AN ANALYSIS OF ENERGY-ECONOMY INTERACTIONS

Lois Schertz Willett

Abstract

There is a growing interest in energy and energy policy analysis because of the gap between the United States' energy consumption and energy production. Numerous policies for dealing with America's "energy crisis" have been discussed and evaluated.

Underlying these policy investigations have been a variety of simulation models designed to analyze energy demand, energy supply, and the interaction between the two. Several of the models used for energy policy analysis do not couple the energy sector to the rest of the economy. Some modeling efforts even assume that there is no casuality from energy to GNP.

The purpose of this study is to examine the structural relationships that govern the interaction between the energy sector and the rest of the economy, so as to contribute to the development of more effective national energy policies. A computer simulation model that illuminates the feedback coupling between the energy sector and the rest of the U.S. economy is used in the analysis. The model is used to analyze the effects of increasing capital intensity of the energy sector on the level of economic output and the efficiency of a general class of conservation initiatives in mitigating these effects.

When conservation initiatives are introduced, cumulative energy consumption is reduced and sales and profits of the producing sectors are lower. Average GNP is lower and average general unemployment is higher when conservation is introduced.

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1.0 Introduction

Domestic energy consumption increased 17 percent between 1970 and 1978. In contrast, domestic energy production fell 2.4 percent during this same time period. Consumption in 1978 was 78 quadrillion BTU's while production was only 61 quadrillion BTU's (Census 1979). This growing gap between energy production and consumption made the United States increasingly dependent on foreign sources of energy; sources which have been increasingly subject to political instability, as the Iran-Iraq conflict illustrates. The growing gap between domestic energy consumption and production, rapidly escalating energy prices, and the uncertainty associated with foreign energy sources fueled a great interest in energy and energy policy analysis. Numerous policies for dealing with America's "energy crisis" have been discussed and evaluated.

Underlying the policy investigations have been a variety of analytical models designed to analyze energy demand, energy supply, and their interaction. Several of the models used for energy policy analysis do not couple the energy sector to the rest of the economy. Some modeling efforts even assume that there is no casuality from energy to GNP.

The purpose of the study reported in this paper was to examine the interaction of the energy sector and the rest of the economy. For this purpose a model--Enecon1--was developed. It includes a full feedback coupling between the energy sector and the rest of the U.S. economy. The model is designed to illuminate the structural relationships governing the interaction between the energy sector and the other sectors of the U.S. economy so as to contribute to the development of more effective national energy policies. The behavior generated by the model is due solely to the interactions of the feedback relationships within the model. The model can be used by any senator, representative, or members of their staffs to gain an understanding of the impact of policies such as conservation initiatives, investment tax credits, a windfall profits tax, or wage and price controls. Because the model was developed for the public sector its emphasis is on transparency of structural relationships and user orientation in implementing policy alternatives. Because of the public sector's interest in increasing capital intensity of the energy sector and conservation initiatives these items were addressed in the first phase of effort.

This paper consists of six sections. The second section describes eight key model characteristics necessary for a comprehensive evaluation of energy policy initiatives. The third section contains a structural overview of the model. A more detailed description can be found in (Schertz 1980) and (Richmond 1980). Sections four and five describe the base run of the model and the conservation initiative. Suggestions for extending the analysis are contained in section six.

2.0 Key Energy-Economy Model Characteristics

Eight characteristics of the model are important in understanding its adequacy for policy analysis. They are:

- o Real-world representation of decision-making
- o Disequilibrium focus
- o Endogenous GNP
- o Inclusion of energy as a factor or production
- o Endogenous labor force and labor productivity
- o Conservation of financial flows
- o Conservation of physical flows
- o Endogenous government

Realistic representation of decision processes were included within this model in order to show how people will actually react to policy initiatives and disequilibrating factors. An accurate representation contributes to a more complete understanding of the implication of policy proposals and aids policy makers in identifying specific policy intervention points. Only when an accurate portrayal of real world decision processes is achieved can the model be effective in anticipating the potential offsetting influences that will actually arise from policy interventions.

ENECON1 incorporates a disequilibrium orientation in order to consider the adjustment processes inherent in the energy market. Thus, the model does not force supply to equal demand and allows all transient responses to have an effect. Because of controlled prices and time delays within the energy system, transient responses may be quite significant. The disequilibrium orientation permits the model to capture the imperfections in the energy market due to price controls, taxes, information delays, and construction delays. The model permits the assessment of the effects of delays, capital turnover, and long lead times in life-style changes. Therefore, it simulates the short to intermediate term economic dislocations that occur after a policy is implemented.

