APPENDIX I:

GROUPED DATA FROM THE ILLE-ET-VILAINE STUDY OF OESOPHAGEAL CANCER USED FOR ILLUSTRATION IN CHAPTERS 4 AND 6

AGE (YRS)	ALCOHOL (GM/DAY)	TOBACCO (GM/DAY)	CASES	CONTROLS
25-34	0-39	0-9	0	40
"	"	10-19	0	10
"	"	20-29	0	6
"	"	30+	0	5
"	40-79	0-9	0	27
"	"	10-19	0	7
"	"	20-29	0	4
"	"	30+	0	7
"	80-119	0-9	0	2
"	"	10-19	0	1
"	"	20-29	0	0
"	"	30+	0	2
"	120+	0-9	0	1
"	"	10-19	1	0
"	"	20-29	0	1
"	"	30+	0	2
35-44	0-39	0-9	0	60
"	"	10-19	1	13
"	"	20-29	0	7
"	"	30+	0	8
"	40-79	0-9	0	35
"	"	10-19	3	20
"	"	20-29	1	13
"	"	30+	0	8
"	80-119	0-9	0	11
"	"	10-19	0	6
"	"	20-29	0	2
"	"	30+	0	1
"	120+	0-9	2	1
"	"	10-19	0	3
"	"	20-29	2	2
"	"	30+	0	0

AGE (YRS)	ALCOHOL (GM/DAY)	TOBACCO (GM/DAY)	CASES	CONTROLS
45-54	0-39	0-9	1	45
"	"	10-19	0	18
"	"	20-29	0	10
"	"	30+	0	4
"	40-79	0-9	6	32
"	"	10-19	4	17
"	"	20-29	5	10
"	"	30+	5	2
"	80-119	0-9	3	13
"	"	10-19	6	8
"	"	20-29	1	4
"	"	30+	2	2
"	120+	0-9	4	0
"	"	10-19	3	1
"	"	20-29	2	1
"	"	30+	4	0
55-64	0-39	0-9	2	47
"	"	10-19	3	19
"	"	20-29	3	9
"	"	30+	4	2
"	40-79	0-9	9	31
"	"	10-19	6	15
"	"	20-29	4	13
"	"	30+	3	3
"	80-119	0-9	9	9
"	"	10-19	8	7
"	"	20-29	3	3
"	"	30+	4	0
"	120+	0-9	5	5
"	"	10-19	6	1
"	"	20-29	2	1
"	"	30+	5	1

AGE (YRS)	ALCOHOL (GM/DAY)	TOBACCO (GM/DAY)	CASES	CONTROLS
65-74	0-39	0-9	5	43
"	"	10-19	4	10
"	"	20-29	2	5
"	"	30+	0	2
"	40-79	0-9	17	17
"	"	10-19	3	7
"	"	20-29	5	4
"	"	30+	0	0
"	80-119	0-9	6	7
"	"	10-19	4	8
"	"	20-29	2	1
"	"	30+	1	0
"	120+	0-9	3	1
"	"	10-19	1	1
"	"	20-29	1	0
"	"	30+	1	0
75+	0-39	0-9	1	17
"	"	10-19	2	4
"	"	20-29	0	0
"	"	30+	1	2
"	40-79	0-9	2	3
"	"	10-19	1	2
"	"	20-29	0	3
"	"	30+	1	0
"	80-119	0-9	1	0
"	"	10-19	1	0
"	"	20-29	0	0
"	"	30+	0	0
"	120+	0-9	2	0
"	"	10-19	1	0
"	"	20-29	0	0
"	"	30+	0	0

APPENDIX II:

