initial effort, it was decided to undertake a overview of energy-macroeconomic linkages and energy demand forecasting. This study reports on the

results of a visit the author made to Amman last May. During that three-week period, he worked together with officials of the National Planing Council and the Ministry of Industry and Trade to develop an appropriate methodology for analyzing energy-economy interactions and deriving consistent medium-term energy demand projections. As such, the study was the joint product of many persons who contributed ideas, data, and understanding of the Jordanian economy. However, the conclusions reached in this report are the sole responsibility of the author.

Being an overview involving only a few months effort, the objectives of this study necessarily were modest. It concentrates on macroeconomic and demand issues, and leaves aside most of the energy supply questions refered to above. In the time-period available, it was not feasible to collect new data or fully analyze all important energy-economy questions, particularly those involving the details of sectoral energy use.

Instead, it was decided that a small economy-wide simulation model would be built, based on the Five-Year Plan and using existing energy and national income account statistics. The model was designed to focus on the links between medium-term growth and energy prices (both international and domestic), broad investment allocation decisions, and consistent energy demand projections. The key policy variables in the model would be domestic energy

prices and subsidies, sectoral investment allocations, and foreign borrowing.

This report reviews the development of that model and the implications of its initial results for Jordanian energy policy and future analysis. As background for this analysis, Section II provides a brief overview of the energy situation in Jordan, focusing on existing demand and subsidy patterns. The formulation and rationale of the economy-wide model then is reviewed in Section III. Results of various scenarios and policy simulations of the model are examined in Section IV. Finally, Section V discusses the main conclusions and recommendations of this study.

II. ENERGY AND THE JORDANIAN ECONOMY

The recent economic performance of Jordan has been excellent by global standards with aggregate growth averaging more than 7% between 1970 and 1980, and more than 9% annually since 1975. The most recent Five-Year Plan anticipates rapid growth continuing at least through the mid-1980s.

The major factors underlying this performance have been:(1) expanding foreign exchange resources in the form of workers' remittances, foreign aid, and capital inflows mainly from other Arab countries;(2) the economic boom in

the oil-exporting Gulf countries which, combined with the Lebanese troubles, has strenthened Jordan's position as a regional trade, commerce, and transportation center;(3) rapid growth in production of minerals and manufactures;(4) the economy's relative openness, well educated labor force, and entrepreneurial business spirit. Positive benefits of rapid growth have included high employment rates at growing real wages, diversified commodity production, increased exports, a favorable international credit position, and relatively low inflation.

Rapid aggregate growth also has brought with it rapid growth in energy usage. According to World Bank figures, per capita energy consumption was 141 kilograms of oil equivalent (koe) in 1960. Based on imports of 1.7 million tons of crude oil and a population of 2.2 million, per capita energy consumption had increased to 772 koe 1979, or at an annual rate of more than 9%. Energy consumption also has increased more rapidly than GDP. Between 1975 and 1979, electricity generation went up at almost 20% annnually while consumption of petroleum products rose at about 18%.

Although energy consumption has grown very rapidly in recent years, in absolute terms it is still small. At less than 800 koe, per capita energy use is about one-half the level in the Gulf countries and less than one-seventh the

level in the industrialized countries. Since energy consumption is closely correlated with income, these figures are a reflection mostly of lower per-capita income in Jordan.

When comparisons are done relating energy consumption to GDP, the situation appears somewhat different. Looking at energy use per unit of GDP, Jordan's energy intensity is marginally higher than the weighted average that the World Bank has calculated for all middle-income countries. Comparing countries which have per capita income within 10% of Jordan's, Korea and Jamaica are significantly more energy-intensive; Lebanon and Syria are about the same; Turkey and Malaysia are slightly less energy-intensive. Only Tunisia uses significantly less energy per unit of GDP. Of course, such simple comparisons do not really say anything about energy efficiency since the sectoral composition of these economies, and the ways they use energy, are very different.

In order to understand how energy fits into the rest of the Jordanian economy, it is necessary to differentiate between forms of energy and sectors of use. Throughout this paper, energy is differentiated into three forms--crude oil, refined products, and electricity--and economic activity is divided into seven productive sectors--agriculture, mining and minerals, manufacturing, transportation and communications, other services,

electricity generation, and petroleum refining. In addition, final demand is divided into household expenditure, government expenditure, gross investment, and foreign trade. This choice for disaggregation represents a compromise between a desire for more detail and the realities of available data.

Table 1 summarizes the pattern of sectoral energy consumption in 1979. The first two columns show how much was spent, in millions of Jordanian Dinars (mJD), by each sector for petroleum products and electricity. (1979 was chosen as the base-year for this and all other calculations since it was the most recent year for which a full set of accounts was available.) Transportation is the dominant energy user and household consumption is second most important. Of total petrolem product purchases in 1979 of 64.2 mJD, 34 mJD or 52% were incurred by the transportation sector, and another 25% by private households purchasing gasoline and heating/cooking fuels.

Electricity use in Jordan is growing rapidly, but remains a relatively small part of total energy consumption. Total expenditures in 1979 were one-seventh of combined energy costs of all sectors, excluding the energy costs of refining and generating electricity. The pattern of electricity use is very different from the pattern for petroleum products. Household use is dominant, accounting for 45% of total consumption, with services and

Table 1

Sectoral Energy Consumption in 1979
(units: mJD)

	Actual Expenditure Pet. Prod.	Electricity	Subsidy Recieved	Implied Cost of Pet. Prod.
Agriculture	.5	0.0	.03	.5
Mining and Minerals	1.0	0.0	.1	1.1
Manufacturing	2.4	1.9	3.8	6.2
Transport and Comm.	34.0	.3	13.5	47.5
Services	2.4	2.7	1.7	4.1
Household Consumption	15.7	4.7	1.9	17.6
Government Consumption	3.7	.4	.8	4.5
Petroleum Refining	1.2	.1	.8	2.0
Electrcity Generation	3.3	.1	3.8	6.2

manufacturing accounting for an additional 45%.

As in many countries, not all recent energy price increases have been passed on to the users. Jordanian energy prices are distorted by a variety of direct and indirect subsidies. The most important subsidies have been on diesel, aviation fuel, kerosene, and fuel oil. Total petroleum product subsidies in 1979 amounted to 28 mJD.

Officials from the Ministry of Industry and Trade assigned to this study were able to calculate how much of this total was recieved by each sector. The subsidy figures in the third column of Table 1 were derived from careful examination of the pattern of petroleum product use in each sector (i.e., gasoline, fuel oil, diesel fuel, etc.) and the subsidy rates on specific refined products. Transportation recieved the largest total subsidy, 13.5 mJD. Even though there was positive taxation on gasoline, the subsidies on aviation and diesel fuel were far greater in absolute amounts. Although the next most important sectors, electricity and manufacturing, recieved much lower total subsidies, their rate of subsidy was far higher, in excess of 150%.

