UNIVERSITY OF ILLINOIS
DIGITAL COMPUTER LABORATORY
STATISTICAL LIBRARY

LIBRARY ROUTINE KSL 4.50 - 272

TITLE: Limited Information Estimation, Single Equation (LISE)

DESCRIPTION: The routine estimates parameters in economic models by the limited information single equation method. Consider the equation:

$$y_1 = B_{12}y_2 + B_{13}y_3 + \cdots + C_{11}z_1 + C_{12}z_2 + \cdots + U_1$$

The routine estimates the B's and C's and also calculates their standard errors.

A parameter tape specifies which of the endogenous and exogenous variables are to be included in the equation under study. To find estimates for other structural equations on the same data, it is necessary only to use a different parameter tape.

METHOD OF USE:

	Stops
1. Master tape	343KS
2. Data tape I	24108
3a. Parameter tape	24108
3b. Parameter tape	24108
etc.	
4. Data tape II, move wh. sw. up and down	24108
5a. Parameter tape	24108
5b. Parameter tape	24108
etc.	

To read an additional parameter tape using the same data at stop 24108, raise the black switch.

To read a different data tape at stop 24108, move the white switch up and down.

PREPARATION OF DATA TAPES:

The data tape consists of a set of one or more covariance matrices (See also section on conversion for correlations). Each covariance matrix in the set must have the same number of elements. The elements are punched as signed

fractions, and the matrix is punched in triangular form (for example, the output from K-8). Each matrix is terminated by punching an N symbol. The final matrix in the set is terminated by an N and a J.

The order of the covariance matrices, n, must be less than or equal to 14. The largest number of matrices in any set, S, can be determined from the following inequality:

$$S\ (n^2 + n) < 18{,}600.$$

It is desirable for greater accuracy to scale each variable so that the elements of the matrix are as large as possible. If all elements in a matrix are scaled by the same constant, the results are unchanged.

PREPARATION OF PARAMETER TAPES:

Each parameter tape determines one structural equation and operates in turn on each of the covariance matrices in the set (1, 2, ..., S). The parameters for different equations in the same model may follow one another on the same tape.

Parameter tape	Meaning
$+ a_1 + a_2 + \ldots + a_f$ N	The a's represent the row numbers of the covariance matrices which are to be the endogenous variables in the equation.
$+ b_1 + b_2 + \ldots + b_g$ N	The b's represent the row numbers of the covariance matrices which are to be the exogenous variables in the system.
$+ c_1 + c_2 + \ldots + c_h$ N	The c's represent the row numbers of the covariance matrices which are to be the exogenous variables in the equation.
+ t N	t is the number of observations used.

The limits of f, g, h, and t, for this routine are as follows:

$$2 \leq f \leq 6 \qquad 1 + f + g < t$$
$$2 \leq g \leq 8 \qquad f + g \leq n$$
$$0 \leq h \leq 6$$

CONVERSIONS WHEN CORRELATIONS ARE USED:

The method used is sensitive to widely varying values of the elements of the covariance matrices. Sometimes submatrices generated by the routine are nearly singular. The standard errors in particular are either very large or cannot be calculated at all. For these cases, the substitution of correlations for covariances often will enable the routine to find results. If b_{12}, b_{13}, ..., c_{11}, c_{12}, ... are the estimates using correlations, the estimates for covariances are:

$$B_{12} = \frac{\sigma_{y_1}}{\sigma_{y_2}} b_{12}, \quad B_{13} = \frac{\sigma_{y_1}}{\sigma_{y_3}} b_{13}, \ \cdots,$$

$$C_{11} = \frac{\sigma_{y_1}}{\sigma_{z_1}} c_{11}, \quad C_{12} = \frac{\sigma_{y_1}}{\sigma_{z_2}} c_{12}, \ \cdots$$

The standard errors use the same transformations as the estimates.

MATHEMATICAL METHOD:

Let $M_{y^*y^*}$, M_{y^*z}, M_{zz}, $M_{y^*z^*}$, and $M_{z^*z^*}$ be covariance submatrices specified by the parameter tape where the y*'s are the endogenous variables, the z's are exogenous in the system, and the z*'s are exogenous in the equation. Let W and R be defined as follows:

$$W = M_{y^*y^*} - M_{y^*z} M_{zz}^{-1} M_{y^*z}'$$

$$R = M_{y^*z} M_{zz}^{-1} M_{y^*z}' - M_{y^*z^*} M_{z^*z^*}^{-1} M_{y^*z^*}'$$

The eigenvector, u, associated with the largest eigenvalue, λ, of the equation, $(W - \lambda R)\, u = 0$, provides estimates

for the B's as follows:

$$B_{12} = -\frac{u_2}{u_1} \; ; \quad B_{13} = -\frac{u_3}{u_1} \; ; \; \cdots$$