The model used in the analysis of energy policy proposals includes feedback relationships that link energy to GNP and back again. Thus, GNP growth is not an externally provided input to the model. Reverberations that various energy policies have an overall economic activity can be determined.

The model includes both the direct and indirect impact of energy on production in order to evaluate policies designed to alleviate energy-related problems. When energy is included as a factor of production, reduction in energy supplies or increases in energy price exert a direct influence on output. Realistically, cutbacks in energy supplies could cause output to fall, especially in the short to intermediate term before factor substitution is possible.

Because labor force and labor productivity are major determinants of GNP and because energy availability and energy use impact both, they were included as endogenous inputs to the model used to investigate energy-economy interactions. In this way, the labor force and labor productivity are affected by energy prices, energy supply constraints, capital availability, and availability of wages, incomes, and unemployment.

The overall financial implications of energy policies is accurately assessed if financial flows are physically conserved within the model. Only by conserving money flows can the model capture the costs, as well as the

benefits, of various policies designed to influence financial well-being. Conserving financial flows shows the longer term impacts of policies such as tax increases or decreases, because of the assumption that if financial resources are needed, they do not come from somewhere at no cost.

Similar to financial flow conservation, conservation of physical flows (such as capital, labor, and energy) are important for effective policy analysis. When physical flows are conserved within a model, it is not possible to obtain benefits without paying the associated costs. In other words, it is impossible to obtain "something for nothing." For example, if capital flows are conserved within the model, there is an assumption that the capital requirements of the energy sector can not be met without accelerated production in the capital sector. Thus, "crowding out" investment in other sectors and effects on the rest of the economy are taken into account.

The federal government has proposed many of the policies currently discussed to alleviate the problems associated with energy scarcity: deregulation of energy prices, imposition of an energy tax, investment tax credits, and various tax reduction initiatives. When a government sector is endogenous to the model being used for policy evaluation, the physical and financial forces that influence its effectiveness are represented.

With the above characteristics, a model can assess a wide range of benefits and costs of policy alternatives. It is particularly likely that models with these key features will not overstate the benefits or understate the costs of policies aimed at mitigating energy-related problems.

3.0 An Overview of the Model's Structure

ENECON1, the model developed for this analysis, illuminates the relationships between the energy sector and other sectors of the U.S. economy. Because the model's structural relationships generate behavior, the model is effective as a tool for policy analysis. The model gives an intuitive feeling for the location and identity of effective policies. The model is effective as a tool for ranking policy alternatives because its results can be compared in a relative sense.

The model used in this analysis was developed using system dynamics. Model behavior is generated through the dynamic interplay of the model's feedback relationships, not by exogenous time series. The first version of the model is focused on the U.S. economy. International interactions, such as foreign-exchange transactions, and OPEC decision-making, are endogenously generated by the model. However, it is possible to investigate the impact of international influences by treating them as exogenous disturbances.

Within the model boundary, the interactions between the producing sectors of the economy and the household sector and between these sectors and a simple government sector, are included. An overview of the major flows of money, labor, and output between the sectors is presented in Figure 1. As the figure indicates, there are five main sectors in the model: capital, goods and services, energy, household, and government. Each of the producing sectors in the model has the same basic structure. Each producing sector uses capital, labor, and energy to produce its output. Each sector also maintains an inventory of its output, a backlog of orders for its output, and a money balance. Each sets a price for its output.