Not only do these subsidies add to the government budget deficit, they also encourage excessive energy consumption. Recognizing these distortionary effects, the Government of Jordan has declared its intention to eliminate all energy subsdies during the period of the

next Five-Year Plan.

When these subsidies are taken into account, we see that the petroleum product column of Table 1 is seriously underestimated. Corrected estimates are shown in the fourth column of Table 1, where the subsidies (col. 3) are added to the actual expenditures (col 1) in order to get a truer picture of real costs. Thus, in 1979, Jordan consumed 92.2 mJD worth of petroleum products, which represents about one-eighth of 1979 GDP of 714.7 mJD. The principal difference in the energy consumption patterns, with and without subsidies, is that subsidies hide the relative importance of petroleum product purchases by the electricity and manufacturing sectors.

A major objective of this study was to derive estimates of future energy demand which would be consistent with the pattern of development embodied in the Five-Year Plan. In order to accomplish this, it was necessary to examine how energy demand is determined in each production and final demand sector. The specifics of how this was done are described in detail in Section III, but generally demand is determined by the relative prices of electricity and petroleum products, by sectoral investment patterns, and by substitution of energy by other factor inputs.

Turning now to the supply side, Jordan is totally dependent on imported crude oil for meeting convential

energy demands. Except for very small amounts of hydropower and occasional small inports of petroleum products, virtually all of Jordan's energy is produced with domestically refined products. The required crude oil is purchased from Saudi Arabia at competitive prices and piped from the Tapline to the refinery at Zarqa. The refinery presently has a crude oil capacity of 7500 tons per day and is in the process of expanding capacity by an additional 50%.

In 1979 about 1.6 million tons of petroleum products were produced. Almost 60% of production was transportation fuels--diesel (29%), gasoline (17%), and aviation fuel (11%). The remainder was divided between fuel oil (24%), kerosene (9%), LPG, and heavy distillates. The lighter products were used mainly in the household sector while fuel oil was used primarily in industry and for electricity generation.

Table 2 summarizes the costs of Jordanian energy production for 1979. The principal cost factor in petroleum refining is crude oil (65.4 mJD) which accounted for more than three-quarters of the total value of product output (85.5 mJD). In addition, there were wage payments, profits, and some minor intermediate costs. Fuel costs represented an even greater share of electrcity generation costs, almost 80% (8.7 mJD out of 11.0 mJD). Without the fuel subsidy of 5.4 mJD, the electricity sector would have

Table 2

Cost Structure of Energy Production in 1979
(units: mJD)

	Petroleum Refining	Electricity Generation
Costs items		
-Crude oil	65.4	0.0
-Petroleum products	2.0	8.7
-Other intermediate inputs	4.0	1.2
Wages and Profits	14.1	1.1
Total value of output	85.5	11.0

had to raise prices (as has been done recently) or run at a loss.

The differences between the value of domestic output in Table 2 and total domestic demand in Table 1 were made up by foreign trade. There were small net foreign sales of electricity and imports of refined products in 1979 which accounted for about 6% of all energy purchases. In estimating future supply, this study makes the assumption that in normal years, Jordan will not be a net importer or exporter of either petroleum products or electricity.

Energy represents a significant cost to the Jordanian economy. Excluding net energy trade, in 1979 total costs amounted to 102.4 mJD (92.2 mJD petroleum products and 10.2 mJD electricity) which represented over 14% of GDP. Crude oil imports of 65.4 mJD represented almost 9% of total goods and services imports (net of customs duties) and one-sixth merchandise imports.

Crude oil imports were a major factor in balance of payments financing. Including factor payments, Jordan had to finance a deficit of 232 mJD in 1979, of which crude oil represented more than 28%. Although final calculations are not available, crude oil costs in 1981 may exceed total merchandise exports and amount to as much as one-third of the balance of trade deficit. In the past two years, crude oil prices have gone up by almost 100% and the quantity of imports has risen by about 20%.

Consequently, the above ratios have all increased substantially, although there is no indication that this has reduced Jordanian growth.

III. MODEL FORMULATION

An even more detailed view of how energy fits into the economy-wide picture comes from examining a transactions matrix of all sales and purchases by the economy in any one year. The transactions matrix for the base-year, 1979, is shown as Table 3. The columns of this table refer to purchases by each sector of the output of other sectors. The rows refer to deliveries or sales by a producing sector to particular users. By definition, the the sum of all demands (net of customs duties) on any row must equal supply from imports and and domestic output. Similarly, along each column for a production sector, the sum of intermediate costs plus value-added equals the total value of domestic gross output. The columns on the left side of the table (1-7) refer to goods and services production and those on the right side (8-12) to elements of final demand.

Table 3, was derived by the project team using national income accounts, the input-output table, and energy subsidy data. Looking along the columns, or the rows for petroleum refining and electricity generation, the

Table 3

1979 Transactions Matrix

(units: mJD)

	Agri. (1)	Min. (2)	Ind. (3)	Pet. Prod. (4)	Elec. (5)	Tran. (6)	Serv. (7)	House Cons. (8)	Govt. Cons. (9)	Inv. (10)	Exp. (11)	Imp. (12)	Duties (13)	Gross Output (14)
Agri. (1)	8.7	-	133.1	-	-	-	-	53.5	13.1	-	27.3	119.9	3.4	112.4
Min. (2)	-	4.9	10.0	-	-	-	2.8	1.1	-	-	29.0	10.6	.2	37.0
Ind. (3)	12.8	.6	141.7	.5	.2	15.6	107.0	330.7	55.1	140.0	74.0	196.7	80.0	601.5
Pet. Prod. (4)	.5	1.1	6.2	2.0	8.7	47.5	[illegible]	17.6	4.5	-	8.0	13.2	1.5	85.5
Elec. (5)	-	-	1.9	.1	.1	.3	2.7	4.7	.4	-	.9	.1	-	11.0
Trans. (6)	.7	.1	1.1	1.0	.1	.3	18.3	69.0	26.1	-	99.5	80.6	-	135.6
Serv. (7)	46.1	2.9	138.3	2.4	.8	13.5	43.1	267.0	138.9	140.0	100.8	252.6	.3	578.9
Crude Oil (8)	-	-	-	65.4	-	-	-	-	-	-	-	65.4	-	-
Value-added (9)	43.6	27.4	169.2	14.1	1.1	58.4	400.9	683.6	236.1	280.0	339.5	739.1	85.4	714.7
Gross Output (10)	112.4	37.0	601.5	85.5	11.0	135.6	578.9							
Energy Subsidy (11)	.03	.06	3.8	.8	5.4	13.5	1.7	1.9	.8					

basic characteristics of energy demand which were summarized in Tables 1 and 2 re-emerge. We see that energy inputs are very important for the transportation and electricity generation sectors and of minor direct importance to agriculture and services. In terms of final demands, less than 4% of household expenditure is spent directly on energy, but energy is an important element in the additional 10% which households spend on transportation. Similarly, the government sector uses relatively little energy directly, but a considerable amount indirectly when account is taken of transportation.