If the vector, v, is formed from the product,

$$(-M_{z*z*}^{-1} M_{y*z*}') \; u = v,$$

then estimates for the C's are found as follows:

$$C_{11} = -\frac{v_1}{u_1} \; ; \quad C_{12} = -\frac{v_2}{u_1} \; ; \; \cdots$$

To find the standard errors of the estimates, first calculate the value of the scaler,

$$K = \frac{1}{(t - f - h)\,(u_1)^2} \quad (1 + \frac{1}{\lambda})\; u'W\, u$$

where $(t - f - h)$ is the number of degrees of freedom. Next delete the first row and first column of $J = (W\, u)\,(W\, u)'$ to form $J_{1,1}$. Similarly delete the first row and column of R to form $R_{1,1}$ and the first column of $(M_{z*z*}^{-1} M_{y*z*})$ to form $(M_{z*z*}^{-1} M_{y*z*})_{o,1}$. (These are the rows and columns associated with the eigen-element, u_1). Then:

$$F_{(u)} = \left[R_{1,1} - \frac{1}{\lambda u'Wu} J_{1,1}\right]^{-1} \text{ and}$$

$$F_{(v)} = \left[(M_{z*z*}^{-1} M_{y*z*}')_{o,1} \; F_{(u)}' \; (M_{z*z*}^{-1} M_{y*z*}')_{o,1}' + M_{z*z*}^{-1}\right]$$

$K\, F_{(u)}$ and $K\, F_{(v)}$ are matrices of variances and covariances for the estimates of the B's and the C's. The square roots of the diagonal elements are the standard errors.

APPROXIMATE TIME ESTIMATES:

1. Read master tape: 90 seconds.
2. Read set of covariance matrices: 1 to 6 seconds per matrix depending upon the order of the matrix and the number of digits per element.
3. Calculate estimates and punch results: 8 to 20 seconds per matrix depending upon the size of f, g, and h.

INDICATIONS OF FAILURES: FF If the master tape stops on FF from location 3KK, a sum check failure has occurred. Clear machine and try to read the master tape again.

Symbols indicating failures may be punched in the results. The meaning of these is described below:

0/XXX The number of elements in a subsequent covariance matrix does not agree with the number in the first matrix of the set. The matrix number, XXX, is in sexadecimals. Matrix XXX will be omitted and replaced by the next matrix in the set. The machine will not stop, but will continue to read the remainder of the matrices in the set.

1/ A submatrix, M_{zz}, $M_{z^*z^*}$, R, or $F_{(u)}^{-1}$ is singular or nearly singular. The routine will not stop but will continue with the next problem.

2/ During matrix multiplication overflow on an element occurred. Any results already punched are correct. Scale down the covariance matrix and rerun. Routine will skip to the next problem.

3/ Failure in rescaling W, R, or $R^{-1}W$. Scale the covariance matrix down and try again. Routine will skip to the next problem.

4/ Failure in adjusting estimates or standard errors to proper scaling for printing. Try a correlation matrix instead of a covariance matrix. Routine will skip to next problem.

5/ Failure in forming $F_{(u)}^{-1}$. The value of λ is probably near zero. Routine will skip to the next problem.

6/ Trial vector of $(R^{-1}W - \lambda I)\, u = 0$ has not converged after 30 iterations. Routine will accept a trial vector and continue with the same problem.

7/ Failure in rescaling elements of $F_{(v)}$. Routine will skip to the next element of $F_{(v)}$.

DATE December 1, 1959
SUBMITTED BY Kenneth Dickman
APPROVED BY J. N. Snyder

ns

LOCATION			ORDER	NOTES
Abs.	Rel.	Sym		
			J	
			LIMITED INFORMATION ESTIMATION	
			0017K	
17			00F 0030F	Max. No. trials for eigenvalue routine
			0020K	
20			00900F 00900F	
21			00864F 00864F	
22			00716F 00716F	
23			00680F 00680F	
24			00800F 00800F	
25			00764F 00764F	
26			001008F 001008F	
27			00972F 00972F	
28			00F 00F	
29			00936F 00936F	
30			001F 001F	
31			0050F 0050F	
32			0060F 0060F	
33			0070F 0070F	
34			0031F 0031F	
35			0032F 0032F	
36			0033F 0033F	
37			50F 74F	
38			00F00 0100 0000 0000J	10^{-2}
39			00F00 1000 0000 0000J	10^{-1}
40			00F00 0000 0050 0000J	Tolerance on root
41			00724F 00724F	
42			00752F 00752F	
43			00758F 00758F	
44			20F 00F	2^{-2}
45			80F 00F	