GROUPED DATA FROM THE OXFORD CHILDHOOD CANCER SURVEY USED FOR ILLUSTRATION IN CHAPTERS 6 AND 7

YEAR OF DEATH	AGE AT DEATH	X-RAYED	CASES	CONTROLS
1944	9	YES	3	0
1944	9	NO	25	28
1945	9	YES	5	2
1945	9	NO	16	19
1945	8	YES	2	2
1945	8	NO	30	30
1946	9	YES	7	1
1946	9	NO	28	34
1946	8	YES	7	2
1946	8	NO	28	33
1946	7	YES	2	0
1946	7	NO	36	38
1947	9	YES	5	1
1947	9	NO	25	29
1947	8	YES	3	1
1947	8	NO	40	42
1947	7	YES	5	1
1947	7	NO	44	48
1947	6	YES	11	2
1947	6	NO	42	51
1948	9	YES	6	4
1948	9	NO	25	27
1948	8	YES	6	4
1948	8	NO	29	31
1948	7	YES	11	2
1948	7	NO	35	44
1948	6	YES	4	1
1948	6	NO	49	52
1948	5	YES	4	7
1948	5	NO	57	54
1949	9	YES	2	4
1949	9	NO	38	36
1949	8	YES	8	3
1949	8	NO	21	26
1949	7	YES	8	5
1949	7	NO	36	39
1949	6	YES	6	3
1949	6	NO	46	49
1949	5	YES	5	2
1949	5	NO	50	53
1949	4	YES	15	4
1949	4	NO	46	57

YEAR OF DEATH	AGE AT DEATH	X-RAYED	CASES	CONTROLS
1950	9	YES	4	1
1950	9	NO	27	30
1950	8	YES	9	4
1950	8	NO	39	44
1950	7	YES	9	5
1950	7	NO	35	39
1950	6	YES	4	2
1950	6	NO	38	40
1950	5	YES	12	7
1950	5	NO	41	46
1950	4	YES	8	5
1950	4	NO	48	51
1950	3	YES	8	8
1950	3	NO	63	63
1951	9	YES	6	2
1951	9	NO	37	41
1951	8	YES	8	3
1951	8	NO	35	40
1951	7	YES	12	5
1951	7	NO	31	38
1951	6	YES	4	4
1951	6	NO	36	36
1951	5	YES	7	1
1951	5	NO	37	43
1951	4	YES	16	6
1951	4	NO	54	64
1951	3	YES	12	5
1951	3	NO	63	70
1951	2	YES	9	11
1951	2	NO	62	60
1952	9	YES	4	5
1952	9	NO	33	32
1952	8	YES	7	2
1952	8	NO	24	29
1952	7	YES	8	5
1952	7	NO	34	37
1952	6	YES	11	8
1952	6	NO	35	38
1952	5	YES	5	5
1952	5	NO	42	42
1952	4	YES	12	6
1952	4	NO	43	49
1952	3	YES	8	6
1952	3	NO	55	57
1952	2	YES	17	10
1952	2	NO	74	81
1952	1	YES	9	7
1952	1	NO	34	36

YEAR OF DEATH	AGE AT DEATH	X-RAYED	CASES	CONTROLS
1953	9	YES	3	5
1953	9	NO	36	34
1953	8	YES	2	5
1953	8	NO	33	30
1953	7	YES	7	2
1953	7	NO	25	30
1953	6	YES	6	8
1953	6	NO	47	45
1953	5	YES	5	1
1953	5	NO	44	48
1953	4	YES	11	13
1953	4	NO	64	62
1953	3	YES	14	9
1953	3	NO	50	55
1953	2	YES	13	11
1953	2	NO	56	58
1953	1	YES	8	9
1953	1	NO	56	55
1953	0	YES	6	4
1953	0	NO	43	45
1954	9	YES	4	4
1954	9	NO	25	25
1954	8	YES	8	8
1954	8	NO	32	32
1954	7	YES	4	6
1954	7	NO	23	21
1954	6	YES	8	8
1954	6	NO	40	40
1954	5	YES	7	6
1954	5	NO	36	37
1954	4	YES	15	8
1954	4	NO	46	53
1954	3	YES	15	14
1954	3	NO	62	63
1954	2	YES	9	6
1954	2	NO	46	49
1954	1	YES	9	5
1954	1	NO	51	55
1954	0	YES	5	5
1954	0	NO	41	41
1955	9	YES	6	2
1955	9	NO	22	26
1955	8	YES	3	4
1955	8	NO	30	29
1955	7	YES	9	2
1955	7	NO	23	30