Table 3 represents a snapshot of the Jordanian economy in 1979. In order to investigate possible medium-term changes in the energy-economy relationship, calculation of similar tables for future years is necessary. Consistent calculation of future transactions tables, based on alternative scenarios of economic policy and outside economic factors, is the major objective of the modelling exercise.

For this purpose a small, dynamic, multi-sector model of the Jorandian economy was built. A small model has advantages as well as disadvantages. The major shortcoming of a highly aggregated model such as this is that it is hard to derive sector-specific policy conclusions. For instance, having only one manufacturing sector or one transportation sector makes it impossible for the model to

say anything about energy demand in heavy industry or relative growth of demand for aviation or diesel fuels. On the other hand, small models are easier to construct and, more importantly, are easier to understand.

While designing this model, special attention was paid to this last point. The team building the model sought to make all assumptions and parameters as transparant as possible, so that the underlying causality would be clear to policy makers. The following sub-sections attempt to discuss not just the equations of the model but also the reasoning that went into their choice.

Definitions and Basic Assumptions

As noted previously, the economy is divided into the seven producing sectors shown as the first seven rows and columns of Table 3:

--Agriculture

--Mining and Minerals

--Manufacturing

--Petroleum Refining

--Electricity Generation

--Transportation and Communications

--Services.

Together, these sectors produce all domestic value-added. In addition, there are five final demand categories, corresponding to columns 8-12 of Table 3:

--Household Consumption

--Government Consumption

--Investment

--Exports

--Imports.

The sum of these expenditures equals gross domestic expenditure.

This aggregation procedure was dictated by data availability. The basic source of the intersectoral information necessary to build a consistent model was the recently completed input-output table for 1979. This table did not differentiate between forms of petroleum products, so it was not possible to go beyond two types of energy in the model. Future studies of energy use patterns would be richer if statistics were collected on the basis of the the specific types of energy each sector uses for various purposes. Similarly, it would be useful for deriving energy demands to disaggreagte the manufacturing sector into heavy and light industry and sub-divide transportation into air and road.

For each of the seven producing sectors, the model calculates endogenously, for each projected year, gross output, demand for energy (petroleum products and electricity separately), demand for other intermediate inputs, and value-added. In addition, the model calculates the import requirements of each sector, energy subsidies,

and customs duties. For final demand categories, the model determines the patterns of expenditures, including energy demands. Various macroeconomic variables (GDP, balance of trade, indirect taxes, etc.) and market prices are also endogenous.

Exogenous variables fall into three categories. First, there are economic forecasts. These include border prices of tradable goods and services (most importantly for this model the price of crude oil), future levels of exports of each tradable good, sectoral wage rates, and growth of private consumption. Second, there are economic policy variables. These include sectoral investment plans, indirect tax rates and energy subsidies, and government consumption growth. Last, there are exogenous technical factors. These include sectoral production functions, substition possibilities in energy, rates of technological change, etc.

The solution of the model for any given year determines certain initial conditions for the next and consequently the model can simulate Jordanian development forward in time until its underlying assumptions are no longer sufficiently valid to produce realistic projections. The model has been run with an 11-year time horizen, to 1990.

Prices

There are eight market prices in this model,

corresponding to the seven goods and services produced domestically and crude oil. A basic assumption is that the border prices which Jordan faces are independent of the level of Jordanian output or trade. This "small-country" assumption is typical of models like these and simplifies the analysis considerably. The assumption implies that within reasonable limits, the differences between relative border prices and relative domestic market prices are caused by tariffs and other forms of indirect taxation which are at least partly under government control.

In equation form, this means that the domestic price of good i, P_i, is proportional to the tariff rate, t_i, and the border price, PW_i, or in equation form:

$$(1) \qquad P_i = PW_i(1+t_i) \quad .$$

This relationship holds for calculating the domestic prices of agriculture, mining and minerals, manufacturing, services, and crude oil. The border prices are forecasts of external economic factors and the tariff rates are exogenous policy variables. Units were chosen so that all domestic prices in 1979 equaled unity.

For the other three goods--petroleum products, electricity, and transportation--a slightler different procedure was followed. Here, it is important to take account of the sensitivity of these sectors to changes in

crude oil prices, by relating their market prices to their costs of production, in which energy costs are substantial fraction. First, the model calculates the domestic price of petroleum products as a linear function of the border price of crude oil. That is:

(2) $$P_{pet.\ prod.} = .22 + .73PW_{crude\ oil}$$

The price of petroleum products then enters the calculation of the market prices of electricity and transportation. But in doing so, the subsidies on refined petroleum products must be taken into account. When subsidy rates are positive, the apparent costs of production are reduced and the domestic price is corrspondingly lower, and vice versa. In equation form, we have:

(3a) $$P_{elec} = .7 + .3P_{pet.\ prod}(1\text{-subsidy rate})$$

(3b) $$P_{trans} = .75 + .25P_{pet.\ prod}(1\text{-subsidy rate})$$

These subsidy rates are treated as policy variables to be chosen for each scenario.

The constant terms in equations (1)-(3) represent the non-energy costs of production, including intermediate inputs, as well as wages and capital costs per unit of gross output. As expected these are least significant for

refining and most important for transportation. Therefore, in these three sectors, the elasticity of the domestic market price with respect to the price of crude oil is highest for refining and lowest for transportation.

Energy subsidies also affect the prices that the other sectors pay for petroleum products. Defining PP_i as the price that sector i actually pays for petroleum products, the relationship is:

$$(4) \qquad PP_i = P_{pet.\ prod.}(1\text{-subsidy rate})$$

Here, the subscript i refers to each of the seven producing sectors as well as the final demand categories, household and government consumption.

Determination of Sectoral Production Levels

In each simulated year, the model must calculate gross output for each sector and the amount of energy and other intermediate inputs which are required. Three different procedures are used, depending on the technical and economic characteristics of the particular sector.

First, consider agriculture, manufacturing, and services. These are the largest sectors in the economy and also the most aggregated in this model. The model utilizes a simple production function to relate gross output of each of these goods to inputs of capital, labor, and energy. In each sector, it is assumed that technology

(i.e., the particular combinations of capital, labor, and energy which the production function allows per unit of gross output) changes in response to changing relative prices, but that the change is gradual.

This is done through a simple "putty-clay" approach. In each year, decisions are made about the optimal (or most economically efficient) choice of technology using the new capital available from the previous year's investment. This is the "putty" phase. In subsequent years, price changes do not alter this choice which has become fixed, or "clay". Therefore, the production function is used only to calculate each year's incremental gross output, the characteristics of prior years' output and technology reminaing unchanged. In equation form, we have the following simple recursion:

$$(5) \qquad X_{i,t} = X_{i,t-1} + x_{i,t}$$

where $X_{i,t}$ stands for gross output of sector i during year t, and lower-case $x_{i,t}$ refers to the increase between year t-1 and year t.

