ENERGY LABORATORY

MASSACHUSETTS INSTITUTE
OF TECHNOLOGY

A USER'S GUIDE
TO THE MIT NATURAL GAS MODEL

by

Kevin R. Lloyd

June, 1975

Energy Lab Report
N° MIT-EL 75-011

A USER'S GUIDE
TO THE MIT NATURAL GAS MODEL

June 9, 1975

prepared by
Kevin Lloyd

TABLE OF CONTENTS

Section 1. Overview

The MacAvoy/Pindyck econometric model of the natural gas industry operates interactively on the TROLL system for economic research.* The model contains a number of policy and parameter inputs which allow the user to specify a precise set of economic and regulatory conditions. These parameters along with the values which have been chosen by the authors as those most likely to obtain are detailed in Appendix 1. The programming code for the simulation model consists of 1266 equations which are generally block recursive and are solved for each year of the forecast period. For those interested in further detail, Appendix 2 is an index to the model as it appears in the TROLL language.

Forecasts with the MacAvoy/Pindyck model may be obtained in two ways. For those users desiring to set up and control the entire procedure themselves, Section 2 describes from start to finish the steps necessary for one set of forecast results. Section 3 describes the use of a TROLL program designed to control the simulation process internally while allowing maximum flexibility of user interaction in specifying parameter values, thus eliminating the need for extensive knowledge of the TROLL programming commands. Sample output, both numeric and graphic, is presented in Section 4 to illustrate the procedure for accessing forecast results.

---

*TROLL provides a comprehensive environment for creating, estimating, and simulating economic models. For further information contact the National Bureau of Economic Research, 575 Technology Square, Cambridge, Ma. 02139 Telephone: 617-661-8788

Section 2. Set-up and Simulation

The MacAvoy/Pindyck model because of its large size requires 512K bytes of core for simulation. This should be obtained immediately after the initial login to TROLL by using the CP command. This will cause the user to be put into CP, after which a second login to TROLL is necessary. Page 5 illustrates the entire procedure including the request for larger core size.

The model and all related data files are contained in user account MIT17 and MIT17 data archives. The search commands necessary to allow outside user access to these files is shown near the bottom of page 5. The other general set-up operations shown include specifying simulation algorithm parameters in the "conopt" command, and invoking a data binding which will substitute data from LOFPWO for all occurrences of LOFPWC.

At this point a number of parameters must be specified. Using the "bindval" command followed by ordered pairs of entries accomplishes this task. In every case the first entry is the parameter name and the second entry, always numeric, is the value to be used in simulation. Since a few of these parameters are used to specify historic conditions, such as the estimated depreciation rate of appliances or observed fuel price increases, they must remain constant regardless of the particular forecast; Appendix 1 explains the meaning of all the parameters and notes those which are restricted to historic values. The console session from the top half of page 6 show the process of actually setting the values in TROLL.

Several more operations are required before the actual simulation

may commence. The model has previously been analyzed for consistency and the computer code generated for solution, so the "simulate relax" command simply calls for its retrieval. Also, since the model needs lagged values for its initialization, all simulations must begin from 1970 so that demand forecasts may originate from actual demand data rather than from supply data in later years when consumption curtailments became prevalent. However, it is desirable to use the latest available information for starting the forecasts of supply. Consequently, real values of endogenous variables on the supply side of the model are inputed into the simulation process for the early years. The procedure for doing this is quite lengthy, and must be repeated for every simulation, so it has been put into a macro file called "i70ulist." Giving the command "&i70ulist" just retrieves that file and executes the commands it contains. The execution is called for near the bottom of page 6 and the complete contents of the macro (those commands being executed by TROLL) is printed on page 7. The "simstart" command sets the first year of the simulation at 1970.

