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LAMFO AND LAMPO: PROGRAMS FOR CALCULATING THE FUTURE PRODUCTION OF PETROLEUM FROM UNDISCOVERED RESOURCES USING THE CREAMING METHOD

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SUMMARY

Program LAMFO was written to estimate, probabilistically, how much crude oil may be discovered and produced annually from an area that already has a well established history of discovery. The program is based on a combination of the methods used in programs LAMDA (Hinde, 1984a) and FORC2 (Hinde, 1985a). The program calculates a histogram of production for each year of the estimate (usually 20 years), a histogram of the total amount of crude oil discovered during the period of the estimate, and a histogram of the total amount of crude oil in fields that are discovered and brought into production during the period of the estimate. The histograms are stored in a disk file. The file may be read and printed by program LAMPO. This record describes how to prepare the data and run the two programs.

INTRODUCTION

There are two aspects to estimating future discovery and production of crude oil from undiscovered fields. First is the estimation of the amount of crude oil that will be discovered in the future. Second is the calculation of the rate at which this crude oil will be produced.

A number of uncertain factors must be estimated in order to forecast future levels of crude oil production from undiscovered fields (Forman, 1985). These include: the size and number of the undiscovered fields; the time of discovery of the undiscovered fields; future exploration levels; success rates; the lead time from discovery to production; and field production rate.

A number of computer programs have already been written at BMR to carry out parts of this task. Programs LAMDA (Hinde, 1984a) and VALAM and ARLAM (Hinde, 1984b), for instance, are creaming methods used to estimate the amount of crude oil that may be discovered by drilling a specified number of new-field wildcat wells in an area where a number of fields have already been discovered. Programs FORCT (Hinde, 1982) and FORC2 (Hinde, 1985a) are used to estimate future rates of oil production using subjective estimates of the sizes of the fields and the timing of their discovery.

Program LAMFO has been written incorporating program LAMDA, ammended to include an estimate of future exploration levels, and program FORC2 so that a probabilistic estimate of possible future crude oil production may be produced in one operation for an area with a history of discovery. Program LAMPO simply prints the output.

Program LAMFO is similar to program LAMDA, but it incorporates as input a subjective estimate of future new-field wildcat drilling levels. It carries out an assessment and outputs the results in the same way as LAMDA. No plot is produced. The estimate of future new-field wildcat drilling allows simulation of new-field discoveries to be carried out on an annual basis. The addition of FORC2 to the program allows the simulated field sizes to be converted to estimates of annual production. The results are summed and stored as histograms in a disk file. This file is read by program LAMPO, which prints out a summary of the estimate of future annual production, an estimate of the total amount of crude oil discovered within a period of n years after the first discovery (usually 10 years), and an estimate of the total amount of crude oil in fields that are discovered and brought into production within the n years period. This file may also be read by program FORAD (Hinde, 1985b), which is used to sum the histograms for a number of regions.

This record is designed to enable the reader to prepare the data for input to program LAMFO and to run both programs. The methods used are similar to those in programs LAMDA and FORC2 and are not described here.

FORMAT OF INPUT DATA

The following table details the input required for program LAMFO. It should be typed into a file called 'DATLF'. Most of the data file may be created automatically from the AUSTCO data base using program ASLAM (Hinde, 1984c). Only the data for line 4, the data for variable IFILEQ in line 10, and the data for lines 12 to 14 need to be added.

Line	Cols	Variable	Description	Format for entire line
1	1-80	ITITLE	Used to identify the computer run.	(40A2)
2	1-11	BASIN	Basin name.	(A11)
3	1-9	SUBAS	Sub-basin or infrabasin name.	(A9)
4	1-8	IPROD	Type of production profile ('ONSHORE' or 'OFFSHORE').	(4A2)
5	1-80	ITITL2	Date of compilation of the data.	(40A2)
6	1-80	ITITL2	Name of the person who compiled the data.	(40A2)
7	1-80	ITITL2	The characters 'OIL', 'GAS', or 'BOE'.	(40A2)
8	1-10	IUNIT	The units of volume (see Note 1).	(5A2)
9	1-80	ITITL2	Remarks (eg date last well reached total depth).	(40A2)
10	1-5	N	The new-field wildcat number of the last well in the list of data to be analysed.	(5I5,1X, 3F10.0, 7A2)
	6-10	NRUNS	Number of iterations to be carried out (suggested values: 2000 or 5000). If no assessment is required, leave blank.	
	11-15	NFIRST	The new-field wildcat number of the first well in the list of data at which analysis is to start.	
	16-20	MDRILL	The number of additional new-field wildcat wells for which the assessment is to be run. If no assessment is required, leave blank.	