Cobb-Douglass production functions, which are the simplest forms which allow factor substitution, are then used to determine incremental output, $x_{i,t}$, based on the previous year's investment, $DK_{i,t-1}$. Ignoring the sector and time subscripts which are implied, the specific

equations are of the form:

(6) $x = AL^{a}EN^{b}DK^{c}$

where A is a constant term which changes over time reflecting technical progress, L is the additional labor required to produce incremental gross output x, EN is the additional energy input, and the exponents (a,b,and c) are technical coefficients which differ between these three sectors.

As a first approximation, the model assumes that each of these three aggregate sectors chooses the level of labor, L, and energy inputs, EN, which maximizes profits based on the previous year's investment, prices, and wages. Leaving aside the rather simple mathematical manipulations which determine profit maximization, the final equations are:

(7a) $x = (A(bPQ/W)^{b}(cPQ/PE)^{c}DK^{a})^{1/(1-b-c)}$

(7b) $L = bPQx/W$

(7c) $EN = cPQx/PE$

where W represents the exogenous real wage, PQ refers to the net price of the sector's output and PE refers to the price the sector pays for aggregate energy inputs.

These latter two parameters need additional

explanation. The production function refers only to inputs of labor, capital and energy. Other intermediate inputs are taken to be fixed proportions of total output. Therefore, the unit values of these fixed inputs must be deducted from the market price of output, P_i, before maximizing profits. Hence, the so-called net price, PQ_i, which is used in equation (7a) is defined as:

(8) $PQ_i = P_i$ - sum of value of non-energy intermediate inputs, per unit of gross output

Ideally, it would be desirable to have endogenous substitution of one form of energy for another depending on relative prices. Unfortunately, there was insufficient data in Jordan to allow the model to separately include both electricity and petroleum products in the production functions. As an alternative, a simple aggregation scheme was devised. As part of the forecasting underlying the model, the marginal shares of the two energy forms in these sectors was estimated. From these estimates, an energy aggregate for that sector is defined, EN_i, and with it a corresponding price, PE_i. That is:

(9) PE_i = (marginal electricity share)$P_{electricity}$ +(marginal pet. prod. share)PP_i

where the two marginal shares (which will normally differ from base-year shares) sum to unity and the price of petroleum products is net of subsidies, as defined in equation (4).

In solving for gross output in these three sectors, real wages are taken as exogenous (determined largely by economic conditions in neighboring countries), as is technical progress (reflected in increasing values over time of the "A" coefficients in equation (6)). For manufacturing and services, it was assumed that there are constant returns to scale (implying that the a+b+c=1), while there are decreasing returns to scale in agriculture reflecting limitations on land. The annual increases in sectoral capital stock, DK, are also exogenous to the model. Initial values of these were derived from the Five-Year Plan, but they can be changed for scenarios testing other policies.

Next, consider the mining and transportation sectors. Being more homogeneous sectors, it was felt there was less scope for factor substitution (between capital, labor, and energy) than in the broadly defined sectors, allowing, fixed coefficient production functions to be used. In other words, instead of an equation of the same form (7a), yearly incremental output, x_i, in these two sectors is proportional to the prior year's amount of capital investment, using incremental output-capital ratios which

were exogenously projected. That is:

(10) $x_{i,t}$ = (incremental output-capital ratio)$DK_{i,t-1}$

where i refers to the mining and transportation sectors and prior year investment, $DK_{i,t-1}$, is part of the policy scenario. Equation (5) is then used to calculate total gross output in these sectors.

Finally, a third method is used to calculate gross output in the energy sectors--petroleum refining and electricity generation. Instead of relating output in these sectors directly to prior investment as in the other sectors, here it is determined by current demand levels. Since it is assumed that Jordan will not be a net trader of refined products or electricity, a necessary condition for consistency is that domestic production of these goods equals the sum of all demands. In equation form:

(11) X_i = (sum of intermediate demand for energy good i)
+ household demand for energy good i
+ government demand for energy good i

where i refers to petroleum products and electricity. How the demands on the right-hand side of equation (11) are determined is discussed in the following sub-sections.

Using equation (11) to determine energy production

levels does not imply that investment in these sectors should be disregarded. Rather, the model itself does not guarantee that prior investment will be sufficient to produce the annual incremental demands implied by equation (11). Therefore, it is necessary for users of the model to check the results to insure this consistency.

Energy and Other Intermediate Demands

So far, we have discussed how the model determines the elements of gross output which appear in the annual transactions table. The next steps are to determine the economy's intermediate demands, i.e., the values which appear in the first eight rows in each of the first seven columns (see Table 3).

Consider first non-energy intermediate demand. These are determined on the basis of fixed input-output coefficients which were derived from the 1979 input-output study. Defining the amount demanded of good i by sector j as $X_{i,j}$, we have:

$$X_{i,j} = a_{i,j}X_j \tag{12}$$

where $a_{i,j}$ is the input-output coefficient and X_j is gross output of sector j. The index j goes from 1-7 representing each producing sector and the index i refers to the non-energy sectors--agriculture, mining, manufacturing, transportation, and services.

A similar procedure, using equations of the same form as (12), is used to derive the demands for refined products and electricity by all sectors other than agriculture, manufacturing, and services. For these three sectors, demand for energy products is related to the demand for energy aggreates, which are calculated using equation (7c). Here, we have:

$$(13) \qquad X_{i,j,t} = X_{i,j,t-1} + (\text{marginal share of energy good } i \text{ in sector } j)EN_{j,t}$$

where the marginal shares are the same as in equation (9), index i refers to petroleum products and electricity, and index j refers to agriculture, manufacturing, and services.

Finally, crude oil imports are calculated on the basis of the gross output of the refining sector, based on a fixed coefficient and using the same form as equation (12).

Final Demand

There are five final demand categories which must be considered--exports, investment, household consumption, government consumption, and imports. Investment and exports are treated exogenously, with their future values derived at least initially from the Five-Year Plan. Members of the project team from the National Planning Council put considerable effort into the difficult task of

deriving a consistent set of export and investment projections from the Plan's outline.

It is important to distinguish between breaking down investment by sector of origin and by sector of destination. The former refers to how much of total investment is produced by a particular sector. In this model all investment goods are from either manufacturing (which includes equipment) or services (which includes construction). The latter breakdown of investment refers to the sectors in which new production capacity is created and, therefore, includes all sectors. Although the transactions table only shows investment by sector of origin, the internal consistency of the model insures that summing investment either way yields the same total amounts.

For these simulations, total investment, I_t, is the sum of $DK_{i,t}$, the exogenously given investments by sector of destination, times the price of investment goods. Investment by sector of origin, I_i, is then calculated using technical coefficients, z_i, which define good i's share of total investment expenditure, or::

$$(14) \qquad I_i = z_i I$$

where i refers to manufacturing and services only.