The forecast is actually performed after the "dotil" command is given. The date specified here is the last year of the forecast period, and it may be any year from 1971 to 1985. After this process is complete the output is stored in the file named after the "filesim" command, which in this example is "demo1." The simulation procedure is now complete and may be repeated from the point of the "TROLL COMMAND:" at the top of page 6.

```
-1074-33--
PLEASE LOG IN:  n370

PASSWORD:  research

C.U. IS ONLINE
pc

vm/370 online    1jh359 qsyosu

l yty m
ENTER PASSWORD:

DASD 360 LINKED R/W; R/W BY 017 USERS
DASD 361 LINKED R/W; R/W BY 017 USERS
DASD 362 LINKED R/W; R/W BY 017 USERS
DASD 363 LINKED R/W; R/W BY 017 USERS
DASD 364 LINKED R/W; R/W BY 017 USERS
LOGMSG - 09:41:11 EDT FRIDAY 06/06/75
*HASP/OS IS LOADING PRTY 6 AND UP ONLY   1000 EDT 6/6/75
LOGON AT 11:54:43 EDT FRIDAY 06/06/75
NBER TROLL V6.3D 5/27/75
NAME: mit17
PASSWORD:
NEVER TURN YOUR TERMINAL'S POWER OFF IN TROLL;
TROLL COMMAND: cp define storage 512k;

STORAGE = 00512K
DMKDSP450W CP ENTERED; DISABLED WAIT PSW
CP
i troll
NBER TROLL V6.3D 5/27/75
NAME: mit17
PASSWORD:
NEVER TURN YOUR TERMINAL'S POWER OFF IN TROLL;
TROLL COMMAND: search first mit17_data_aei
NAME OR ';': mit17_data_gasmod2
NAME OR ';': mit17_data_gasmod
NAME OR ';': mit17_data_offshore
NAME OR ';': mit17;

TROLL COMMAND: usemod gasmod;

TROLL COMMAND: conopt start 5 stop 100;

TROLL COMMAND: bindata lofpwc lofpwo;
```

```
TROLL COMMAND: bindval d 0.07 r 0.07 p 0.10;

TROLL COMMAND: bindval pnn 0.011 inflator 0.065
NAME: pgnp 0.042 pmiles 0.065;

TROLL COMMAND: bindval pdro 5 pacpd 0.20
NAME: pqo 0.085 pdw 0.005 pacr 2000000;

TROLL COMMAND: bindval poil73 0.25 pfoil73 0.25
NAME: pcoal73 0.25 palt73 0.25;

TROLL COMMAND: bindval poil74 0.40 pfoil74 0.40
NAME: pcoal74 0.40 palt74 0.40;

TROLL COMMAND: bindval poil75 0.04 pfoil75 0.04
NAME: pcoal75 0.04 palt75 0.04;

TROLL COMMAND: bindval poil 0.0 pfoil 0.0
NAME: pcoal 0.0 palt 0.0;

TROLL COMMAND: bindval jump73 1.00 jump74 2.00
NAME: jump75 0.50 oinc 0.50;

TROLL COMMAND: bindval pcapc 0.025;

TROLL COMMAND: bindval step73 3.0 step74 5.0
NAME: step75 25.0 ginc 7.0;

TROLL COMMAND: bindval move73 10.0 move74 7.0
NAME: move75 20.0 minc 7.0;

TROLL COMMAND: simulate relax;

SIMULATE COMMAND: &i70ulist;

%%%%%%SIMULATE COMMAND: simstart 1970; ...

%%SIMULATE COMMAND: dotil 1980;

%%%%%%SIMULATE COMMAND: filesim demo1;

TROLL COMMAND:
```

```
TROLL COMMAND: prtmacro i70ulist;

I70ULIST -

ULIST 1970 TO 1971, DSET &NELIST CAP ; ;
ULIST 1970 TO 1971, DSET &NCLIST VAM ; ;
ULIST 1970 TO 1971, DSET &SELIST CAP VAM ; ;
ULIST 1970 TO 1971, DSET &SCLIST CAP VAM ; ;
ULIST 1970 TO 1971, DSET &WLIST  CAP VAM ; ;
ULIST 1970 TO 1971, DSET P1IPW P2IPW P3IPW P4IPW P5IPW P6IPW;
ULIST  1970 TO 1971, CAPW COUTPW KAPW LNPW LXPW MSPW
NNPW PEPW OKPW T1PW T2PW T3PW T4PW T6PW T9PW T0PW WKPW WYPW
PAPW MOPW ARPW MIPW NBPW NYPW NDPW OHPW T5PW T7PW CNPW ;
ULIST 1970 TO 1972, DSET CAPT COUTPT KAPT LNPT LXPT MSPT
NNPT PEPT OKPT T1PT T2PT T3PT T4PT T6PT T9PT T0PT WKPT WYPT
PAPT MOPT ARPT MIPT NBPT NYPT NDPT OHPT T5PT T7PT CNPT ;
ULIST 1970 TO 1972, DSET P1IPT P2IPT P3IPT P4IPT P5IPT;
ULIST 1970 TO 1972, DSET P6IPT;
ULIST 1970 TO 1972, DSET CAPO COUTPO KAPO LNPO LXPO MSPO
NNPO PEPO OKPO T1PO T2PO T3PO T4PO T6PO T9PO T0PO WKPO WYPO ;
ULIST 1970 TO 1972, DSET CAQG COUTQG KAQG LNQG LXQG MSQG
NNQG PEQG OKQG T1QG T2QG T3QG T4QG T6QG T9QG T0QG WKQG WYQG
PAQG MOQG ARQG MIQG NBQG NYQG NDQG OHQG T5QG T7QG ;
ULIST 1970 TO 1972, DSET CAQO COUTQO KAQO LNQO LSQO MSQO
NNQO PEQO OKQO T1QO T2QO T3QO T4QO T6QO T9QO T0QO WKQO WYQO ;
ULIST 1970 TO 1972, DSET &NELIST PFOIL NN PALT YY POIL     ; ;
ULIST 1970 TO 1972, DSET &NCLIST PALT NN YY PFOIL POIL     ; ;
ULIST 1970 TO 1972, DSET &SELIST PALT PFOIL YY NN POIL      ; ;
ULIST 1970 TO 1972, DSET &SCLIST PFOIL POIL NN      ; ;
ULIST 1970 TO 1972, DSET &WLIST PFOIL NN PCOAL POIL     ; ;
ULIST 1970 TO 1972, DSET &PMLIST   SRO SRG SZO SZG ; ;
ULIST 1970 TO 1972, DSET &PMLIST   OX OR ; ;
ULIST 1970 TO 1972, DSET &ONLIST WXT XT RT ; ;
ULIST 1970 TO 1973 DSET LOFPT LOFDRO LOFQG LOFPWG LOFQO LOFQC ;
ULIST 1970 TO 1973 DSET LOFPWO ;
ULIST 1970 TO 1972 DSET LOFWWT LOFDT LOFXRT LOFFWT LOFACRD LOFACPN ;
ULIST 1970 TO  1974, DSET LOFACR;
ULIST 1970 TO 1971, DSET &NELIST TP ; ;
ULIST 1970 TO 1971, DSET &NCLIST TP ; ;
ULIST 1970 TO 1971, DSET &SELIST TP ; ;
ULIST 1970 TO 1971, DSET &SCLIST TP ; ;
ULIST 1970 TO 1971, DSET &WLIST TP ; ;
ULIST 1970 TO 1973, DSET USDEF ;

TROLL COMMAND:
```

Section 3. Programmed Simulation

The necessity of using TROLL system commands may be minimized by invoking a simulation macro program that was written to aide users of the gas model. Its use is illustrated on pages 10 through 13, again with output from a console session. All printing in capital letters has been typed by the terminal, and responses to prompts, typed in small characters, have been supplied by the user. The only set-up involved is that of logging into TROLL with 512K core as described in Section 2, and giving a single search command as shown on the top of page 10. The execution of the macro program commences with the command "&gassim." From this point on the process is in the control of the program and requires only user responses to terminal prompts. These four examples emphasize the simplicity as well as the flexibility of the macro program.

The example on page 10 makes the simulation process nearly as brief as possible. The user is just duplicating on his account a forecast which has previously been programmed and performed on an account of the Natural Gas Project at MIT. He has declined the opportunity to alter any of the basic growth or price parameters specified by the authors, and has requested information regarding the various regulatory policies before choosing one for his simulation. Although able to forecast to 1985 he has chosen to terminate the simulation in 1978 and file the results in "demo2."

In the case presented on page 11 the user has requested changes in both the growth parameters and alternate fuel prices, but has again used one of the preprogrammed gas pricing scenarios. Presumably because he

had the console session from the previous simulation it was not necessary to print the additional information this time. A deregulation forecast was made through the year 1977 and filed in "demo3."

This time the user chose to use the default growth and price parameters once again, but designed his own gas pricing policy. His input prices allow even more deregulation than suggested by the preprogrammed phased deregulation policy, and the results of the forecast through 1983 are filed in "demo4."