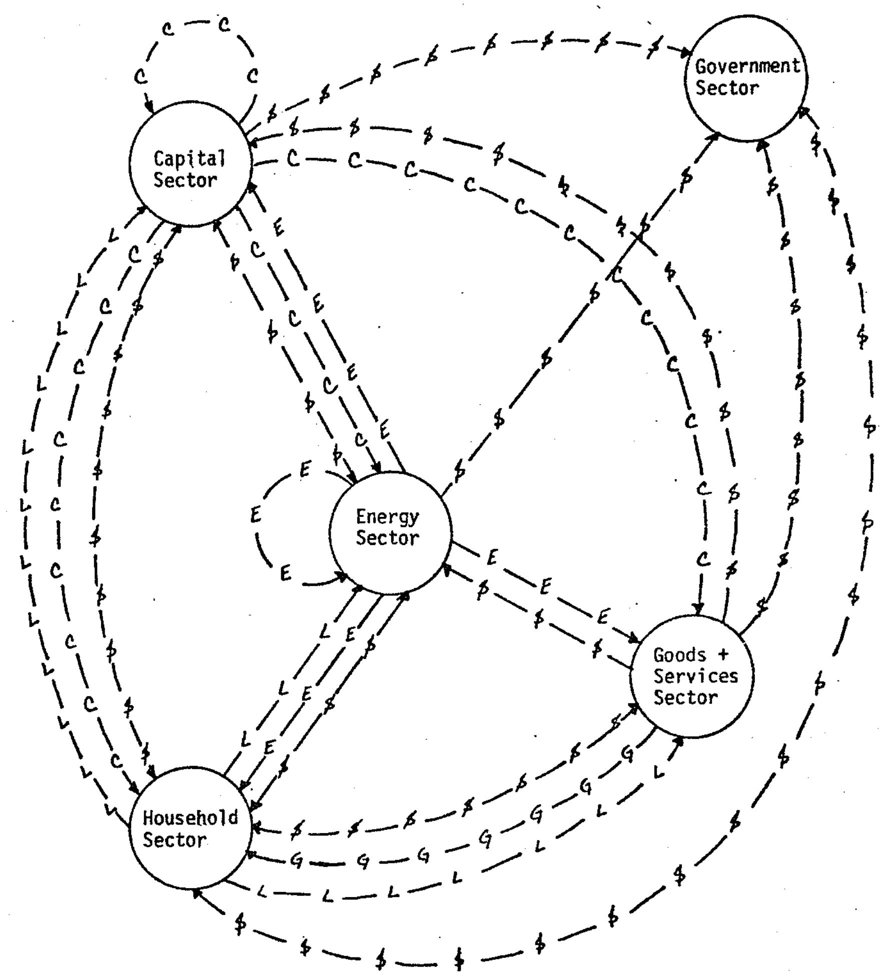


Figure 1: Major Exchanges of Money, Labor, and Output Between Sectors in ENECON1.

The capital sector represents the capital producing industries of the economy. This sector supplies capital to the energy sector, to the household sector, to the goods and services sector, and to itself. Self-supply is indicated by the self-contained loop in Figure 1; i.e., the capital sector requires capital to produce capital. In addition to capital, the capital sector orders and pays for energy and labor used in production. The capital sector also pays tax revenues to the government sector.

The energy sector represents the aggregate of all energy producers in the economy. The energy sector supplies energy to the producing sectors and to the household. Like the capital sector, the energy sector demands and pays for capital, labor, and energy and also pays tax revenues to the government.

The goods and services sector encompasses all production that is not generated by the capital or energy sector. The goods and services sector requires energy, capital, and labor for production. It is assumed to sell its output to the household sector only. Like the capital and energy sectors, this sector pays tax revenues to the government.

The household sector represents all consumers. Households pay for capital, energy, and goods and services. Households provide labor to the producing sectors in return for wages. The household pays tax revenues to the government and receives transfer payments from the government. In the diagram the labor sector is illustrated as part of the household. Within the model it is actually treated as a separate sector.

The government sector's function is to re-allocate money from the various production sectors to the household sector. It sets tax rates,

collects tax revenues from the three producing sectors and the household sector, and privides transfer payments to households when household liquidity so dictates. The government sector as a producer of services, an employer of labor, and a utilizer of capital and energy is included in the goods and services sector.

The structure of the model's three producing sectors -- capital, energy, and goods and services -- is generic. Each sector orders and pays for capital, energy, and labor. Each generic producing sector also pays tax revenues to the goverment, manages an output inventory and order backlog. maintains a money balance, and sets a price for its output. The production sectors are distinguished by differences in parameter values. For example, production in the goods and services sector is more labor-intensive than production in the capital and energy sectors and the energy sector's production is more energy-intensive than the other sectors.

There are six major levels or stocks included in each production sector:

- o Money balance
- o Price of output
- o Percent mark-up over unit cost
- o Inventory of output
- o Backlog of orders
- o Capital stock

Each level in the production sector is increased and decreased by its associated rates of flow. Information which arises from each stock within the system alters these rates of flow. Labor is also a stock variable within the model. However, labor stocks are considered a part of the labor sector.

Energy is included within the generic production sector, but it is not represented as a stock. It is assumed that energy is consumed as it becomes available to a sector, because rarely is energy actually stored for any period of time within the sector.

One of the key variables within the generic production sector is money adequacy, a measure of the producing sector's liquidity. In the model, money adequacy is calculated as a measure of the sector's existing stock of cash and near cash relative to its desired stock. The sector's desired stock of liquid assets is determined by the product of desired payments and a desired payment coverage, the latter measured in fraction of a year. If the sector's liquid asset reserves, or money balance exceeds desired levels, it has a high money adequacy. If the sector's money balance is less than what is needed to service its desired payments, its money adequacy is low.