LOCATION			ORDER	NOTES	
Abs.	Rel.	Sym			
			0088K		
88			00F 0096F		
89			00F 0098F		
90			00F 001F		
91			00F 003500F		Initial drum address for store of
92			40F 00F		set of covariances
93			00F 00F		
94			8511F 00F		
95			8611F 00F		
			00100K	from final	Put drum set I in memory
100	0	(MN1)	50200F 50L	interlude and	
			26(Y1) 002560F	5(ER1)	
			00125F 26200F		
	3		4118F 26200F		
			00K		Drum Set II to memory
104		(MN2)	50200F 50L	from .53(D2)	
			26(Y1) 002700F		
			00175F 26200F		
			00K	from 13,20(D7)	Drum Set III to memory
107		(MN3)	50200F 50L		
			26(Y1) 002900F		
			00125F 26200F		
			00K	from 24(D10)	Drum Set IV to memory
110		(MN4)	50200F 50L		
			26(Y1) 003080F		
			00175F 26200F		
			00K	from 24(D13)	Drum Set V to memory
113		(MN5)	50200F 50L		
			26(Y1) 003260F		
			0095F 26200F		
			00K	from 11(D17)	Drum Set VI to memory
116		(MN6)	50200F 50L		
			26(Y1) 003380F		

LOCATION			ORDER	NOTES
Abs.	Rel.	Sym		
			0058F 26200F	
			00K	from 224 in Number of elements in covariance
119		(ER0)	922F 92451F	Set I matrix in error
			F518F 0028F	
			8212F 92961F	
			92135F 26202F	
			00K	
123	0	(ER1)	9266F 92451F	from 99(M14) Matrix is singular.
			92135F 92515F	from 10(D16), 34(D18)
			F559F 4259F	
			L018F 324L	
			26(MN2) L56L	
			402(MN1) 26(MN1)	
	6		00125F 24(D2)	
			00K	
130		(ER2)	92130F 22(ER1)	from 8,17(M2) Overflow in matrix multiplication routine
			00K	
131		(ER3)	92194F 22(ER1)	from 8(+1) Failure in rescaling W, R, or $R^{-1}W$.
			00K	
132		(ER4)	92258F 22(ER1)	from 301 in Failure in adjusting values for printing
				Set IV, V, VI
			00K	
133		(ER5)	92322F 22(ER1)	from 212 in Failure in forming $F_{(u)}^{-1}$
				Set V
			00K	Subroutine to find smallest
134	0	(S1)	K5F 4211L	from 20(D5),6(D8) scaler in a set.
			413F L526F	11(D14)
			464L 424L	
			4611L 5069F	
			L1F L4F	
			368L L54L	
			0020F 4611L	
			464L 264L	
			F54L 424L	

LOCATION			ORDER	NOTES	
Abs.	Rel.	Sym			
			F53F 423F		
	10		L045F 364L		
	11		L5F 22F		
			00K		
146	0	(S2)	K5F 4215L	from 25,29(D5),13(D8)	Subroutine to rescale all rows
			413F L516L	13(D14)	of an inverted matrix consistently
			424L L517L		
			427L 428L		
			414F L5F		
			101F 66F		preset to location of set of scalers
			95F 405F		
			505F 75F		
			001F 40F		
			F57L 427L		
	10		428L F54F		
			424F L045F		
			367L F55L		
			425L F53F		
			423F L045F		
			364L 22F		
			00F 00F		location of smallest scaler
	17		00F 00F		location of matrix
			00K		
164	0	(M1)	K5F 427L	from 10,17,39,46(D6)	Matrix multiplication subroutine
			413F L515F	20(D8),8(D9)	Locations preset:
			4057F 502L		
			26(M2) L515F	8,12,16,23(D10)	
			4257F L511F		10, 11, 12, 13, 14, 15
			L457F 4657F	209,216(Set VI)	
			F53F 423F		
			L012F 32F		
	8		222L 00F		
			00K		
173	0	(M2)	K5F 4213L	from 3(M1)	Vector-matrix multiplication

LOCATION			ORDER	NOTES
Abs.	Rel.	Sym		
			411F 5069F	
			L557F 405L	
			412F 41F	
			2L5L S5F	
			00F 00F	
			4058F 3615L	
			L5F 3614L	
			L458F 36(ER2)	Overflow on element
			40F L55L	
	10		L410F 405L	
			F52F 422F	
			L013F 3618L	
			224L 22F	
			L458F 269L	
			L5F 3216L	
			2614L L458F	
			369L 26(ER2)	Overflow on element
			L5F 40F	Preset to store product
			F518L 4218L	
193	20		L557F L411F	
			4257F F51F	
			421F L014F	
	23		3213L 262L	
			00200K	Set I
200	0		50F L595F	from 3(MN1)
			L491F 4010L	
			50F 502L	
			26(N12) 40F	Read set of covariance matrices
			L521(N12) 4018L	and store on drum
			4019L 1020F	
			4293F 4217L	
			L516L 405L	
			L520F 429L	
			50F L5F	
	10		00F 00F	drum address