The last example illustrates complete user specification of the input parameters. The program has allowed the user to set the parameters in three phases. First he deals with economic growth; next he specifies the prices of alternate fuels; finally, the pricing mechanism for natural gas is designed. Using these values the simulation is performed through the year 1979 and the results stored in "demo5."

```
TROLL COMMAND: search mit17;
TROLL COMMAND: &gassim

THIS PROGRAM WILL PERFORM SIMULATION OF THE MACAVOY/PINDYCK GAS MODEL
USING EITHER THE DEFAULT PARAMETER VALUES AS CHOSEN BY THE AUTHORS OR
THE INPUT VALUES SUPPLIED BY THE USER IN RESPONSE TO PROMPTS.  ALL
VALUES FOR RATES OF GROWTH SHOULD BE TYPED AS DECIMAL FRACTIONS RATHER
THAN PERCENTAGES.  FOR EXAMPLE, A FOUR PERCENT RATE OF INFLATION WOULD
BE ENTERED AS 0.04 OR SIMPLY .04 AND NOT AS 4.0.  GAS PRICE INCREMENTS
REFER TO NEW CONTRACT PRICES AND ARE IN CENTS PER MCF.  ALL QUESTIONS
SHOULD BE ANSWERED WITH YES OR NO.  IF AT ANY TIME YOU WISH TO STOP THE
SIMULATION PROCESS TYPE ¬ IN RESPONSE TO ANY PROMPT.


DO YOU WISH TO CHANGE THE ECONOMIC GROWTH PARAMETERS?:  no
DO YOU WISH TO CHANGE ALTERNATE FUEL PRICES?:  no
DO YOU WANT A PREPROGRAMMED GAS PRICE SCENARIO?:  yes
DO YOU WANT INFORMATION CONCERNING THESE PROGRAMS?:  yes

A. STRONG REGULATION ASSUMES THAT LEGISLATION WILL BE PASSED WHICH
ROLLS THE NEW CONTRACT PRICE LEVEL BACK TO ITS 1974 LEVEL.  ALLOWANCE
IS THEN MADE FOR PRICE INCREASES OF 3 CENTS ON NEW GAS PRODUCED EACH
YEAR THEREAFTER.

B. CURRENT REGULATION ASSUMES CONTINUATION OF THE REGULATORY
STATUS QUO, WITH THE PROVISION THAT THE CURRENT ALLOWANCE OF 51 CENTS
PER MCF WILL BE OVERRULED AND PRICES WILL CONTINUE RISING AT THE RATE
OF 5 CENTS PER YEAR FROM THEIR 1974 LEVEL.

C. NATIONAL AREA RATE REGULATION FOLLOWS THE MOST RECENT RULINGS
BY THE FEDERAL POWER COMMISSION WHICH HAVE SET PRICES IN 1974 AT
42 CENTS PER MCF AND 1975 PRICES AT 51 CENTS PER MCF.  ANNUAL
INCREMENTS OF 2 CENTS PER MCF ARE ALLOWED UNDER THIS POLICY.

D. PHASED DEREGULATION IS DESIGNED TO BE MARKET EQUILIBRATING ON AN
AGGREGATE NATIONAL LEVEL.  THIS POLICY ASSUMES A 25 CENT PER MCF
INCREASE IN 1975 OVER THE 1974 PRICE BEFORE NATIONAL CEILING PRICES
BECAME EFFECTIVE.  AFTER 1975 ANNUAL INCREMENTS ARE 7 CENTS SO THAT IN
1980 MARKET EQUILIBRIUM IS REACHED.

TYPE 'STRONG','CURRENT','NATIONAL', OR 'DEREG':  national
%%%%%%%%%%LAST YEAR OF FORECAST PERIOD. MUST NOT EXCEED 1985:  1978
%%%%%%%NAME OF DSET IN WHICH FORECAST WILL BE STORED:  demo2

THE SIMULATION PROCESS IS NOW COMPLETE.  FOR ACCESS TO FORECAST
RESULTS REFER TO THE DSET COMMANDS UNDER THE PRINTING AND PLOTTING
SECTIONS IN THE TROLL REFERENCE MANUAL.

TROLL COMMAND:
```

```
TROLL COMMAND: search mit17;
TROLL COMMAND: &gassim

THIS PROGRAM WILL PERFORM SIMULATION OF THE MACAVOY/PINDYCK GAS MODEL
USING EITHER THE DEFAULT PARAMETER VALUES AS CHOSEN BY THE AUTHORS OR
THE INPUT VALUES SUPPLIED BY THE USER IN RESPONSE TO PROMPTS.  ALL
VALUES FOR RATES OF GROWTH SHOULD BE TYPED AS DECIMAL FRACTIONS RATHER
THAN PERCENTAGES.  FOR EXAMPLE, A FOUR PERCENT RATE OF INFLATION WOULD
BE ENTERED AS 0.04 OR SIMPLY .04 AND NOT AS 4.0.  GAS PRICE INCREMENTS
REFER TO NEW CONTRACT PRICES AND ARE IN CENTS PER MCF.  ALL QUESTIONS
SHOULD BE ANSWERED WITH YES OR NO.  IF AT ANY TIME YOU WISH TO STOP THE
SIMULATION PROCESS TYPE ~ IN RESPONSE TO ANY PROMPT.


DO YOU WISH TO CHANGE THE ECONOMIC GROWTH PARAMETERS?:  yes
ANNUAL RATE OF POPULATION GROWTH:  .008
ANNUAL RATE OF GNP GROWTH:  .03
ANNUAL INFLATION RATE:  .05
ANNUAL RATE OF PIPELINE CAPACITY GROWTH:  .015
DO YOU WISH TO CHANGE ALTERNATE FUEL PRICES?:  yes
RATE OF REAL INCREASE IN NO. 6 OIL PRICE IN 1975:  .08
RATE OF REAL INCREASE IN NO. 2 OIL PRICE IN 1975:  .08
RATE OF REAL INCREASE IN COAL PRICE IN 1975:  .15
RATE OF REAL INCREASE IN  COAL/OIL PRICE IN 1975:  .12
ANNUAL RATE OF REAL INCREASE IN NO. 6 OIL PRICE AFTER 1975:  .05
ANNUAL RATE OF REAL INCREASE IN NO. 2 OIL PRICE AFTER 1975:  .05
ANNUAL RATE OF REAL INCREASE IN COAL PRICE AFTER 1975:  .07
ANNUAL RATE OF REAL INCREASE IN  COAL/OIL PRICE AFTER 1975:  .06
NOMINAL PRICE INCREASE OF CRUDE OIL IN 1975:  2.50