Private and public consumption are treated in similar

ways. The growth of total expenditures for these final demand items is assumed exogenously. In equation form:

(15a) $C_t = C_{t-1}(1+gc)$

(15b) $G_t = G_{t-1}(1+gg)$

where C_t and G_t are defined as household and government consumption in year t, and gc and gg are their exogenous growth rates.

The model then uses a consistent set of demand functions to derive how much of total expenditure is spent on goods produced by each of the seven sectors. The demand functions, in which relative prices determine actual expenditure patterns, have the following general forms:

(16a) $C_{i,t}=(C_{i,0} + c_i(C_t-C_0))/PC_{i,t}$

(16b) $G_{i,t}=(G_{i,0} + g_i(G_t-G_0))/PG_{i,t}$

where $C_{i,t}$ and $G_{i,t}$ are the quantities of good i purchased in year t by households and the government respectively, $PC_{i,t}$ and $PG_{i,t}$ are the prices paid for these goods, and c_i and g_i are the proportions of additional expenditures (above base-year levels) households and the government spend on good i. For consistency, these marginal shares, c_i and g_i, sum to unity.

Except for petroleum products, the prices in equations (16) are the same as the market prices defined in equations (1). However, for petroleum products, subsidies must be taken into account. Thus, we have:

(17a) $PC_{pet.prod.} = P_{pet.\ prod.}(1\text{-household subsidy})$

(17b) $PG_{pet.prod.} = P_{pet.\ prod.}(1\text{-government subsidy})$

which are identical with equations (4).

The last elements of final demand are sectoral imports. The model's internal consistency requires that for each sector, domestic gross output plus imports equal the sum of all demands. In equation form, this implies that:

(18) $M_i + X_i =$ intermediate demands for good i

$$+ C_i + G_i + I_i + E_i$$

where M_i is defined as imports of good i, E_i refers to exports of good i, and all other variables are as defined previously. Intermediate demands are the sums of the values calculated in equations (12) and (13).

Value-Added and Macroeconomic Variables

By definition, value-added in each year is the difference between the value of a sector's gross output and the sum of the costs of its intermediate inputs. The

model computes value-added both in terms of base-year prices and current market prices.(Value-added at base-year prices, VA_i, serves as a quantity index of real sectoral growth.) The following identity is used:

$$(19) \qquad VA_i = X_i + (\text{sum over all } j \text{ of } X_{i,j})$$

where the index i covers all seven productive sectors and the index j includes these, plus crude oil imports when i refers to the refining sector. There is no need to include base-year prices explicitly in equation (19) since these have all been defined equal to unity.

Pure price inflation is not explicitly considered in this model. The differences between market and base-year prices reflect real, or relative, price changes. These derive from year-to-year changes in relative border prices, import tariffs, and subsidy rates. Value-added at market prices, VAM_i, is then computed as:

$$(20) \qquad VAM_i = P_i X_i - (\text{sum all } j,\ P_j X_{i,j})$$

where all variables are as previously defined and the indices are the same as for equation (19). These market prices are inclusive of tariffs, but are net of petroleum product subsidies.

Energy subsidies are calculated straightforwardly,

based on the quantities of petroleum products each sector directly consumes and the difference between the market price of petroleum products, $P_{pet.\ prod.}$, and the prices each sector actually pays. (See equations (2) and (4)). The energy subsidy recieved by sector i, ES_i, is calculated as:

$$(21) \qquad ES_i = X_{pet.\ prod.,i} P_{pet.\ prod.} (\text{subsidy rate}_i)$$

where the index i refers to all producing sectors, plus household and government consumption, and $X_{pet.\ prod.,i}$ is the quantity of refined products purchased by sector i, as determined in equations (12) and (13).

The presence of tariffs on the imports of several sectors, particularly manufacturing goods, means that duties are collected which later enter into national income calculations. That is:

$$(22) \qquad DUT_i = M_i PW_i (\text{tariff rate, good } i)$$

where DUT_i is the total amount of customs duties paid on imports of good i, M_i, and the index i covers all sectors with non-zero tariff rates.

The trade gap is defined as the difference, at border prices, between the endogenously determined value of total imports and the sum of exports, E, which is projected

exogenously. In equation form:

(23) Trade gap = (sum of PW_iM_i) + imports of crude oil - E

where all imports are as calculated as described above.

The model's internal consistency insures that national income measured from the expenditure side exactly equals national income measured from the production side. That is:

(24) (sum of VAM_i) = GDP_f = C + G + I + - Trade gap -(sum of DUT_i)

where the sums are calculated over all seven producing sectors and C,G, and I refer to total private consumption, government consumption, and investment. Here, GDP_f is gross domestic product at factor cost. To calculate gross domestic product at market prices (net of energy subsidies), GDP_m, the sum of duties is added to GDP_f. In equation form, we have:

(25) $GDP_m = GDP_f$ + (sum of DUT_i) .

In the present version of the model, the trade gap is an endogenous variable, while the totals of the other items of final demand expenditure--private and public consumption, investment, and exports--are taken

exogenously. Thus, by assumption, changes in energy prices do not have a large affect on real growth, but instead are felt in terms of changes in foreign exchange deficits. The project team felt this was the most realistic initial assumption for Jordan. However, as will be discussed later in this report, the model can be redesigned readily to accomodate other assumptions about macroeconomic-energy relationships. Similarly, the model could be, and should be, extended in future versions to to include additional elements of public finance (e.g., direct taxes) and a more complete treatment of labor supply and demand, both of which were impossible to include in this version because of time limitations.

IV. ANALYSIS OF SIMULATIONS

This section discusses the results of initial simulations of this model framework. It is important to recognize that the results are preliminary. They are based on a very brief effort in Amman of collecting economic statistics and interpreting the Five-Year Plan. Doubtless, there is much room for refining the data which went into these simulations.

The model operates very simply. The user stipulates a set of underlying assumptions about future economic conditions and policies--a scenario--and the model then

calculates all the variables discussed in Section III--the elements of the annual transactions tables. By comparing the results of different scenarios, it is possible to examine the sensitivity of key issues to alternative assumptions.

Here, the main interest is to focus on several important energy issues. As such, the main endogenous variables to be considered are:

--the rate of growth and pattern of future energy demand;

--implied rates of growth of refining and electricity generation;

--the effect of energy on the balance of goods and services trade.

In terms of the outside economic environment and government policy, these scenarios examine implications of changes in:

--crude oil prices;

--energy subsidy rates;

--planned investment allocations.

The following sub-sections report first on the scenario which is taken to be the basic case and then on how alternative scenarios affect the above economic variables.

The Base Case

The base case serves as a benchmark against which the

implications of other scenarios are measured. The underlying assumptions are not necessarily the most accurate nor are the results necessarily the most likely. Rather, the base case represents what the project team felt was the most reasonable initial approximation, given the data available last Spring.