LOCATION			ORDER	NOTES
Abs.	Rel.	Sym		
			F510L 4010L	
			F59L 429L	
			L017L 329L	
			F518F 4218F	Problem counter at 18
			222L 00F	
			2620L 00F	
			J0F L5F	
			00F 00F	
			00F 00F	
220	20		L519L L018L	
			401F L3F	Test for J: Stop on 24108
			3623L 24(D2)	
			L31F 368L	
	24		26(ERO) 00F	Error in number of elements
225		(N12)	00K	Input routine (N12)
			00K	
264	0	(D2)	5251F 50L	Read parameters:
			26(N12) L521(N12)	$+a_1$ $+a_2$ + ... $+a_f$ N
			L035L 1020F	
			4050F 413F	f at 50
			5261F 504L	
			26(N12) L521(N12)	
			L036L 1020F	$+b_1$ $+b_2$ + ... $+b_g$ N
			4060F 413F	g at 60
			5271F 508L	
			26(N12) L521(N12)	
	10		L037L 1020F	$+c_1$ $+c_2$ + ... $+c_h$ N
			4070F L5L	h at 70
			1020F 4213L	
			4214L L5F	
			F069F 40F	
			F513L 4213L	
			4214L F53F	
			423F L050F	

LOCATION			ORDER	NOTES
Abs.	Rel.	Sym		
			3619L 2213L	
	19		L54L 1020F	
284	20		4221L 4222L	
			413F L5F	
			F069F 40F	
			F521L 4221L	
			4222L F53F	
			423F L060F	
			3627L 2221L	
			L58L 1020F	
			4229L 4230L	
			413F L5F	
	30		F069F 40F	
			F529L 4229L	
			4230L F53F	
			423F L070F	
			3638L 2229L	
			4051F L521(N12)	
			4061F L521(N12)	
			4071F L521(N12)	
			5219F 5038L	
	39		26(N12) 41F	+t N
304	40		50F F5F	
			6650F 40F	
			S5F 5042L	
			26(R1) 4077F	$\sqrt{1/f}$ at 77
			5069F L519F	
			L050F L070F	
			0020F 4019F	
			5069F 1918F	
			6619F S5F	
			4019F 5050F	$\left(\frac{1}{t - f - h}\right)$ at 19
	50		7550F S5F	
			4049F 4159F	f^2 at 49
			L594F L491F	

LOCATION			ORDER	NOTES
Abs.	Rel.	Sym		
317	53		4087F 26(MN2)	Initial drum address at 87
381		(R1)	00381K	Square root routine
390		(Y1)	00K	Drum transfer routine
			00K	
430	0	(A)	L51L 422L	Auxiliaries for (M14)
			418F 40115(M14)	
			L5F 40F	Preset: 2(A) - loc. X
			L52L L430F	
			402L F58F	5,12(A) - size X
			428F LOF	
			3221(M14) 262L	9(A) - loc. X^{-1}
	7		L51L 0020F	
			469L 418F	15(A) - store of scalers
			L5F 40F	
	10		L59L L430F	
			409L F58F	
			428F LOF	
			3614L 269L	
			L59L 4615L	
			L5F 40F	
			F515L 4215L	
	17		26106(M14) 00F	
448			00K(M14)	Inversion routine (M14)
			Insert (M14)	
			00900K	First interlude:
900	0		L5F 4013L	
			L520F 46202F	Store Set I on drum and
			L510L 4619(M14)	adapt (M14) for scaling
			0020F 4699(M14)	
			L592F 40111(M14)	by powers of 2.
			L511L 4021(M14)	
			L512L 40105(M14)	
			J0200F 507L	

LOCATION			ORDER		NOTES
Abs.	Rel.	Sym			
			26(Y1) 002560F		
			00125F 26999F		
	10		0044F 00(ER1)		
			26(A) L37F		
	12		367(A) 2280(M14)		
			26900N		
			00200K		
200			L587F 402(D3)	from 3(MN2)	Set II Set drum address for matrix S
			00K		
201	0	(D3)	L593F 4231L		Form submatrices
			L520F 423L		
			8511F 00F		
			10F 40F		C_{ij} at 900
			F52L 402L		
			F53L 423L		
			L031L 362L		
			L521F 4222(D4)		
			L534F 421(D4)		
			423(D4) L531F		
	10		4229(D4) 4626(D4)		
			5069F 5011L		
			26(D4) L522F		M_{y*y*} at 864
			4222(D4) L535F		
			421(D4) L532F		
			4229(D4) 5015L		
			26(D4) L524F		M_{zy*} at 716
			4222(D4) L535F		
			423(D4) L532F		
			4626(D4) 5019L		
221	20		26(D4) L370F		M_{zz} at 800; Test: $h \neq 0$
			36(D5) L525F		
			4222(D4) L536F		
			421(D4) 423(D4)		