ANNUAL NOMINAL PRICE INCREASE OF CRUDE OIL AFTER 1975:  1.00
DO YOU WANT A PREPROGRAMMED GAS PRICE SCENARIO?:  yes
DO YOU WANT INFORMATION CONCERNING THESE PROGRAMS?:  no
TYPE 'STRONG','CURRENT','NATIONAL', OR 'DEREG':  dereg
%%%%%%%%%LAST YEAR OF FORECAST PERIOD. MUST NOT EXCEED 1985:  1977
%%%%%%%NAME OF DSET IN WHICH FORECAST WILL BE STORED:  demo3

THE SIMULATION PROCESS IS NOW COMPLETE.  FOR ACCESS TO FORECAST
RESULTS REFER TO THE DSET COMMANDS UNDER THE PRINTING AND PLOTTING
SECTIONS IN THE TROLL REFERENCE MANUAL.

TROLL COMMAND:
```

```
TROLL COMMAND: search mit17;
TROLL COMMAND: &gassim

THIS PROGRAM WILL PERFORM SIMULATION OF THE MACAVOY/PINDYCK GAS MODEL
USING EITHER THE DEFAULT PARAMETER VALUES AS CHOSEN BY THE AUTHORS OR
THE INPUT VALUES SUPPLIED BY THE USER IN RESPONSE TO PROMPTS.  ALL
VALUES FOR RATES OF GROWTH SHOULD BE TYPED AS DECIMAL FRACTIONS RATHER
THAN PERCENTAGES.  FOR EXAMPLE, A FOUR PERCENT RATE OF INFLATION WOULD
BE ENTERED AS 0.04 OR SIMPLY .04 AND NOT AS 4.0.  GAS PRICE INCREMENTS
REFER TO NEW CONTRACT PRICES AND ARE IN CENTS PER MCF.  ALL QUESTIONS
SHOULD BE ANSWERED WITH YES OR NO.  IF AT ANY TIME YOU WISH TO STOP THE
SIMULATION PROCESS TYPE ~ IN RESPONSE TO ANY PROMPT.


DO YOU WISH TO CHANGE THE ECONOMIC GROWTH PARAMETERS?:  no
DO YOU WISH TO CHANGE ALTERNATE FUEL PRICES?:  no
DO YOU WANT A PREPROGRAMMED GAS PRICE SCENARIO?:  no
NOMINAL PRICE INCREASE OF INTERSTATE GAS IN 1975:  40.0
ANNUAL NOMINAL PRICE INCREASE OF INTERSTATE AFTER 1975:  5.0
NOMINAL PRICE INCREASE OF INTRASTATE GAS IN 1975:  20.0
ANNUAL NOMINAL PRICE INCREASE OF INTRASTATE GAS AFTER 1975:  5.0
ANNUAL NEW ACREAGE LEASED OFFSHORE IN MILLIONS OF ACRES:  4.0
%%%%%%%%%%LAST YEAR OF FORECAST PERIOD. MUST NOT EXCEED 1985:  1983
%%%%%%%%%%NAME OF DSET IN WHICH FORECAST WILL BE STORED:  demo4

THE SIMULATION PROCESS IS NOW COMPLETE.  FOR ACCESS TO FORECAST
RESULTS REFER TO THE DSET COMMANDS UNDER THE PRINTING AND PLOTTING
SECTIONS IN THE TROLL REFERENCE MANUAL.

TROLL COMMAND:
```

```
TROLL COMMAND: search mit17;
TROLL COMMAND: &gassim

THIS PROGRAM WILL PERFORM SIMULATION OF THE MACAVOY/PINDYCK GAS MODEL
USING EITHER THE DEFAULT PARAMETER VALUES AS CHOSEN BY THE AUTHORS OR
THE INPUT VALUES SUPPLIED BY THE USER IN RESPONSE TO PROMPTS.  ALL
VALUES FOR RATES OF GROWTH SHOULD BE TYPED AS DECIMAL FRACTIONS RATHER
THAN PERCENTAGES.  FOR EXAMPLE, A FOUR PERCENT RATE OF INFLATION WOULD
BE ENTERED AS 0.04 OR SIMPLY .04 AND NOT AS 4.0.  GAS PRICE INCREMENTS
REFER TO NEW CONTRACT PRICES AND ARE IN CENTS PER MCF.  ALL QUESTIONS
SHOULD BE ANSWERED WITH YES OR NO.  IF AT ANY TIME YOU WISH TO STOP THE
SIMULATION PROCESS TYPE ~ IN RESPONSE TO ANY PROMPT.


DO YOU WISH TO CHANGE THE ECONOMIC GROWTH PARAMETERS?:  yes
ANNUAL RATE OF POPULATION GROWTH:  .008
ANNUAL RATE OF GNP GROWTH:  .03
ANNUAL INFLATION RATE:  .05
ANNUAL RATE OF PIPELINE CAPACITY GROWTH:  .015
DO YOU WISH TO CHANGE ALTERNATE FUEL PRICES?:  yes
RATE OF REAL INCREASE IN NO. 6 OIL PRICE IN 1975:  .08
RATE OF REAL INCREASE IN NO. 2 OIL PRICE IN 1975:  .08
RATE OF REAL INCREASE IN COAL PRICE IN 1975:  .15
RATE OF REAL INCREASE IN  COAL/OIL PRICE IN 1975:  .12
ANNUAL RATE OF REAL INCREASE IN NO. 6 OIL PRICE AFTER 1975:  .05
ANNUAL RATE OF REAL INCREASE IN NO. 2 OIL PRICE AFTER 1975:  .05
ANNUAL RATE OF REAL INCREASE IN COAL PRICE AFTER 1975:  .07
ANNUAL RATE OF REAL INCREASE IN  COAL/OIL PRICE AFTER 1975:  .06
NOMINAL PRICE INCREASE OF CRUDE OIL IN 1975:  2.50
ANNUAL NOMINAL PRICE INCREASE OF CRUDE OIL AFTER 1975:  1.00
DO YOU WANT A PREPROGRAMMED GAS PRICE SCENARIO?:  no
NOMINAL PRICE INCREASE OF INTERSTATE GAS IN 1975:  40.0
ANNUAL NOMINAL PRICE INCREASE OF INTERSTATE AFTER 1975:  5.0
NOMINAL PRICE INCREASE OF INTRASTATE GAS IN 1975:  20.0
ANNUAL NOMINAL PRICE INCREASE OF INTRASTATE GAS AFTER 1975:  5.0
ANNUAL NEW ACREAGE LEASED OFFSHORE IN MILLIONS OF ACRES:  4.0
%%%%%%%%%LAST YEAR OF FORECAST PERIOD. MUST NOT EXCEED 1985:  1979
%%%%%%%%NAME OF DSET IN WHICH FORECAST WILL BE STORED:  demo5

THE SIMULATION PROCESS IS NOW COMPLETE.  FOR ACCESS TO FORECAST
RESULTS REFER TO THE DSET COMMANDS UNDER THE PRINTING AND PLOTTING
SECTIONS IN THE TROLL REFERENCE MANUAL.

TROLL COMMAND:
```