YEAR OF DEATH	AGE AT DEATH	X-RAYED	CASES	CONTROLS
1955	6	YES	12	9
1955	6	NO	34	37
1955	5	YES	14	5
1955	5	NO	43	52
1955	4	YES	16	6
1955	4	NO	40	50
1955	3	YES	17	7
1955	3	NO	61	71
1955	2	YES	8	5
1955	2	NO	50	53
1955	1	YES	8	10
1955	1	NO	44	42
1955	0	YES	9	3
1955	0	NO	22	28
1956	8	YES	5	2
1956	8	NO	23	26
1956	7	YES	9	1
1956	7	NO	37	45
1956	6	YES	11	7
1956	6	NO	31	35
1956	5	YES	6	9
1956	5	NO	39	36
1956	4	YES	14	13
1956	4	NO	49	50
1956	3	YES	21	9
1956	3	NO	50	62
1956	2	YES	16	11
1956	2	NO	53	58
1956	1	YES	6	4
1956	1	NO	37	39
1956	0	YES	9	8
1956	0	NO	41	42
1957	7	YES	8	2
1957	7	NO	23	29
1957	6	YES	9	3
1957	6	NO	25	31
1957	5	YES	8	7
1957	5	NO	46	47
1957	4	YES	4	4
1957	4	NO	42	42
1957	3	YES	11	7
1957	3	NO	47	51
1957	2	YES	11	5
1957	2	NO	51	57
1957	1	YES	6	6
1957	1	NO	46	46
1957	0	YES	9	6
1957	0	NO	32	35

YEAR OF DEATH	AGE AT DEATH	X-RAYED	CASES	CONTROLS
1958	6	YES	4	5
1958	6	NO	30	29
1958	5	YES	4	6
1958	5	NO	48	46
1958	4	YES	9	9
1958	4	NO	54	54
1958	3	YES	9	7
1958	3	NO	50	52
1958	2	YES	10	7
1958	2	NO	78	81
1958	1	YES	14	7
1958	1	NO	48	55
1958	0	YES	6	4
1958	0	NO	41	43
1959	5	YES	3	2
1959	5	NO	50	51
1959	4	YES	4	3
1959	4	NO	53	54
1959	3	YES	6	4
1959	3	NO	68	70
1959	2	YES	10	10
1959	2	NO	58	58
1959	1	YES	4	3
1959	1	NO	57	58
1959	0	YES	3	4
1959	0	NO	42	41
1960	4	YES	3	2
1960	4	NO	42	43
1960	3	YES	10	10
1960	3	NO	52	52
1960	2	YES	4	5
1960	2	NO	69	68
1960	1	YES	10	4
1960	1	NO	43	49
1960	0	YES	5	5
1960	0	NO	34	34
1961	3	YES	4	4
1961	3	NO	41	41
1961	2	YES	3	6
1961	2	NO	48	45
1961	1	YES	13	5
1961	1	NO	42	50
1961	0	YES	1	3
1961	0	NO	40	38

YEAR OF DEATH	AGE AT DEATH	X-RAYED	CASES	CONTROLS
1962	2	YES	7	2
1962	2	NO	46	51
1962	1	YES	5	2
1962	1	NO	46	49
1962	0	YES	7	4
1962	0	NO	35	38
1963	1	YES	6	6
1963	1	NO	40	40
1963	0	YES	3	4
1963	0	NO	51	50
1964	0	YES	7	1
1964	0	NO	25	31

APPENDIX III:

MATCHED DATA FROM THE LOS ANGELES STUDY OF ENDOMETRIAL CANCER USED FOR ILLUSTRATION IN CHAPTERS 5 AND 7

CASE OR CONTROL	AGE	GALL BLADDER DISEASE	HYPER TENSION	OBESITY	ESTROGEN (ANY) USE	CONJUGATED DOSE (SEE CODE)	ESTROGEN DURATION (MONTHS)	NON ESTROGEN DRUG
CASE	74	NO	NO	YES	YES	3	96+	YES
CONTROL	75	NO	NO	UNK	NO	0	0	NO
CONTROL	74	NO	NO	UNK	NO	0	0	NO
CONTROL	74	NO	NO	UNK	NO	0	0	NO
CONTROL	75	NO	NO	YES	YES	1	48	YES
CASE	67	NO	NO	NO	YES	3	96+	YES
CONTROL	67	NO	NO	NO	YES	3	5	NO
CONTROL	67	NO	YES	YES	NO	0	0	YES
CONTROL	67	NO	NO	NO	YES	2	53	NO
CONTROL	68	NO	NO	NO	YES	2	45	YES
CASE	76	NO	YES	YES	YES	1	9	YES
CONTROL	76	NO	YES	YES	YES	2	96+	YES
CONTROL	76	NO	YES	NO	YES	1	3	YES
CONTROL	76	NO	YES	YES	YES	2	15	YES
CONTROL	77	NO	NO	NO	YES	1	36	YES
CASE	71	NO	NO	UNK	YES	UNK	96+	NO
CONTROL	70	YES	NO	NO	YES	2	7	YES
CONTROL	70	NO	NO	NO	YES	0	0	YES
CONTROL	71	NO	YES	YES	YES	2	7	YES
CONTROL	70	NO	NO	YES	YES	2	27	YES
CASE	69	YES	NO	YES	YES	2	36	YES
CONTROL	69	NO	YES	NO	YES	1	96+	YES
CONTROL	69	NO	NO	YES	YES	2	1	YES
CONTROL	69	NO	NO	NO	YES	0	0	YES
CONTROL	68	NO	NO	UNK	NO	0	0	NO
CASE	70	NO	YES	YES	YES	2	71	YES
CONTROL	71	NO	NO	NO	NO	0	0	NO
CONTROL	71	NO	YES	YES	YES	3	5	YES
CONTROL	70	NO	NO	YES	NO	0	0	NO
CONTROL	71	NO	NO	UNK	NO	0	0	NO
CASE	65	YES	NO	NO	YES	1	96+	YES
CONTROL	65	NO	NO	UNK	NO	0	0	NO
CONTROL	64	NO	NO	NO	YES	3	91	YES
CONTROL	64	NO	NO	NO	YES	2	96+	YES
CONTROL	65	NO	NO	YES	YES	2	60	NO
CASE	68	YES	YES	YES	YES	1	36	YES
CONTROL	68	NO	YES	UNK	NO	0	0	YES
CONTROL	68	NO	NO	YES	NO	0	0	YES
CONTROL	68	YES	NO	UNK	YES	0	0	NO

CASE OR CONTROL	AGE	GALL BLADDER DISEASE	HYPER TENSION	OBESITY	ESTROGEN (ANY) USE	CONJUGATED DOSE (SEE CODE)	ESTROGEN DURATION (MONTHS)	NON ESTROGEN DRUG
CONTROL	68	NO	NO	UNK	YES	1	1	YES
CASE	61	NO	NO	UNK	NO	0	0	YES
CONTROL	61	NO	NO	YES	NO	0	0	YES
CONTROL	61	NO	NO	NO	YES	1	24	YES
CONTROL	61	NO	NO	UNK	NO	0	0	YES
CONTROL	60	YES	NO	NO	NO	0	0	NO
CASE	64	NO	NO	YES	YES	1	54	YES
CONTROL	64	NO	NO	UNK	NO	0	0	NO
CONTROL	65	NO	YES	UNK	YES	3	2	YES
CONTROL	64	NO	YES	YES	YES	3	10	YES
CONTROL	65	NO	NO	UNK	NO	0	0	NO
CASE	68	YES	NO	YES	YES	3	96+	YES
CONTROL	69	NO	NO	UNK	NO	0	0	NO
CONTROL	69	NO	NO	YES	NO	0	0	YES
CONTROL	69	YES	YES	YES	YES	0	0	YES
CONTROL	69	YES	NO	YES	YES	1	35	NO
CASE	74	NO	NO	NO	YES	2	96+	YES
CONTROL	74	NO	YES	NO	YES	3	4	YES
CONTROL	73	NO	YES	NO	YES	2	11	YES
CONTROL	74	NO	NO	YES	YES	1	6	YES
CONTROL	74	NO	NO	YES	YES	1	12	NO
CASE	67	YES	NO	YES	YES	0	0	YES
CONTROL	68	NO	YES	NO	YES	0	0	YES
CONTROL	68	NO	YES	YES	YES	3	65	YES
CONTROL	68	NO	NO	UNK	NO	0	0	NO
CONTROL	68	NO	NO	YES	YES	2	96+	YES
CASE	62	YES	NO	NO	YES	1	UNK	YES
CONTROL	62	YES	NO	NO	NO	0	0	NO
CONTROL	63	NO	NO	YES	NO	0	0	NO
CONTROL	63	NO	NO	UNK	NO	0	0	NO
CONTROL	63	NO	NO	YES	YES	2	UNK	NO
CASE	71	YES	NO	YES	YES	2	59	YES
CONTROL	70	NO	YES	YES	NO	0	0	YES
CONTROL	71	NO	NO	YES	YES	UNK	UNK	YES
CONTROL	71	NO	YES	YES	NO	0	0	YES
CONTROL	71	NO	YES	YES	YES	2	84	YES
CASE	83	NO	YES	YES	YES	3	96+	YES
CONTROL	82	NO	NO	YES	NO	0	0	NO
CONTROL	82	NO	YES	NO	YES	3	4	YES
CONTROL	82	NO	YES	NO	NO	0	0	YES
CONTROL	82	NO	NO	UNK	NO	0	0	NO
CASE	70	NO	NO	YES	NO	0	0	YES
CONTROL	70	YES	YES	YES	YES	2	55	YES
CONTROL	70	NO	YES	YES	YES	2	14	YES
CONTROL	70	NO	YES	YES	YES	1	39	YES