As Figure 2 illustrates, money adequacy affects several variables within the producing sector. Each producing sector attmepts to maintain its money adequacy by altering both its stream of payments and revenues. Thus, for example, an increase in money adequacy, indicating excess cash, increases desired capital thereby stimulating orders for capital which in turn increases payments for capital (loop 1). When payments rise, other things equal, money balance declines, causing money adequacy to fall which then lowers orders for capital. Money adequacy also affects the hiring and firing of labor within the sector (loop 2). If money adequacy rises, other things equal, more people are hired by the sector. But increased hiring means increased payments for labor, and thus a decrease in money balance and money adequacy. In this way, increases in money adequacy lead to higher spending, which lowers the money balance and causes money adequacy to fall.

In addition to altering payments, the sector attempts to control its liquidity by changing price to alter its revenue stream (loop 3). For example, if money adequacy decreases, a pressure to increase the price of output is generated. When the other sectors pay the higher price as they receive shipments of the sector's output, the producing sector's money adequacy rises.

The tax rate assessed on each sector's income is also based on its money adequacy (loop 4). If a sector has a high money adequacy its tax rate rises and hence, its tax payments are increased. This, in turn, reduces the sector's money balance, and the money adequacy of the sector falls.

All of these loops are negative, or goal-seeking, feedback loops because they seek to maintain money adequacy at a desired level. Any departure from desired liquidity is reversed by the action of the loop. These particular negative feedback loops act to maintain liquid asset reserves at desired levels in each production sector.

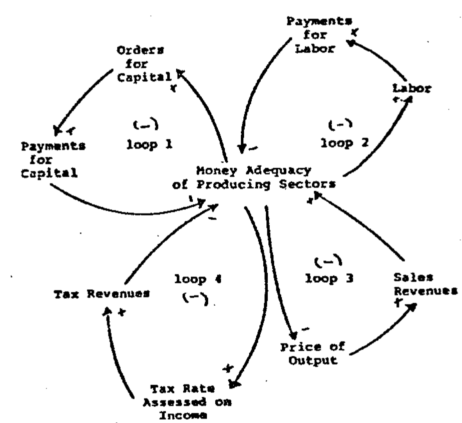


Figure 2: FEEDBACK RELATIONSHIPS BETWEEN MONEY ADEQUACY AND OTHER VARIABLES WITHIN THE GENERIC PRODUCTION SECTOR

The energy sector contains assumptions reflecting fossil fuel depletion in addition to the causal mechanisms of the generic production sector. As fossil fuel reserves are accumulated this depletes fossil fuel reserves remaining. With less reserves available, the model assumes that more capital (and therefore more energy) is needed to extract each unit of remaining reserves. Thus, depletion causes a rise in the capital-output ratio in the energy sector.

The labor sector of the model includes five levels: labor in the goods and services sector, labor in the energy sector, labor in the capital sector, general unemployment, and labor wage. The household sector represents consumer's purchases and income stream and the consumer's stock of capital and goods and services. Three levels are included within this sector: inventory of goods, inventory of capital, and money balance. Each level is increased and decreased by its associated rates. This sector is the only sector which orders goods and services.

The government sector includes six levels: government money balance, the tax rates assessed on each sector's income, and the transfer payment fraction. The government's money balance is increased by the tax revenues paid by each sector and decreased by the transfer payments paid to the household sector.

4.0 Reference Run Behavior

The model used to investigate energy-economy interactions--ENECON1--is initialized in equilibrium using numerical data for the year 1950. Historical data were used to determine the labor and capital intensity of the producing sectors, and to obtain the relative magnitudes of expenditures by the household sector between goods and services, capital, and energy.

In the initial equilibrium, all secular growth influences are assumed to be zero. Population growth, technological advance, money supply growth, and labor force expansion are all neutralized in the model and remain neutralized for all model runs. These influences are "frozen" to investigate the interactions of the energy sector with the rest of the economy against a fixed economic backdrop. Once the "fixed economy" dynamics are well understood, each growth influence can be systematically unfrozen revealing the contribution of each to overall macroeconomic behaviors.

In the model, the base run dynamics are precipitated by a ten percent increase in the capital-output ratio in the energy sector in year 5. This one-time, step increase proxies the increased capital requirements of the energy sector that will result from the depletion of fossil fuel reserves. A setp function is used because it is the simplest testing input that will call forth the inherent dynamics within the model.

The model analysis was conducted under a progression of tests. Throughout each step in the progression one simplifying assumption is relaxed. This enables one to see the marginal contribution of each effect on the model variables and model behavior. The first test in the progression is conducted with wages and prices frozen and with government inactive. In another test, wages and prices are both activated with government still inactive. In the last test, the model is tested with wages and prices de-controlled and government activated. In this section the significant impact of the relaxation of each assumption is discussed. For a more detailed description of model behavior see (Schertz 1980).