Section 4. Forecast Results

The type of output which may be obtained from forecasts with the MacAvoy/Pindyck model is illustrated on the following pages. Using the "prtdset" command, Table 1 of page 15 has been printed on the terminal showing the value of a single variable across several different forecasts. Other formatting capabilities, as shown in Table 2 on the same page present the output of several variables for only one forecast. Figures 1 and 2 on pages 16 and 17 are analogous to the tables substituting the "pltdset" command to obtain graphics.

```
TROLL COMMAND: prtdset variables usqs,
'RANGE' OR 'DSETS': range 1973 to 1978,
'DSETS': dsets demo2 demo4 demo5;
```

SIMULATION OUTPUT BY VARIABLE

USQS - DEFINITION

	DEMO2	DEMO4	DEMO5
1973	2.262398E+07	2.262398E+07	2.262398E+07
1974	2.362069E+07	2.362069E+07	2.362069E+07
1975	2.485600E+07	2.681861E+07	2.681861E+07
1976	2.572954E+07	2.800941E+07	2.800941E+07
1977	2.632139E+07	2.875498E+07	2.875645E+07
1978	2.731595E+07	3.047536E+07	3.035187E+07

Table 1

```
TROLL COMMAND: prtdset dsets demo2,
'RANGE' OR 'VARIABLES': range all,
'VARIABLES': variables usqsm usqd used;
```

SIMULATION OUTPUT BY DSET

DEMO2

	USQSM	USQD	USED
1970	2.258376E+07	2.234077E+07	-242992.
1971	2.278424E+07	2.302469E+07	240448.
1972	2.330979E+07	2.349278E+07	182992.
1973	2.362398E+07	2.430674E+07	682752.
1974	2.462069E+07	2.625605E+07	1.635360E+06
1975	2.585600E+07	2.857590E+07	2.719904E+06
1976	2.672954E+07	3.067766E+07	3.948128E+06
1977	2.732139E+07	3.261539E+07	5.294000E+06
1978	2.831595E+07	3.450838E+07	6.192432E+06

Table 2

```
TROLL COMMAND:
```

```
TROLL COMMAND: pltdset variables uswp,
'RANGE' OR 'DSETS': range 1972 to 1977,
'DSETS': dsets demo3 demo4 demo5;
```

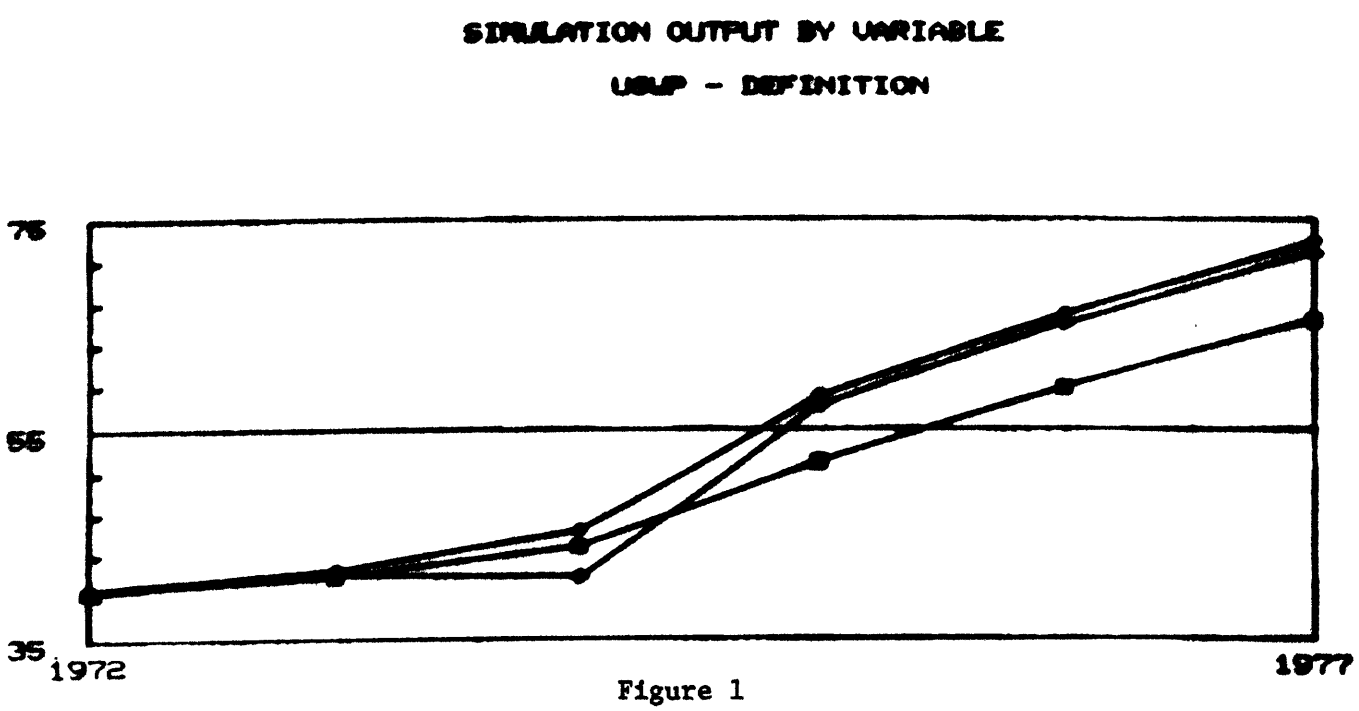

Figure 1

```
TIME BOUNDS: 1972 TO 1977
SYMBOL SCALE NAME
   ■     #1   DEMO3
   •     #1   DEMO4
   ♦     #1   DEMO5
```

TROLL COMMAND: pltdset dsets demo4,

'RANGE' OR 'VARIABLES': range 1973 to 1983,

'VARIABLES': variables uspt uspw uswp;