LOCATION			ORDER	NOTES
Abs.	Rel.	Sym		
			L533F 4229(D4)	
			4626(D4) 5025L	
			26(D4) L523F	M_{z*z*} at 764
			4222(D4) L534F	
			423(D4) L531F	
			4626(D4) 5029L	
	30		26(D4) 26(D5)	M_{z*y*} at 680
	31		90F 40F	
			00K	
233	0	(D4)	K5F 4232L	Extraction subroutines:
			4110F F5F	
			424L 5069F	preset: 1(D4) add. of col. numbers
			4111F F5F	3(D4) add. of row numbers
			425L L5F	22(D4) store of M_{rc}
			408F L5F	
			409F L58F	26(D4) loc. of c
			L49F 405F	29(D4) loc. of r
			L15F 3231L	
			L59F 407F	
	10		L58F 406F	
			L09F 3614L	
			L59F 406F	
			L58F 407F	
			4112F 4113F	
			F512F L413F	
			4013F F512F	
			4212F L06F	
			3619L 2615L	
252	19		L513F L47F	
253	20		L420F 4221L	
			5069F L5F	
			5069F 40F	
			F522L 4222L	store of M_{rc}
			F55L 425L	

LOCATION			ORDER		NOTES
Abs.	Rel.	Sym			
			F511F 4211F		
			LOF 3227L		
			225L F54L		
			424L F510F		
			4210F LOF		
	30		3232L 263L		
			5069F L5F		
	32		2222L 22F		
			00K		
266	0	(D5)	L524F 462(A)	from 30(D3)	
			L532F 425(A)		
			4212(A) L520F		
			429(A) L526F		
			4215(A) 425(S2)		
			L560F 428L		
			0020F 467L		
			J0F L57L		
			26(M14) 00F		$M_{zz}^{-1} \times 2^{-s-2}$ at 900
			L370F 3618L		Test: $h \neq 0$
	10		L525F 462(A)		
			L533F 425(A)		
			4212(A) L527F		Scalers at 1008
			429(A) L570F		
			4217L 0020F		
			4616L 5069F		
			J0F L516L		
			26(M14) 00F		$M_{z^*z^*}^{-1} \times 2^{-s-2}$ at 972
			L560F L470F		
			4245F 5019L		
286	20		26(S1) 4096F		2^{-s} at 96.
			L588F 4216(S2)		
			L560F 4245F		
			L520F 4217(S2)		
			5069F 5024L		

LOCATION			ORDER	NOTES
Abs.	Rel.	Sym		
			26(S2) L370F	
			36(D6) L570F	
			4245F L527F	
			4217(S2) 5028L	
295	29		26(S2) 26(D6)	
			OOK	
296	0	(D6)	L524F 4218(M2)	from 29(D5)
			L537F 4015F	
			L520F 4615F	
			L522F 4215F	
			L530F 4010F	
			4011F L550F	
			4210F 4014F	
			L560F 4012F	
			4013F 0020F	
			4611F 509L	
	10		26(M1) L520F	
			4218(M2) L524F	$M_{zz}^{-1} M_{zy*} \times 2^{-s-2}$ at 800
			4215F L522F	
			4615F L550F	
			4012F 0020F	
			4610F L530F	
			4011F 5016L	
			26(M1) L596F	
			404F F569F	$M_{y*z} M_{zz}^{-1} M_{zy*} \times 2^{-s-2}$ at 900
			4046F L54F	
316	20		001F 404F	
			3622L 2223L	
			F546F 4246F	$s \times 2^{-39}$ at 46
			2219L 417F	
			L542F 4225L	
			L577F 40F	
			F525L 4225L	$\sqrt{1/f}$ at 752
			F57F 427F	

LOCATION			ORDER	NOTES
Abs.	Rel.	Sym		
			L050F 3229L	
			2625L L52(D3)	
	30		4087F L370F	drum order at 87
			36(D7) L525F	
			4218(M2) L527F	Test: $h \neq 0$
			4615F L523F	
			4215F L570F	
			4012F 4013F	
			0020F 4611F	
			L530F 4610F	
			5069F 5038L	
	39		26(M1) L529F	$M_{z*z*}^{-1}M_{z*y*} \times 2^{-s-2}$ at 764
336	40		4218(M2) L525F	
			4215F L523F	
			4615F L530F	
			4011F L550F	
			4012F 0020F	
			4610F 5045L	
342	46		26(M1) 26(D7)	$M_{y*z*}M_{z*z*}^{-1}M_{z*y*} \times 2^{-s-2}$ at 936
			00K	
343	0	(D7)	L549F 4245F	from 31,46(D6)
			L521F 426L	
			428L L546F	
			427L L520F	
			468L 4615L	
			4616L 413F	
			414F L5F	
			102F 10F	
			L0F 40F	$W \times 2^{-s-2}$ at 864
			L58L L430F	
	10		408L 426L	
			F53F 423F	
			L045F 326L	
			L370F 36(MN3)	