In the first section of the base run description of model behavior when wages and prices are controlled and government is inactive, it is quite evident that there are mutually reinforcing relationships underlying the expansion of the capital and energy sectors. In order to increase production each sector requires output from the other sector in addition to its own output, thus stimulating the self-ordering processes. This web of reinforcing relationships is illustrated by a causal loop diagram in Figure 3.

Loop 1 depicts the expansion of the energy sector. An increase in the capital-output ratio increases the orders for capital by the energy sector. The energy sector's capital stock expands thereby increasing energy production. More energy is consumed as production of energy increases. Increased consumption depletes the output inventory of energy, which increases the sector's orders for energy. The energy sector responds to the increased orders by increasing desired production, leading to a further increase in the orders for capital. This loop, initiated by an increase in the capital-output ratio in the energy sector, is a reinforcing spiral which leads to further increases in orders for capital by the energy sector.

Loop 2 illustrates another reinforcing loop active in the mutual expansion of the energy sector and the capital sector. As orders for capital by the energy sector are increased, shipments of capital by the capital sector rise. An increase in shipments causes an increase in desired production which, in turn, increases production. An increase in production requires more energy. Thus, the orders for energy by the capital sector expand. This expansion draws down inventory in the energy sector and leads to an increase in the energy sector's desired production, further stimulating the energy sector's orders for capital.

The third reinforcing loop deals with the expansion of the capital sector. An increase in desired production in the capital sector stimulates

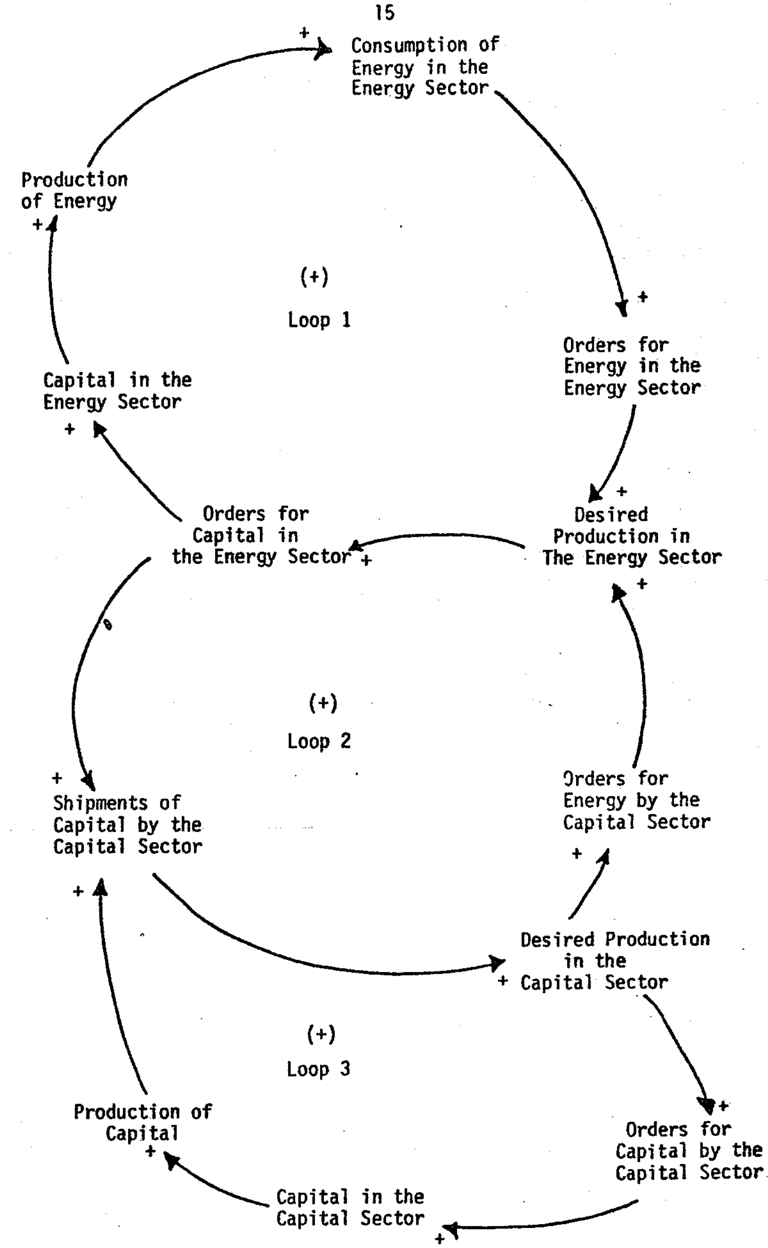


Figure 3: Mutually Reinforcing Relationships Underlying Expansion of the Capital and Energy Sectors

capital investment by the sector. The increase in orders for capital eventually leads to an expansion of the capital stock in the sector and thus an increase in the production of capital. Increased production increases inventory levels which enables shipment rates to rise. An increase in shipments expands the desired production in the capital sector, completing the reinforcing loop. These three reinforcing loops generate the expansion of capital and energy sector output during the simulation.