	21-25	ISEED	A 5-digit number to seed the random number generators. If omitted, 12345 is used.	
	27-36	FLDMIN	An economic cut-off, specifying the minimum size of field that can be brought into production; if a field smaller than FLDMIN is generated, it is ignored. If not required, leave blank.	
	37-46	HMAX	The maximum value of the range of the histogram of undiscovered oil resources. If left blank, the program calculates a value.	
	47-56	SDMAX	A maximum undiscovered field size. SDMAX is input as the number of standard deviations that the log field size is allowed above its average (default is 2).	
	57-70	IFILEQ	Name of the new file into which the output histograms are to be written.	
11	1-10	XTH1	Minimum value of the triangular distribution of success rate.	(3F10.0)
	11-20	XTH2	Most likely value of the triangular distribution of success rate.	
	21-30	XTH3	Maximum value of the triangular distribution of success rate.	

If no assessment is required, line 11 may be left blank.

12-13	1-5 6-10 .. 46-50	IDRILR (I),I= 1,20	An estimate of the number of wells that will be drilled in each of the next 20 years.	(10I5)
14	1	TYPELT	Type of distribution of values for the lead time between the discovery of a field and the start of production (K-constant, E-truncated exponential, U-uniform, blank-frequency histogram, C-cumulative, T-triangular).	(A1,I5, (6F10.3))
	2-6	NLT	Number of x-value and probability	

		pairs specifying the distribution of lead time.	
	7-16	VALLT(1)	X-value of the first pair in the lead time distribution.
	17-26	FREQLT(1)	Corresponding probability or relative frequency of the first pair in the lead time distribution.
	27-36	VALLT(2)	X-value of the second pair.
	37-46	FREQLT(2)	Corresponding probability or relative frequency of the second pair.
	47-56	VALLT(3)	X-value of the third pair.
	57-66	FREQLT(3)	Corresponding probability or relative frequency of the third pair.

If more than 3 pairs are required to specify the distribution 1 to 4 continuation lines may be added. Up to 3 pairs can be entered per continuation line, 20 columns per pair, starting in column 1 (each number has F10.3 format).

15	1-5	IWELL(I)	New-field wildcat number of of the I'th new-field discovery well.	(I5,F10.5, I2,1X,10A2)
	6-15	FSIZE(I)	The field size of the I'th discovery.	
	16-17	IYEAR(I)	Year I'th new-field discovery reached total depth.	
	19-38	INAME(I, J),J=1, 10	Name of the I'th new-field discovery well.	

Line 15 is repeated until all new-field discovery wells have been entered.

Note 1: The units for volume, variable IUNIT, are usually $10^6 m^3$ for oil, 10^6BBL for barrels of oil equivalents (BOE), and $10^9 m^3$ for gas. LAMFO converts these to 10^6BBL (MMB), 10^6BBL (MMB), and $10^{12} ft^3$ (TCF) respectively for output.

RUNNING THE PROGRAMS

The programs reside in BMR's Hewlett-Packard computer. An input data file called 'DATLF' must be prepared before LAMFO can be run whereas LAMPO uses the file created by LAMFO.

If the programs have been saved they can be run with the commands:

```
RP,LAMFO          (restore program LAMFO)
RU,LAMFO,1        (run program LAMFO, output to LU 1)
RP,LAMPO          (restore program LAMPO)
RU,LAMPO,1        (run program LAMPO, output to LU 1)
```

LU 1 is the logical unit to which the output is sent (1 is input as 1 for the terminal and 16 for the printer).

Program LAMPO will ask for the name of the file produced by LAMFO. This is typed in at the terminal.

If the programs have not been saved, they may be compiled with the following commands:

```
FT,&LAMFO,,%LAMFO  (compile LAMFO, store relocatable in %LAMFO)
FT,&LAMPO,,-B      (compile LAMPO, store relocatable in scratch
                    file, -B)
```

loaded as follows:

```
RU,LOADR          (run the HP loader)
>EB               (extra large background)
>RE,%LAMFO        (relocate %LAMFO)
>END
LO,,-B            (load LAMPO)
```

and run with the RU commands above.

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