LOCATION			ORDER		NOTES
Abs.	Rel.	Sym			
			L529F 4215L		
			L5F LOF		
			40F L515L		R x 2^{-s-2} at 900
			L430F 4015L		
			4616L F54F		
			424F L045F		
363	20		3615L 26(MN3)		
914			00914K		Second interlude:
	0		L5F 407L		
			L590F 0020F		Store Set II on drum and
			463(D3) 4631(D3)		set scaling value in (D3)
			L520F 4231(D4)		
			J0200F 504L		
			26(Y1) 002700F		
	6		00175F 26999F		
			26914N		
			00200K		Set III
200	0		L521F 405F	from 3(MN3)	
			F569F F446F		
			406F 502L		
			26(K1) L520F		W x 2^{0} at 864
			405F 504L		
			26(K1) L520F		R x 2^{0} at 900
			462(A) L531F		
			425(A) 4212(A)		
			L524F 429(A)		
			L526F 4215(A)		
	10		L550F 4213L		
			0020F 4612L		
			J0F L512L		
213	13		26(M14) 00F		R^{-1} x 2^{-r-2} at 800 Scalers at 1008
			00K		
214	0	(D8)	L530F 4010F	from 213	

LOCATION			ORDER	NOTES
Abs.	Rel.	Sym		
			4011F L550F	
			4210F 4012F	
			4013F 4014F	
			4245F 0020F	
			4611F 505L	
			26(S1) 4097F	2^{-r} at 97
			F588F 4216(S2)	
			L524F 4217(S2)	
			4615F L522F	
	10		4218(M2) L521F	
			4215F L526F	
			425(S2) 5012L	
			26(S2) L597F	
			404F F569F	
			4047F L54F	
			001F 404F	
			3618L 2219L	
			F547F 4247F	$r \times 2^{-39}$ at 47
			2215L 5019L	
234	20		26(M1) F569F	$R^{-1} W \times 2^{-r-2}$ at 716
			F469F 406F	
			L522F 405F	
			4116F L549F	
			4245F 5024L	
	25		26(K1) 4116F	$R^{-1} W \times 2^{-r}$ at 716
			00K	
240	0	(D9)	L542F 4215F	from 25(D8)
			L522F 4615F	
			L530F 4010F	
			4214F 416F	
			L56F 408F	
			L543F 4218(M2)	
			4211L 4611L	
			4622L 507L	

LOCATION			ORDER	NOTES
Abs.	Rel.	Sym		
			26(M1) 4178F	R^{-1} Wu x 2^{-r} = q x 2^{-r} at 758
			417F 5069F	
	10		2L11L S5F	
			50F 74F	
			L478F 4078F	Σq^2 x 2^{-2r} at 78
			L511L L430F	
			4011L F57F	
			427F L050F	
			3617L 2210L	
			S5F 40F	
			L578F 5018L	
259	19		26(R1) 4086F	λ x 2^{-r} at 86
260	20		406F 417F	
			L542F 4223L	
			L5F 6686F	
			S5F 40F	u normalized at 752
			L522L L430F	
			4622L F523L	
			4223L F57F	
			427F L050F	
			3629L 2622L	
			L56F L08F	
	30		405F L540F	Test tolerance on $\lvert\lambda_i - \lambda_{i-1}\rvert$
			L25F 36(D10)	
			F516F 4216F	
			L017F 3234L	count trials
			264L 92386F	
	35		92451F 92965F	6/ - trials exceeded
			00K	
276	0	(D10)	L542F 461L	from 31(D9)
			L1F 4079F	$-u_1$ at 79
			L525F 4615F	
			L543F 4218(M2)	
			F569F 4214F	

LOCATION			ORDER		NOTES
Abs.	Rel.	Sym			
			L570F 4012F		
			L370F 328L		Test: $h \neq 0$
			5069F 507L		
			26(M1) L541F		
			4218(M2) L521F		$\sqrt{w} \times 2^{-s-2}$ at 758
	10		4615F L550F		
			4012F 5011L		
			26(M1) F51L		Wu x 2° at 724
			4218(M2) F569F		
			4012F L541F		
			4615F 5015L		
			26(M1) L530F		$u' W_{\mu} \times 2^{\circ}$ at 80
			4011F 4213F		
			L441F 4215F		
			4615F L524F		
296	20		4218(M2) L550F		
			F069F 4012F		
			4014F 5022L		
			26(M1) 92770F		$J_{11} \times 2^{\circ}$ at 800
	24		922F 26(MN4)		
			00K		
301	0	(K1)	K5F 4220L	from 203,205,25(D8)	
			L55F 425L		
			4215L 4216L		Rescaling subroutine
			L56F 0020F		
			4616L 413F		Preset: loc. M at 5
			414F L7F		
			40F L5F		scaling value at 6
			001F 328L		
			26(ER3) 40F		
310	9		F54F 424F		(ER3) indicates overflow
311	10		L06F 3211L		
			226L F55L		
			425L F53F		