In addition to the relationship between the capital and energy sectors, there is a reinforcing relationship between the goods and services sector and household sector. As illustrated in Figure 4, as more labor is employed, the volume of wage payments to the household sector increases, raising money adequacy in the sector. Increased household money adequacy stimulates orders for goods and services, which raises desired production in the goods and services sector. This increase leads to a further increase in the labor employed by the goods and services sector and more expansion of wage payments to the household sector.

When prices and wages are decontrolled in subsequent model runs a vicious cycle leading to price increases in the capital and energy sector is seen. As depicted in Figure 5, an increase in the price of output in the energy sector because of inventory discrepancy increases payments for energy by the capital sector. The capital sector raises its price to cover the costs of production and to rebuild its money adequacy, depleted as a result of rising costs. An increase in the price of capital means the energy sector is paying more for capital when it expands production. Faced with increased factor costs and low money adequacy the energy sector raises its price and the reinforcing spiral continues.

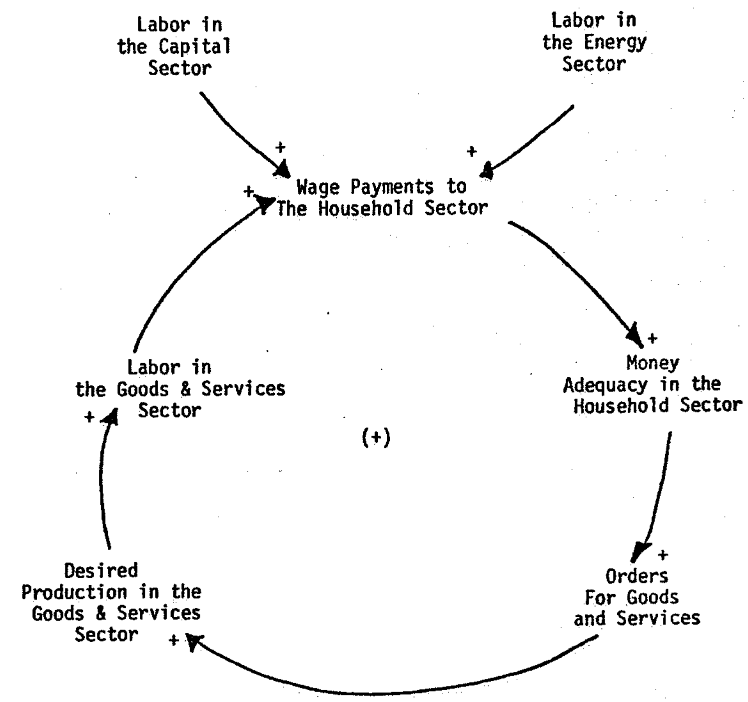


Figure 4: Reinforcing Relationship Between Expansion of the Goods and Services Sector and the Household Sector.