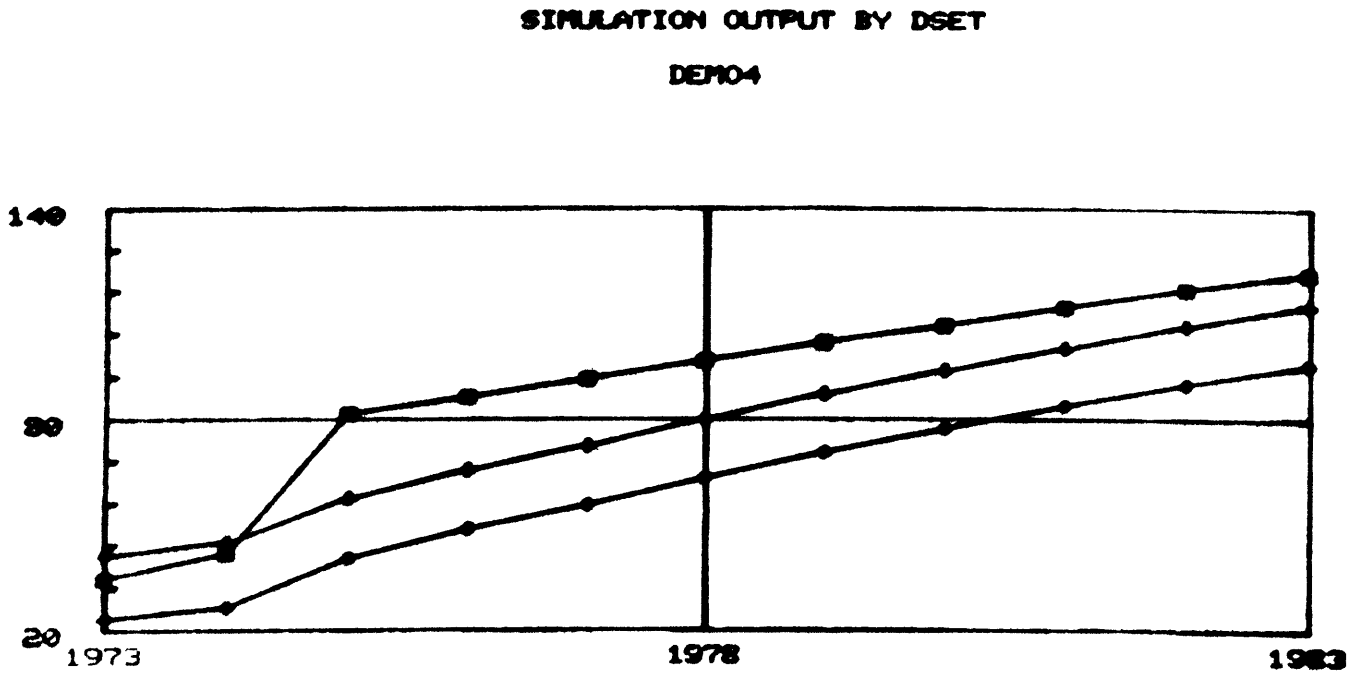

Figure 2

TIME BOUNDS: 1973 TO 1983

SYMBOL	SCALE	NAME
■	$1	USPT
●	$1	USPW
◆	$1	USWP

APPENDIX 1

PARAMETER VALUES

MacAvoy/Pindyck Computer Simulation Model: March 1975 Version

Name	Description or Explanation
D	Depreciation rate of industrial gas appliances. This was found to be 0.07 and must be set to that for simulation.
R	Depreciation rate of residential gas appliances. This also was found to be 0.07 and must be set to that for simulation.
P	Depreciation rate of all oil appliances. This was found to be 0.10 and must be set to that for simulation.
PGNP	Rate of growth of GNP in real terms. This was set at 0.042 for the base set of forecasts.
INFLATOR	Rate of inflation. This was set at 0.065 for the basic forecasts.
PNN	Rate of population growth. This was set at 0.011 for all forecasts.
PMILES	Rate of increase in pipelines' costs in current dollar terms. This was set at the level of INFLATOR for all forecasts.
PCAPC	Rate of growth in pipeline capacity. This is judgmental and should vary with the pricing policy imposed on the new contract price of gas. It was set to 0.00, 0.01, and 0.025 for the base run forecasts of cost of service, status quo, and phased deregulation respectively.
POIL73	Fractional increase in residual oil price in 1973.
PFOIL73	Fractional increase in distillate oil price in 1973.
PCOAL73	Fractional increase in coal price in 1973.
PALT73	Fractional increase in weighted coal/oil price in 1973. (These last four values are in real terms, and to reflect historic conditions in 1973 have all been set to 0.25 for simulation.)
POIL74	Fractional increase in residual oil price in 1974.
PFOIL74	Fractional increase in distillate oil price in 1974.
PCOAL74	Fractional increase in coal price in 1974.
PALT74	Fractional increase in weighted coal/oil price in 1974. (These last four values are in real terms, and for the base run simulations were set to 0.40 to approximate prevailing conditions in 1974.)

Name	Description or Explanation
POIL75	Fractional increase in residual oil price in 1975.
PFOIL75	Fractional increase in distillate oil price in 1975.
PCOAL75	Fractional increase in coal price in 1975.
PALT75	Fractional increase in weighted coal/oil price in 1975. (These last four values again are in real terms and for the base run simulations were set to 0.04.)
POIL	Annual rate of growth of residual oil price after 1975.
PFOIL	Annual rate of growth of distillate oil price after 1975.
PCOAL	Annual rate of growth of coal price after 1975.
PALT	Annual rate of growth of weighted coal/oil price after 1975. (These also are in real terms and for the base forecasts were set to 0.00.)
JUMP73	Absolute price increase in current dollars of crude oil in 1973. (This was set to 1.00 for simulations to reflect historic conditions of 1973.)
JUMP74	Absolute price increase in current dollars of crude oil in 1974. (This was set to 2.00 for the base simulations to approximate conditions in 1974.)
JUMP75	Absolute price increase in current dollars of crude oil in 1975. (This was set to 0.50 for the base simulations.)
OINC	Absolute annual price increase in current dollars of crude oil after 1975. (This was set to 0.50 for the base forecasts.)
STEP73	Absolute price increase in current dollars of interstate new contract sales in 1973. This is in ¢/MCF. (Set to 5.0 in all simulations to reflect conditions in 1973.)
STEP74	Absolute price increase in current dollars of interstate new contract sales in 1974. This is in ¢/MCF. (Set to 5.0 in all simulations to approximate conditions in 1974.)
STEP75	Absolute price increase in current dollars of interstate new contract sales in 1975. This is in ¢/MCF. (This was set at 3.0, 5.0, 25.0 for the forecasts of cost of service, status quo, and phased deregulation respectively.)
GINC	Absolute price increase in current dollars of interstate new contract sales annually after 1975. This is in ¢/MCF. (Set to 3.0, 5.0 and 5.0 for the forecasts of cost of service, status quo, and phased deregulation respectively.)
MOVE73	Absolute price increase in current dollars of intrastate new contract sales in 1973. This is in ¢/MCF. (Set to 10.0 in all simulations to reflect conditions in 1973.)