LOCATION			ORDER	NOTES
Abs.	Rel.	Sym		
			423F L045F	
			365L 413F	
			5069F L5F	
			00F 40F	
			F515L 4215L	
			4216L F53F	
			423F L045F	
321	20		3615L 22F	
			00922K	
922	0		L5F 404L	Third interlude
			J0200F 501L	
			26(Y1) 002900F	
			00125F 26999F	
	4		26922N	
			00200K	Set IV
200	0		92643F F559F	from 3(MN4)
			J23F 501L	
			26(P16) 92259F	
			92965F 92258F	Print problem number
			92582F 92322F	
			92707F 92835F	
			92961F 5086F	
			7539F 40(N)	
			F569F 40(X)	
			L597F 40(D)	
	10		L539F 40(10)	
			5069F 5011L	Change $\lambda \times 2^{-r}$ to $\lambda \times 10^{-x}$
			26300F L5(F)	
			4615L L5(N)	
			66(D) S5F	
			J4F 5015L	
			26(P16) 92135F	Print root
			92515F 92259F	

LOCATION			ORDER	NOTES
Abs.	Rel.	Sym		
			92194F 92706F	
			92322F 92514F	
220	20		92643F 5069F	
			92387F 92322F	
			92194F 92706F	
			92131F 92515F	
			92194F 92770F	
			9267F 92707F	
226	26		92643F 92965F	
			OOK	from 226
227	0	(D11)	L579F 40(D)	
			L542F 422L	
			413F 50F	
			7539F 40(N)	
			F569F 40(X)	
			5069F 505L	
			26300F L5(F)	
			469L L5(N)	
			66(D) S5F	
			54F 509L	
	10		26(P16) 92965F	Print: $B_{1_i} = -\frac{u_i}{u_1} \times 10^{-x_i}$
			F52L 422L	
			F53F 423F	
			L050F 3214L	
			222L L370F	Test: $h \neq 0$
			3617(D12) 92131F	
			92515F 92259F	
			92194F 92451F	
			92578F 92707F	
	19		92643F 92965F	
			OOK	
247	0	(D12)	L546F 422L	from 19(D11)
			L543F 424L	
			L579F 10F	

LOCATION			ORDER	NOTES
Abs.	Rel.	Sym		
			40(D) 5069F	
			413F 50F	
			7539F 002F	
			40(N) F569F	
			40(X) 507L	
			26300F L5(F)	
			4611L L5(N)	
	10		66(D) S1F	
			54F 5011L	
			26(P16) 92965F	Print: $C_{l_i} = -\frac{v_i}{u_l} \times 10^{-x_i}$
			F54L 424L	
			F53F 423F	
			L070F 3216L	
			224L 5069F	
	17		92135F 92515F	
			00K	
265	0	(D13)	92259F 92706F	from 17(D12)
			92322F 92707F	
			92643F 92961F	
			92259F 92194F	
			92262F 92578F	
			92258F 92706F	
			92131F 92515F	
			92194F 92770F	
			9267F 92707F	
			92643F 92993F	
275	10		92965F L520F	
276	11		4216L F450F	
			0020F 4616L	
			L550F F069F	
			4245F 413F	
			5069F 414F	
			L5F 40F	$R_{11} \times 2^{\circ}$ at 900
			L516L L430F	

LOCATION			ORDER	NOTES	
Abs.	Rel.	Sym			
			4016L F54F		
			424F L045F		
285	20		3616L L516L		
			L430F 4616L		
			F53F 423F		
			L045F 3615L		
289	24		26(MN5) 00F		
			00300K		
300	0		K5F 4210L	from 212(SetIV),6(D11)	
			L3(D) 36(ER4)	8(D12),11,16(D15)	
			L7(N) L2(D)	22(D18)	
			364L 267L		
			F5(X) 42(X)		
			50(N) 75(10)		
			40(N) 262L		
			50(100) 75(X)		
			L5(4) L4(X)		
			S4F 0020F		
	10		46(F) 22F		
		(N)	00F 00F		numerator
		(D)	00F 00F		denominator
		(4)	00F 004F		
		(100)	00F 00100F		
		(X)	00F 00F		
		(F)	00F 00F		print address
		(10)	00F 00F		
		(P16)	00K		
			00927K		Fourth interlude
927	0		L5F 404L		
			J0200F 501L		
			26(Y1) 003080F		
			00175F 26999F		
	4		26927N		

LOCATION			ORDER	NOTES
Abs.	Rel.	Sym		
			00200K	Set V
200	0		F547F F469F	from 3(MN5)
			0020F 4610L	
			L520F 4214L	
			L524F 429L	
			L529F 462(A)	
			4216L 5086F	
	6		7580F 4081F	λ u' Wu x 2^{-r} at 81
207	7		5045F 7545F	
			S5F 4245F	
			413F L5F	
	10		10F 401F	$R_{11} - \frac{J_{11}}{\lambda u' Wu}$
			L71F L281F	
			36(ER5) L51F	
			6681F S5F	
			401F L5F	
			102F L01F	
			5069F 40F	$F_{(u)}^{-1}$ x 2^{-2} at 936
			F59L 429L	
			F514L 4214L	
			F516L 4216L	
220	20		F53F 423F	
			L045F 329L	
			00K	
222	0	(D14)	L526F 4215(A)	from 221
			425(S2) L514F	
			4245F 428L	
			0020F 467L	
			L51L 425(A)	
			4212(A) L520F	
			429(A) 4217(S2)	
			J0F L57L	
			26(M14) 00F	$F_{(u)}$ x 2^{-f} at 900
			L589F 4216(S2)	