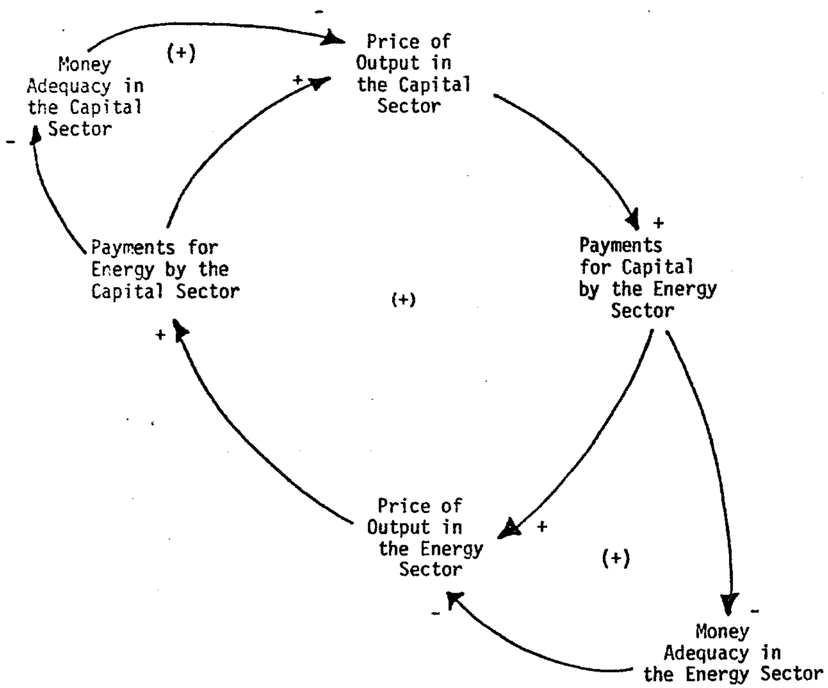


Figure 5: Reinforcing Relationships Leading to Price Increases in the Capital and Energy Sectors.

When government is activated within the model all the relationships between the capital and energy sectors and the goods and services sector and the household sector are quite evident. It should be noted that the household sector has a slightly higher money adequacy because of the governments' role in reallocating financial resources within the model.

5.0 Conservation Initiative

This section summarizes a preliminary analysis of the impact of conservation initiatives on the interaction between the energy sector and the rest of the economy. Once again the model retains the economy in equilibrium before conservation mechanisms are introduced. Conservation initiatives in conjunction with a 10 percent increase in the capital-output ratio of the energy sector are analyzed. Because of conservation the early expansion of the economy is smaller than in the reference run without conservation.

The conservation initiatives dampened the effect of the increase in the capital requirements as seen in the base run. The reason is that other sectors are simultaneously reducing their consumption of energy. Thus, for example, the energy sector has an incentive to increase its orders for capital as a result of the change in the capital-output ratio, but the conservation initiative reduces demand for its output. Thus, the energy sector does not increase its orders for capital as rapidly as in the base case. Likewise, the capital sector no longer needs as much energy to produce, and it has lower orders for energy than in the base case. Therefore, the mutually reinforcing relationships underlying the expansion of the energy and capital sectors (depicted in Figure 2) are not as powerful when conservation initiatives and an increase in the captial requirements of the energy sector are simultaneously introduced.

The household sector absorbs some of the costs of conservation and increased capital requirements because its wage payments and transfer payments are not enough to cover the price increases of the producing sectors. The producing sectors also bear some of the costs because of reduced sales and a fall in profits. The level of GNP is lower when conservation is introduced, but there is a reduction in the total energy consumed over the length of the simulation.

6.0 Continuation of Work

The study can and has been extended by the Resource Policy Center at Dartmouth College. As a result of further testing of the model, additional structural relationships have been modified. In addition to correcting structural weaknesses, several existing structures can be expanded and disaggregated.

Recent work on the model includes assessing the vulnerability of the United States to energy supply shocks (Kern 1981). Additional policy and scenario analyses can be conducted with the model. Many other types of policy initiatives can be examined. These include such policies as a windfall profits tax, investment tax credit, tax reductions, and wage and price controls. In addition, for each type of policy initiative, a range of macroeconomic scenarios can be examined. For example, the labor force can be allowed to expand or contract, money supply can be increased, technological change can be induced and/or continuous depletion of energy reserves can be activated. Finally, policy impacts can be tested with the model in a growth, rather than an equilibrium mode.

The model boundary can be extended to include further macroeconomic interactions. Currently the model's focus is on domestic interactions. How-

However, model structure could be added to extend the boundary of the model to include OPEC oil supply and pricing decisions in addition to an international money and trade market. This additional structure would enable the user to analyze balance of payments and international trade issues.

REFERENCES

Census 1979 — U.S. Bureau of the Census, Department of Commerce. Statistical Abstract of the United States, 1979. Washington, D.C.: U.S. Government Printing Office, 1979, p. 601-602.

Kern 1981 — Kern, Rainer. Assessing the Vulnerability of the United States to Energy Supply Shocks: A Systems Perspective. DSD #380, Resource Policy Center, Thayer School of Engineering, Dartmouth College, Hanover, NH, 1981.

Richmond 1980 — Richmond, Barry. Technical Documentation for First-Version Model of Energy-Economy Interactions. RP #321, Resource Policy Center, Thayer School of Engineering, Dartmouth College, Hanover, NH, 1980.

Schertz 1980 — Schertz, Lois, R. An Analysis of Energy-Economy Interactions: A Systems Perspective. DSD #318, Resource Policy Center, Thayer School of Engineering, Dartmouth College, Hanover, NH, 1980.