All the scenarios discussed in this report, including the base case, share many common assumptions. For example, they all use the same export projections, technical coefficients, tariffs, world prices (other than for crude oil), and final demand expenditure totals. Although the simulations were run over an 11-year time horizen, in this report results are examined only through 1985, corresponding to the current planning period.

As shown in Table 4, exports are projected to be the fastest growing component of gross domestic expenditure, increasing at 14% annually between 1981 and 1985. In absolute amounts, transportation is likely to remain the largest foreign exchange earning sector, accounting for about 30% of additional export reciepts, and having a rate of export growth of 11.4%. Currently, services are the second leading export sector, but since its export growth is expected to average only 6%, by 1985 exports of manufactured goods will be practically as large.

While in 1979 almost 60% of export revenue was from transportation and other services, goods exports are

likely to grow much faster through 1985. Within goods exports, the most favorable assumptions are made for manufactures, with projected annual growth of 34%, which accounts for more than 40% all additional export revenue. Mining and minerals exports grow at 10%, while agricultural exports increase only 7% per year.

There is also rapid growth in the other items of final demand expenditure. As Table 4 shows, the scenarios project household consumption and government expenditure to rise at 7 3/4% per year, with investment increasing somewhat more rapidly at an average rate of 8.6% between 1981 and 1985. However, these projections anticipate some fall in the rate of growth of investment during the period of the Five-Year Plan, from 10-12% in 1980-83 to 6-7% between 1983 and 1985.

Allocations of annual investment expenditures, by sector of destination, are also projected exogenously. The service sector recieves the largest share of total investment, over 40% between 1980 and 1985. Manufacturing and transportation are each allocated approximately one-sixth. Agriculture's average share is 11%, with the mining and the energy sectors dividing the remainder.

These scenarios also assume that the relative border prices of the large aggregate sectors--manufacturing and services--will remain constant through 1985, but that the relative world price of agricultural good will increase at

Table 4

Base Case: Macroeconomic Variables
(units: mJD)

	1980	1981	1982	1983	1984	1985	annual growth, 1981-85
Endogenous Variables							
-GDP_f	686.5	727.9	774.3	838.2	909.7	989.7	8.0%
-Duties	77.8	89.2	100.8	123.9	139.0	152.7	14.4%
-GDP_m	764.3	817.1	885.1	962.1	1048.7	1143.4	8.8%
-Trade Gap	439.9	489.0	518.4	553.8	575.3	597.5	5.1%
-Imports	765.8	841.6	939.2	1018.8	1102.6	1178.1	8.8%
-Crude Oil Imports	99.6	126.2	142.2	160.0	179.6	200.8	12.3%
-Energy Subsidy	31.4	31.3	26.3	19.7	11.1	0.0	
Exogenous Variables							
-Houshld. Consmp.	736.7	793.8	855.3	921.6	992.9	1069.8	7.7%
-Govt. Consmp.	254.4	274.1	295.3	318.1	342.7	369.3	7.7%
-Invsmt.	291.0	327.4	363.7	400.1	427.4	454.6	8.6%
-Exports	325.9	352.6	423.0	469.9	536.1	594.6	14.0%

1.5 % per year. For the basic case, the world price of crude oil increases 2% in each year after 1981. Tariffs are assumed to remain at their current levels, roughly 3% on agricultural imports and 40% on manufactured imports.

In the basic case, net energy subsidies are eliminated gradually by 1985. Starting from 1979 levels, the rates of subsidy in each sector are reduced in equal annual installments. Since the model does not distinguish between different fuels, it is possible that a net subsidy of zero would be consistent with positive taxation of a particular distillate such as gasoline, matched by a subsidy on another refined product such as kerosene.

We turn now to the results of the base case. The discussion focuses on the energy and macroeconomic implications for 1981-1985. Table 4 summarizes the macroeconomic projections. Perhaps the most striking result is that GDP at factor cost is projected to grow at only 8% annually. While for most countries this would be satisfactory, it is below recent Jordanian experience.

Since the aggregate growth rate is largely determined by the assumptions made about investment levels and production technology, the only ways it could be significanly raised would be by increasing total investment, redistributing investment to sectors with higher marginal rates of return, or changing the underlying technology to increase sectoral returns to

investment. Some of these alternatives are examined in later scenarios.

Given aggregate growth, the magnitudes of the other endogenous macroeconomic variables appear reasonable. Imports grow at about the same rate as GDP, but since exports are assumed to grow at 14% annually, the net trade deficit increases only moderately, at about 5% per year. The cost of crude oil imports continues growing at a rate roughly 50% above GDP growth. As can be seen from Table 4, GDP_m grows faster than GDP_f because customs duties are increasing rapidly. This reflects the large growth in imports of manufactures which is required because the base case implies relatively slow growth in this sector.

Table 5 shows the projections of yearly gross output (in base-year prices to reflect quantity growth) and value-added (in market prices) for all sectors. It is somewhat surprising to find manufacturing the slowest growing sector, especially since about 16% of total capital formation is allocated to capacity expansion in manufacturing. While this proportion is somewhat less than in the recent past, the principal cause of low growth in maufacturing seems to lie with the parameters of the production function. The implicit marginal rate of return to investment is 8-10% which may be too low for this sector. In order to improve the manufacturing projections, additional data analysis in Jordan will be required.

Table 5

Base Case: Sectoral Gross Output and Value-Added
(units: mJD)

	1980	1981	1982	1983	1984	1985	annual growth, 1981-85
Agriculture							
-Gross output	117.8	128.1	139.6	152.5	166.7	182.0	9.2%
-Value added	47.3	53.0	59.8	67.5	76.1	85.8	12.8%
Mining							
-Gross output	50.3	56.0	62.4	69.6	77.4	85.8	11.3%
-Value added	36.8	40.7	45.3	50.4	56.0	62.0	11.1%
Manufacturing							
-Gross output	635.1	670.8	712.2	759.7	813.6	873.0	6.8%
-Value added	174.4	180.7	189.3	199.1	210.5	222.8	5.4%
Transport							
-Gross output	151.9	171.2	193.0	217.2	243.9	272.3	12.3%
-Value added	64.6	74.3	88.1	104.2	122.8	144.3	18.1%
Services							
-Gross output	618.8	660.0	706.4	758.1	815.2	876.4	7.3%
-Value added	424.8	450.3	481.0	515.1	552.8	593.1	7.1%
Petroleum Refining							
-Gross output	96.1	103.7	114.6	126.4	139.1	152.4	10.1%
-Value added	15.7	16.9	18.8	21.0	23.3	25.8	11.2%
Electricity Generation							
-Gross output	11.3	12.1	13.2	14.3	15.3	16.3	7.7%
-Value added	.8	1.3	3.0	4.9	7.1	9.6	64.8%

The other seeming anomaly is the relatively rapid growth of agriculture. Real gross output increases at more than 9% annually and since agricultural prices are also increasing, value-added goes up at almost 13%. It is not clear the degree to which this rapid growth stems from agriculture's recieving a higher share of total investment than it has in the past or from overly favorable assumptions about technology. In any case, the relationship between investment and output in agriculture requires further, careful study.