LOCATION			ORDER	NOTES
Abs.	Rel.	Sym		
	10		5069F 5010L	
			26(S1) 4098F	
			5069F 5012L	2^{-f} at 98
			26(S2) L598F	
			404F F569F	
			4048F L54F	
			001F 404F	$f \times 2^{-39}$ at 48
			3618L 26(D15)	
	18		F548F 2615L	
			00K	
241	0	(D15)	5079F 7579F	from 17(D14)
			1039F 7586F	Form
			40(D) L538F	
			40(10) F569F	
			40(X) L597F	$K = \frac{1}{(t - f - h)(u_1)^2} \quad \frac{(\lambda+1)}{\lambda} u'Wu$
			102F 401F	
			L586F 102F	
			L41F 1039F	
			7580F 1039F	
			7519F 1039F	
	10		7538F 002F	
			40(N) 5011L	
			26300F L5(N)	
			66(D) S5F	
			40(N) L598F	
			40(D) 5015L	
	16		26300F L5(N)	
258	17		66(D) S5F	
			4082F L5(X)	$K \times 10^{-2x_1} \times 2^f$ at 82
			4083F L5(F)	X_1 at 83
	20		464(D16) 413F	
			00K	
262	0	(D16)	L520F 421L	from 20(D15)
			41F 50F	

LOCATION			ORDER	NOTES
Abs.	Rel.	Sym		
			7582F 502L	
			26(R1) 5069F	
			54F 504L	
			26(P16) 92965F	Print standard errors of B's
			L51L L450F	
			421L F53F	
			423F L045F	
			361L L370F	
	10		361(ER1) 92131F	
			92515F 92259F	Test: $h \neq 0$
			92194F 92451F	
			92578F 92707F	
	14		92643F 92965F	
			00K	
277	0	(D17)	L525F 423L	from 14(D16)
			L430F 463L	
			417F 418F	
			L5F 40F	$(M_{z*z*}^{-1}M_{z*y*})_{01} \times 2^{-s-2}$ at 764
			L53L L430F	
			403L F58F	
			428F L014F	
			368L 263L	
			L53L L430F	
			463L F57F	
	10		427F L070F	
288	11		36(MN6) 222L	
			00932K	Fifth interlude
932	0		L5F 404L	
			J0200F 501L	
			26(Y1) 003260F	
			0095F 26999F	
	4		26932N	
			00200K	Set VI

LOCATION			ORDER	NOTES
Abs.	Rel.	Sym		
200	0		L521F 4218(M2)	from 3(MN6)
			L525F 4215F	
			L520F 4215F	
			L530F 4010F	
			L550F F069F	
			4011F 4012F	
			4013F 0020F	
			4611F L570F	
	8		4014F 508L	
209	9		26(M1) L520F	
	10		4218(M2) L525F	$F'(u)\left[M_{z*z*}^{-1}M_{z*y*}\right]'_{01} \times 2^{-f-s-2}$
			4615F L521F	
			4215F L570F	at 864
			4012F 4210F	
			L530F 4211F	
			5069F 5015L	
	16		26(M1) 413F	$\left[M_{z*z*}^{-1}M_{z*y*}\right]_{01} F'\left[M_{z*z*}M_{z*y*}\right]'_{01}$
			00K	
217	0	(D18)	L520F 428L	from 216 $\times 2^{-f} \times 2^{-2s-4}$ at 900
			4215L L527F	
			4217L F546F	
			F469F 406F	
			0020F 4616L	
			L596F 102F	
			40(D) L548F	
			0020F 4618L	
			413F L7F	
			40F 414F	
	10		L5F 001F	
			3612L 2635L	
			40F F54F	
			424F L06F	
			3615L 2610L	
			5069F L5F	

LOCATION			ORDER	NOTES
Abs.	Rel.	Sym		
			00F 401F	
			5069F L5F	
			10F L41F	$\left[(M_{z*z*}^{-1}M_{z*y*})_{01}\ F'(M_{z*z*}^{-1}M_{z*y*})'_{01}+M_{z*z*}^{-1}\right]$
			1039F 7582F	
237	20		40(N) L583F	
			40(X) 5021L	
			26300F L5(F)	
			4627L L5(N)	
			66(D) 40F	
			S5F 5025L	
			26(R1) 5069F	
			54F 5027L	Print standard errors for C's
			26(P16) 92965F	
			L58L F470F	
	30		428L 4215L	
			L517L F470F	
			4217L F53F	
			423F L070F	
			361(ER1) 228L	
			92450F 92451F	7/ failure on rescaling
253	36		92981F 2629L	
			00937K	Final interlude:
937	0		L3F 342L	Sum check: Stop on 343KS
			FFF 262L	
			J0200F 502L	
			26(Y1) 003380F	
			0058F 26100F	
	5		N50885F N41915F	
			26937N	