CLASS II DOCUMENTATION STANDARDS FOR SIMULATION MODELS

1. ACCESS TO MODEL:

Name of Model: ENECONI

Name and current address of the senior technical person responsible for the model's construction: Barry Richmond, Thayer School Dartmouth College, Hanover, NH 03

Who funded the model development? DOE Fossil Energy

In what language is the program written? DYNAMO

On what computer system is the model currently implemented? Dartmouth Time Sharing System

What is the maximum memory required to store and execute the program? 10 K

What is the length of time required for one typical run of the model? 2-3 min.

Is there a detailed user's manual for the model? No

2. PURPOSE OF THE MODEL:

For what individual or institution was the model designed? Department of Energy

What were the basic variables included in the model?

4 Main Sectors:	Capital	Major Variables:	Money Balance	Energy
	Goods & Services		Inventory of Output	Capital
	Energy		Price of Output	Labor
	Household		General Unemployment	Labor Wage

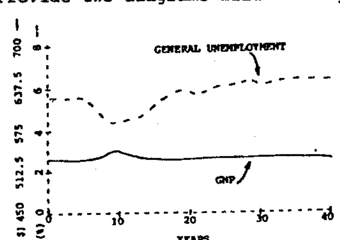
Over what time period is the model supposed to provide useful information on real world behavior? 40 years

Was the model intended to serve as the basis of:

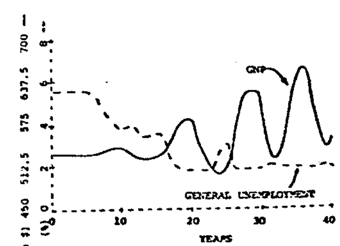
- an academic exercise designed to test the implications of a set of assumptions or to see if a specific theory would explain historical behavior ____
- communication with others about the nature and implications of an important set of interactions X
- projecting the general behavioral tendencies of the real system X
- predicting the value of some system element(s) at some future point in time ____

3. MODEL SPECIFICATION AND THEORETICAL JUSTIFICATION:

Provide two diagrams illustrating the extreme behavior modes exhibited by the major



WAGES AND PRICES CONTROLLED, GOVERNMENT INACTIVE



WAGES AND PRICES ACTIVE, GOVERNMENT ACTIVE

If they are not included in the body of the paper indicate where the reader may find:

a model boundary diagram that indicates the important endogenous, exogenous and excluded variables

a causal influence diagram, a flow diagram, the computer program and definitions of the program elements

Schertz, Lois, R. An Analysis of Energy-Economy Interactions: A Systems Perspective. DSD#318 Resource Policy Center Thayer School of Engineering Dartmouth College

Is the model composed of:

simultaneous equations ______

difference or differential equations __X__

procedural instructions ______

Is the model deterministic __x__ or stochastic ______

continuous __x__ or discrete ______

4. DATA ACQUISITION

What were the primary sources for the data and theories incorporated in the model?

Data Statistical abstract of the United States, 1979. McGraw Hill Energy Data.

Theory Expert Judgement and Analyst's Intuition

What percent of the coefficients of the model were obtained from:

measurements of physical systems __-__

inference from social survey data __2/3__

econometric analyses __-__

expert judgment __1/6__

the analyst's intuition __1/6__

What was the general quality of the data? Excellent

5. PARAMETER ESTIMATION

If they are not given in the publication, where may the reader obtain detailed information on the data transformations, statistical techniques, data acquisition procedures, and results of the tests of fit and significance used in building and analyzing the model? Schertz, Lois, R. An Analysis of Energy-Economy Interacitons: A Systems Perspective, DSD #318 Resource Policy Center, Thayer School of Engineering Dartmouth College

6. MODEL PERFORMANCE AND TESTING

Over what period was the model's behavior compared with historical data?

1950 - 1980

What other tests were employed to gauge the confidence deserved by the model?

Reference testing, internal consistency testing, robustness testing, policy testing.

Where may the reader obtain a detailed discussion of the prediction errors and the dynamic properties of the model? Same as above

7. APPLICATIONS

What other reports are based upon the model? Schertz, Lois R. A First Version Model for Analyzing Energy-Economy Interactions, DSD #313, Dartmouth College

Name any analysts outside the parent group that have implemented the model on another computer system. ______

List any reports or publications that may have resulted from an evaluation of the model by an outside source. ______

Has any decision maker responded to the recommendations derived from the model?

Dave Beecy, Miles Greenbaum, DOE, Fossil Energy

Will there be any further modifications or documentation of the model? Yes

Where may information on these be obtained?

Resource Policy Center
Thayer School of Engineering
Dartmouth College
Hanover, N.H. 03755