The growth pattern in the other five sectors seems to be a reasonable first approximation. Services, the largest single sector, grows at just below the economy-wide average, with more rapid rates of increase in transportation, mining, and petroleum refining. Electricity generation grows at almost 8% annually, which is quite high considering that its market price is rising very rapidly with the elimination of energy subsidies. The base case projects a 65% increase in the relative market price (ignoring general price inflation) of electricity between 1980 and 1985.

In Table 5, the differences between growth rates of value-added and gross output reflect changes in relative market prices. The differences are most dramatic for [illegible] and electricity where the effects of higher

subsidies, are most pronounced.

The characteristics of energy demand through 1985 are summarized in Table 6. While the subsidy projections are in market prices, the entries for sectoral consumption of petroleum products and electricity are in base-year prices. These forecasts, therefore represent a quantity index of increases in energy consumption.

Clearly, transportation continues to dominate Jordanian energy demand, accounting for over 70% of total additional usage of petroleum products through 1985 and recieving more than one-half of all energy subsidies. The next greatest demand increases are by households and electricity generation which utilize 12% and 7% of total increased consumption respectively. Petroleum product use in the other sectors remains relatively low in terms of the total, implying that even if this study underestimated future demand by a substantial amount (e.g., in mining or manufacturing), it would not make a significant differnce in terms of the aggregate energy use pattern.

While the quantities involved are much smaller, household consumption dominates electricity demand almost as thoroughly as transportation dominates demand for petroleum products. Household use accounts for 62% of additional electricity consumption, while services, the next most important user, accounts for less than 20%. Additional consumption elsewhere is relatively minor.

Table 6

Base Case: Sectoral Energy Use and Subsidies
(units: mJD)

	1980	1981	1982	1983	1984	1985	growth 1981-85
Refining							
-Pet. prod.	2.2	2.4	2.6	2.9	3.2	3.5	9.9%
-Elect.	.1	.1	.1	.1	.1	.2	18.9%
-Subsidy	.9	.9	.8	.6	.3	0.0	
Elect. Gen.							
-Pet. prod.	8.9	9.6	10.4	11.3	12.1	12.9	7.7%
-Elect.	.1	.1	.1	.1	.1	.1	
-Subsidy	5.9	5.8	4.8	3.5	1.9	0.0	
Agriculture							
-Pet. prod.	.5	.5	.5	.6	.6	.7	8.8%
Mining							
-Pet. prod.	1.5	1.7	1.9	2.1	2.3	2.6	11.2%
-Subsidy	.1	.1	.1	.1	0.0	0.0	
Manufacturing							
-Pet. prod.	6.2	6.4	6.6	6.8	6.9	7.1	2.6%
-Elect.	1.9	2.0	2.0	2.1	2.1	2.2	2.4%
-Subsidy	4.1	3.8	3.0	2.1	1.1	0.0	
Transport							
-Pet. prod.	53.2	59.9	67.6	76.0	85.3	95.3	12.3%
-Elect.	.3	.3	.4	.4	.5	.5	13.6%
-Subsidy	16.1	16.7	14.4	11.1	6.5	0.0	
Services							
-Pet. prod.	4.2	4.3	4.4	4.5	4.6	4.7	2.2%
-Elect.	3.1	3.3	3.5	3.7	3.9	4.1	5.6%
-Subsidy	1.8	1.7	1.4	.9	.5	0.0	
Household Consumption							
-Pet. prod.	15.6	15.2	16.6	18.1	19.6	21.1	8.5%
-Elect.	5.3	5.8	6.5	7.2	7.8	8.4	9.7%
-Subsidy	1.8	1.6	1.3	1.0	.5	0.0	
Government Consumption							
-Pet. prod.	3.9	3.7	3.9	4.1	4.4	4.6	5.6%
-Elect.	.5	.5	.6	.6	.7	.8	12.5%
-Subsidy.	.7	.6	.5	.4	.2	0.0	

Finally, it should be noted that energy usage in manufacturing and services grows somewhat slower than gross output in those sectors. The reason is that, as energy prices increase, the model uses the technical trade-offs allowed by the production functions to substitute away from energy to relatively less costly inputs. Additinal work is required to improve the estimates of these substitution effecs of price.

Sensitivity Analysis

This sub-section shows how the model can be used to test the sensitivity of the endogenous variables to the assumptions made about economic conditions and policies. This is done by comparing the results of the base case with those generated by three other cases or scenarios. These are:

Case A: Identical with the base case, except that the world price of crude oil rises at 7% instead of 2% annually after 1981.

Case B: Identical with base case, except that energy subsidy rates remain at their 1981 levels through 1985.

Case C: Identical with base case, except that from 1981 on, investment in transportation is reduced by one-third (in comparison with base case levels) with a corresponding increase of investment in manufacturing.

Table 7 summarizes the implications of these alternative scenarios on important energy and macroeconomic variables in 1985.

Consider Case A first. In this scenario, the 1985 price of crude oil is projected to be 21% higher than in the base case. As these higher prices are passed through to energy users, energy demand is reduced, but only to lesser degree. In quantity terms, demand for refined products is off 3.5% (in comparison with the base case), electricty demand is reduced by almost 7%, and crude oil requirement are 3.3% less. However, with these below-unity implied demand elasticities, total expenditures on energy increase substantially. The cost of crude oil imports to the economy rises by 17%, with expenditures on refined products rising even faster at 19%.

As important as these results are for energy policy, in macroeconomic terms, the impact of substantially higher crude oil prices does not appear severe. The balance of trade deficit increases by less than 2% and GDP falls by only 1%. However, if the projections are extended much beyond 1985, the macroeconomic costs to Jordan would be correspondingly higher.

The results of Case B demonstrate the important role of energy subsidies. If energy subsidy rates were to remain at 1981 levels, the total subsidy bill by 1985 would not be very large, only 50.5 mJD. But the negative

Table 7

Results of Sensitivity Analysis
(units: mJD)

	Values in 1981	Values in 1985			
	All Cases	Base Case	Case A	Case B	Case C
GDP_f	727.9	989.7	979.7	964.5	1014.2
Trade gap	489.0	597.5	608.4	630.3	614.4
Crude oil					
(quantity)	79.3	116.6	112.8	121.1	107.6
(import cost)	126.2	200.8	235.3	208.5	185.3
Petroleum products					
(quantity)	103.7	152.4	147.5	158.3	140.7
(cost)	151.6	240.1	274.1	249.4	221.7
Electricity use					
(quantity)	12.1	16.3	15.2	20.0	16.4
(cost)	16.7	31.8	33.2	39.0	32.0
Energy Subsidy	31.3	0.0	0.0	50.5	0.0

impact on GDP and the trade gap would be about three times that caused by higher external oil prices (Case A). Since users fail to pay the full economic costs of energy, demand grows more rapidly. This is especially noticable for electricity which recieves the highest proportional subsidy rate. If these subsidy rates continue at present levels, then real demand for electricity by 1985 could be almost 25% higher than the base case, necessitating higher than anticipated investment in generating capacity.