Name	Description or Explanation
MOVE74	Absolute price increase in current dollars of intrastate new contract sales in 1974. This is in ¢/MCF. (Set to 7.0 in all simulations to approximate conditions in 1974.)
MOVE75	Absolute price increase in current dollars of intrastate new contract sales in 1975. This is in ¢/MCF. (This was set to 5.5, 7.0, and 20.0 for the forecasts of cost of service, status quo, and phased deregulation respectively.)
MINC	Absolute price increase in current dollars of intrastate new contract sales annually after 1975. This is in ¢/MCF. (Set to 5.5, 7.0, and 5.0 for the forecasts of cost of service, status quo, and phased deregulation respectively.)
PDRO	Number of additional drilling rigs available Offshore each year. This is set at 5 in all forecasts.
PACR	Number of additional acres leased Offshore each year. This was set at 2 million in all forecasts.
PACPD	Fraction of total Offshore acreage which was producing acreage defaulted back to the government each year. This was found to be 0.20 and must be set there for all simulations.
PQO	Annual rate of increase in production of Offshore oil. This was estimated to be 0.085 and was set at that level for all forecasts.
PDW	Annual increment in rate at which new contract price is weighted (rolled-in) with old contract prices to form average wellhead price of all gas Offshore. This was found to be 0.005 and must be set at that for all forecasts.

APPENDIX 2

INDEX of EQUATIONS

MacAvoy/Pindyck Computer Simulation Model: March 1975 Version

Equation No.	Description or Explanation
1	Defines Louisiana South total production of gas as sum of Offshore and Onshore production.
2	Defines Louisiana South total reserves of gas as sum of Offshore and Onshore reserves.
3	Defines Louisiana South total average wellhead price of gas as a weighted average (weighted by production) of Offshore and Onshore average wellhead prices. (Factor of 100 accounts for the fact that Offshore price is in terms of dollars and Onshore is in terms of cents.)
4-11	Defines production of gas in each of eight supply regions as the sum of the production of gas in the FPC districts which compose them.
12-19	Defines average wellhead price of gas in each of these eight supply regions as the weighted average (weighted by production) of the average wellhead prices of the FPC districts which compose them.
* 20-24	Computes the fraction of a supply regions's production of gas which remains in intrastate markets within that region. If then else statement constrains this fraction to be less than 1. This is not done for region 6 because all of its production is assumed to be sold intrastate, and it is not done for regions 7 and 8 because all of their production enters interstate markets.
25-29	Defines the quantity of a supply regions's production of gas which remains in intrastate markets within that region. (Done only for five regions - see previous explanation.)
30-34	Defines the quantity of a supply region's production of gas committed to interstate commerce after intrastate portion is removed.
35-63	Defines new contract price of interstate gas in each of 28 FPC districts plus Canada. Sets value equal to previous year's price plus some increment as set in parameters.
64-68	Defines new contract price of intrastate gas in each of five supply regions for which fraction was computed above.

Equation No.	Description or Explanation
69	Defines new contract price of intrastate gas in region 6, which as mentioned above puts all of its production into the intrastate market.
70-98*	Computes average wellhead price of interstate gas produced in each of 28 FPC districts plus Canada.
99	Defines gas produced within Colorado as a fixed percentage of total produced by district of Colorado-Utah.
100	Defines production of gas in all of Louisiana as sum of production in Louisiana North and South.
101	Defines production of gas in New Mexico as all produced by New Mexico North district plus fixed percentage of that produced in the Permian Basin district (which is part in Texas and part in New Mexico.)
102	Defines production in Texas as sum of all FPC districts in Texas plus fixed percentage of Permian Basin.
103	Defines production of gas in Utah as a fixed percentage of total produced by district of Colorado-Utah.
104-108*	Computes average wellhead price of intrastate gas in each of fice supply regions for which fraction was computed above.
109*	Computes average wellhead price of intrastate gas in region 6, which produces completely in the intrastate markets.
110-149	Defines the average wellhead price of gas as "seen" by each of the consuming states. This is a weighted average of all supply regions (both interstate and intrastate) from which the state obtains its gas (weighted according to the quantities it receives from each region.) Weights are from static input/output table.
150-189	Defines pipeline capacity in each of 40 consuming states. Sets value equal to previous year's capacity multiplied by 1+fractional growth. (Growth rate set as parameter value.)
190-229	Defines distance of transportation of gas to each of 40 consuming states. This is designed to grow as a surrogate variable to reflect increased operating costs for the pipelines. Sets value to previous year's value multiplied by 1+ fractional growth. (Again a parameter value.)
230-269	Defines population in each of consuming states for which population is exogenous variable in the consumption equation. (Growth rate is a parameter value.)

Equation No.	Description or Explanation
270-293	Defines personal income in each of consuming states for which personal income is exogenous variable in the consumption equation. (Growth rate is a parameter value.)
294-325	Defines value added in manufacturing in each of consuming states for which value added is exogenous variable in the consumption equation. (Growth rate is a parameter value.)
326-356	Defines capital investment in manufacturing in each of consuming states for which investment is exogenous variable in the consumption equation. (Growth rate is a parameter value.)
357-366	Defines coal price in those consuming states for which coal is an alternate fuel in the demand equations. Sets value equal to previous year's price multiplied by 1+fractional growth. (Growth rate is a parameter value.)
367-390	Defines weighted average price for coal and residual oil in those consuming states for which both coal and oil are alternative fuels in the demand equations. Same structure as coal price equations. (Growth rate is a parameter value.)
391-430	Defines residual oil price in all 40 consuming states. (See above explanation.)
431-470	Defines distillate oil price in all 40 consuming states. (See above explanation.)
*	
471-510	Computes wholesale price of gas in each of 40 consuming states based on pipeline markup.
*	
511-518	Computes residential/commercial demand for gas in each of eight Northeast states.
*	
519-527	Computes R/C demand for gas in each of nine North Central states.
*	
528-534	Computes R/C demand for gas in each of seven Southeast states.
*	
535-540	Computes R/C demand for gas in each of six South Central states.
*	
541-550	Computes R/C demand for gas in each of ten West states.
*	
551-558	Computes industrial demand for gas in each of eight Northeast states.
*	
559-567	Computes industrial demand for gas in each of nine North Central states.