Case C tests the implications of changing the composition of future investment deliveries. As an example of how the model can test the implications of such changes, this scenario considers a modest shift in investment away from transportion (an energy-intensive sector) towards manufacturing (which is less energy-intensive). In contrast with the other two cases, both GDP and the trade gap in 1985 rise somewhat, about 2.5% in comparison with the base case. The reason that GDP rises is that the marginal rate of return to capital is higher in manufacturing than in energy. The balance of trade worsens because transportation imports increase more than manufacturing imports decrease. Demand for petroleum products decreases by more than 7.5% on account of the slower growth of the transportation sector.

The model can utilized in a similar way to test the sensitivity of these and other endogenous variables to

other changes in economic policy, the external environment, economic behavior, and technology. As a planning tool, it would be most important to carefully examine the implications of alternative investment scenarios to look for those which are likely to have the most beneficial effects, not just on energy but for the entire economy.

V. CONCLUSIONS AND RECOMMENDATIONS

In this section, we examine the conclusions which can be drawn from this study regarding the questions which were raised at the beginning of this report. Some of the conclusions can be stated quite strongly, while others are still tentative and indicate directions for future analysis.

It is virtually certain that energy demand will continue to grow rapidly in Jordan. There are two basic reasons. First, real incomes are going up, and with this increase comes increased consumer demand for goods with high income elasticity, energy (in the form of electricity and transportation fuels) being one. Second, the economy itself is in the midst of a structural transformation, in which energy-intensive sectors are growing relatively rapidly. Hence, it is not surprising that the model's results indicate that energy demand is likely to increase

as much as 25% faster than GDP.

The results of this modelling exercise also clearly demonstrate the key role of the transportation sector. In the base case, 70% of additional energy demand through 1985 is for transportation. Even when transportation grows more slowly, Case C, it accounts for more than 60% of additional demand. Thus, despite rapid growth in electricity use, aggregate energy demand will continue to be dominated by liquid fuels.

This study is less clear about how much scope there is for using energy more efficiently. Obviously, energy efficiency would have the greatest quantitative payoff in transportation. Outside of transportation, the most likely sources of efficiency gains are in electricity generation and household energy use. However, the magnitudes involved in these sectors are not large by comparison.

The model assumed rather generous rates of substitution between energy and other inputs in the large aggregate sectors (service, manufacturing, and agriculture) and final demand. But, achieving whatever theoretical potential there is will require more careful analysis, going beyond the scope of this model or study. For transportation, it is most crucial to look at the particular sub-sectors and their energy use patterns. Long-run planning of capacity expansion is important in electricity and development of industries supplying

appropriate technologies (e.g., using solar energy) in the case of households.

Since, liquid fuels will continue to dominate energy demand, there is probably only modest scope for reducing dependence on crude oil. For example, it is possible to utilize coal for generating electricity and industrial heat. But the economics of attempting this at the scales anticipated is very uncertain and required detailed study and analysis.

Energy demand definitely appears sensitive to the energy prices which users pay. The results of the model clearly indicate, as shown in Table 7, that energy demand rises and falls with prices. But the implied elasticity of demand with respect to price is low, on the order of minus one-third. It is somewhat higher in manufacturing and private consumption and lower for transportation.

The model indicates that the effects of energy subsidies on demand growth are substantial. If they continue, demand is likely to increase an additional 10% by 1985. Indeed, the results indicate that Jordan would be worse off leaving the subsidies in place than if the world price of oil were to begin growing rapidly again while subsidies were removed.

Obviously there will be adjustment problems in reducing energy subsidies. The costs to transportation and private households (directly and indirectly through higher

electricity prices) will be significant. But the gains to the economy as a whole are much larger and postponing the elimination of subsidies would only make the adjustment more painful in the future.

In terms of macroeconomic implications, the results of this study indicate that the severity of the energy problem may be less than has been imagined. While, higher energy prices do lead to some reductions in GDP and increases in the trade deficit, these seem relatively minor. As shown in Table 7, a 21% increase in crude oil prices leads to only a 1% reduction in national income and less than a 2% increase in the trade gap. Given Jordan's strong international credit position, it should not be dificult to finance the required additional energy imports.

While it is definately important to insure that the economy use energy more efficiently in the future, looked at in its broadest context, Jordan definately has gained from higher oil prices. These have been the major factor in the regional economic boom which has directly and indirectly led to more rapid economic growth and higher income levels for Jordan. If future world oil prices decline as some are predicting, the indirect negative impact on the Jordanian economy through reduced worker remittances would probably be much larger in magnitude than the direct gains of reduced costs of oil imports.

Being highly aggregated, the model was not designed

to carefully investigate the sources of Jordan's comparative advantage. However, the results do indicate that energy prices would have an some impact on the choice of particular industries in the future. Exactly which industries look more or less attractive requires detailed microeconomic study of these industries. A model such as this could be useful in such an exercise by helping define the economy-wide scarcities or shadow prices.

The principal policy conclusion of this study is that the Government of Jordan should stick to its policy of gradual elimination of energy subsidies. Implimentation of this policy would have beneficial macroeconomic effects and also considerably slow the rate of growth of energy demand. At the same time that subsidies are eliminated for petroleum products, it is equally essential that the higher costs of electricity generation also be passed on to consumers through higher prices.

Other policy conclusions are inferred. While, it appears that the fiscal drag of current or even higher energy prices is not too severe, it is important that the government undertake to plan growth in the energy sector more carefully. In particular this means improved long-run planning of capacity expansion in electricity generation (including use of fuels other than oil-based), looking at the energy efficiency of transportation and particular energy-intensive industries, and investigation of

household energy use patterns.

It is very important to recognize that the principal accomplishment of this study is not this particular report. While of course, the author hopes that the Government of Jordan finds it useful, this study's major achievement is the development of a consistent framework for economy-wide analysis. Therefore, the report itself should be seen an initial stopping point, not the end of this work. To make the maximum gains from what has been done already, it is necessary to continue using and refining the model. At this point, the overall workability of the model has been well demonstrated. It is easy to solve the model or change its underlying assumptions.

Certainly, having a flexible tool like this is useful for investigating future trends in energy demand. But, it could be even more important in analyzing the consistency of Jordan's medium-term economy-wide planning. A framework such as this forces a reconcilliation of apparently conflicting assumptions which are included in the Five-Year Plan. In particular, it allows the user to relate macroeconomic growth with sectoral investment plans, something which apparently is not yet being done.

Finally, additional analytic work at the sectoral level is required to make the model more useful. The experience with the model so far indicates that the next analytic steps should include refining the parameters of

the production functions, estimating price and income eleasticities for elements of private consumption, adding more components of public finance, and disaggregating the manufacturing, services, and transportation sectors.