Equation No.	Description or Explanation
* 568-574	Computes industrial demand for gas in seven Southeast states.
* 575-580	Computes industrial demand for gas in each of six South Central states.
* 581-590	Computes industrial demand for gas in each of ten West states.
* 591-603	Computes demand for gas for field extraction (pumping) purposes in thirteen major producing states.
* 604-611	Computes distillate oil demand in each of eight Northeast states.
* 612-620	Computes distillate oil demand in each of nine North Central states.
* 621-643	Computes distillate oil demand in each of twenty-three Southeast, South Central, and West states.
* 644-651	Computes residual oil demand in each of eight Northeast states.
* 652-660	Computes residual oil demand in each of nine North Central states.
* 661-683	Computes residual oil demand in each of twenty-three Southeast, South Central, and West states.
684-701	Defines crude oil price in each of 18 FPC districts. Sets value equal to previous year's price plus some increment as set in the parameters.
702	Defines Louisiana South total exploratory well drilling activity as sum of Onshore drilling plus a fixed percentage (greater than 100%) of Offshore field wells.
703-720	Defines number of successful gas wells drilled in each of 18 FPC districts.
721-738	Defines number of successful oil wells drilled in each of 18 FPC districts.
739-756	Defines year's gas discoveries in each of 18 FPC districts.
757-774	Defines year's oil discoveries in each of 18 FPC districts.
775-792	Defines index of number of successful gas wells completed in the reference period immediately preceding the current period for each of 18 FPC districts.

Equation No.	Description or Explanation
793-810	Defines index as explained above except for oil wells.
811-828	Defines index of depletion of potential gas resource base in 18 FPC districts.
829-846	Defines index of depletion of potential oil resource base in 18 FPC districts.
847-864	Defines cumulative gas production for each of 18 FPC districts.
865-882	Defines cumulative oil production for each of 18 FPC districts.
*	
883-900	Computes total wells (exploratory) drilled in each of 18 FPC districts.
901-918	If then else statement constrains wells drilled to be positive.
*	
919-936	Computes average size of gas discovery in each of 18 FPC districts.
*	
937-954	Computes average size of oil discovery in each of 18 FPC districts.
*	
955-972	Computes fraction of total exploratory wells which are successful gas wells in each of 18 FPC districts.
*	
973-990	Computes fraction of total exploratory wells which are successful oil wells in each of 18 FPC districts.
*	
991-1008	Computes extensions of gas in each of 18 FPC districts.
*	
1009-1026	Computes revisions of gas in each of 18 FPC districts.
*	
1027-1044	Computes extensions of oil in each of 18 FPC districts.
*	
1045-1062	Computes revisions of oil in each of 18 FPC districts.
1063-1090	Defines reserves of gas in each of 28 FPC districts.
*	
1091-1092 and 1094-1099	Computes production of gas in each of eight mid-continent and gulf coast FPC districts.
*	
1093	Computes production of gas in the Permian Basin district.
*	
1100-1108	Computes production of gas in each of nine remaining FPC districts.

Equation No.	Description or Explanation
1109-1118	Defines production of gas in ten additional FPC districts assuming static reserve/production ratio and no new additions to reserves.
1119-1136	Defines reserves of oil in each of 18 FPC districts.
1137-1154*	Computes production of oil in each of 18 FPC districts.
1155-1160	Defines regional demands for distillate oil.
1161-1166	Defines regional demands for residual oil.
1167-1171	Defines supplies of gas (both intrastate and interstate) to each of the five major demand regions.
1172-1181	Defines R/C and industrial demands for gas separately for each of the five damand regions.
1182	Defines total US demand for field extraction fuel.
1183-1187	Defines total gas demand (R/C and industrial and extraction) for each of five demand regions.
1188-1192	Defines excess demand for gas in each of the five demand regions.
1193-1200	Defines demand for gas coming from each of the eight supply regions.
1201-1208	Defines excess demand for gas coming from each of the eight supply regions.
1209	Defines total domestic production of gas.
1210	Defines US total supply of gas(domestic plus imports).
1211	Defines US total demand for gas.
1212	Defines US total excess demand for gas.
1213	Defines US total exploratory wells.
1214	Defines US total gas dixcoveries.
1215	Defines US total oil discoveries.
1216	Defines US total successful gas wells.
1217	Defines US total successful oil wells.
1218	Defines US fraction of successful oil wells.

Equation No.	Description or Explanation
1219	Defines US fraction of successful gas wells.
1220	Defines US average size of oil discovery.
1221	Defines US average size of gas discovery.
1222	Defines US total extensions of gas.
1223	Defines US total revisions of gas.
1224	Defines US total additions to reserves of gas.
1225	Defines US total reserves of gas.
1226	Defines US total extensions of oil.
1227	Defines US total revisions of oil.
1228	Defines US total additions to reserves of oil.
1229	Defines US total reserves of oil.
1230	Defines US average gas reserve/production ratio.
1231	Defines price deflator. Set as last year's deflator multiplied by 1+estimated rate of inflation. (Rate of inflation is a parameter value.)
1232	Defines total US production of oil as fixed factor times the sum of the 18 FPC districts' production to account for Alaska.
1233	Defines US average crude price.
1234	Defines US average new contract price of gas.
1235	Defines US average wellhead gas price.
1236	Defines US average wholesale price of gas.
1237-1241	Defines five regional (demand regions) average wholesale gas prices.
1242	Defines Offshore reserves.
1243	Defines Offshore acreage presently leased.
1244	Defines Offshore producing acreage defaulted back to the government.

Equation No.	Description or Explanation
1245	Defines total present producing acreage.
1246	Defines non-producing acreage under lease.
1247	Defines new acreage leased in current period.
1248	Defines drilling rigs offshore.
1249	Defines total revenue from Offshore oil and gas production.
1250	Defines Offshore reserve/production ratio.
1251	Defines average size of Offshore wildcat well.
1252	Defines Offshore development wells drilled.
1253	Defines cumulative Offshore wildcat wells drilled.
1254	Defines cumulative Offshore acreage leased.
1255	Defines Offshore production of oil.
1256	Defines Offshore production of condensates.
1257	Defines Offshore crude price.
1258 *	Computes average wellhead price of Offshore gas.
1259 *	Computes wildcat wells drilled Offshore.
1260 *	Computes average size of Offshore wildcat wells.
1261 *	Computes total Offshore extensions and revisions.
1262 *	Computes production of gas Offshore.
1263 *	Computes field wells drilled Offshore.
1264 *	Computes acreage defaulted back to the government.
1265	Computes new producing acreage.
1266	Defines new contract price Offshore. Set in same manner as the new contract prices in each of the other FPC districts.

Note: A * beside the equation number indicates that the equation has been econometrically estimated.