CASE OR CONTROL	AGE	GALL BLADDER DISEASE	HYPER TENSION	OBESITY	ESTROGEN (ANY) USE	CONJUGATED DOSE (SEE CODE)	ESTROGEN DURATION (MONTHS)	NON ESTROGEN DRUG
CONTROL	70	NO	YES	YES	NO	0	0	YES
CASE	74	NO	NO	NO	YES	0	0	YES
CONTROL	75	YES	YES	NO	YES	2	6	YES
CONTROL	74	NO	NO	YES	NO	0	0	YES
CONTROL	74	NO	YES	NO	YES	2	46	YES
CONTROL	75	NO	NO	UNK	NO	0	0	NO
CASE	70	NO	NO	UNK	YES	0	0	YES
CONTROL	70	NO	YES	NO	YES	1	96+	YES
CONTROL	70	NO	NO	UNK	NO	0	0	NO
CONTROL	70	NO	NO	UNK	NO	0	0	YES
CONTROL	70	NO	NO	UNK	NO	0	0	NO
CASE	66	NO	YES	YES	YES	3	48	YES
CONTROL	66	NO	NO	UNK	YES	1	96+	YES
CONTROL	66	NO	NO	UNK	NO	0	0	YES
CONTROL	66	NO	NO	YES	NO	0	0	NO
CONTROL	66	NO	YES	YES	YES	1	12	YES
CASE	77	NO	NO	YES	YES	3	4	YES
CONTROL	77	YES	YES	YES	YES	0	0	YES
CONTROL	77	NO	YES	NO	YES	2	24	YES
CONTROL	77	NO	NO	YES	NO	0	0	NO
CONTROL	78	NO	YES	YES	YES	2	9	YES
CASE	66	NO	YES	NO	YES	3	29	YES
CONTROL	67	NO	YES	NO	NO	0	0	YES
CONTROL	66	NO	NO	YES	NO	0	0	YES
CONTROL	67	NO	NO	YES	NO	0	0	YES
CONTROL	69	NO	YES	YES	YES	2	10	YES
CASE	71	NO	YES	YES	YES	1	96+	NO
CONTROL	72	NO	NO	UNK	NO	0	0	NO
CONTROL	72	NO	NO	NO	NO	0	0	YES
CONTROL	71	NO	NO	UNK	NO	0	0	NO
CONTROL	71	NO	YES	YES	NO	0	0	YES
CASE	80	NO	NO	NO	YES	2	UNK	YES
CONTROL	79	NO	NO	UNK	NO	0	0	NO
CONTROL	79	NO	NO	NO	NO	0	0	NO
CONTROL	79	NO	NO	YES	NO	0	0	NO
CONTROL	80	NO	NO	NO	NO	0	0	NO
CASE	64	NO	NO	YES	YES	2	UNK	YES
CONTROL	64	NO	NO	NO	YES	0	0	YES
CONTROL	63	NO	NO	YES	YES	1	60	YES
CONTROL	64	NO	YES	NO	YES	1	6	YES
CONTROL	66	NO	YES	YES	YES	1	UNK	YES
CASE	63	NO	NO	NO	YES	1	60	YES
CONTROL	63	NO	YES	NO	YES	1	96+	YES
CONTROL	65	NO	NO	NO	YES	1	25	NO
CONTROL	65	NO	NO	NO	NO	0	0	YES
CONTROL	64	NO	NO	NO	YES	1	96+	YES

CASE OR CONTROL	AGE	GALL BLADDER DISEASE	HYPER TENSION	OBESITY	ESTROGEN (ANY) USE	CONJUGATED DOSE (SEE CODE)	ESTROGEN DURATION (MONTHS)	NON ESTROGEN DRUG
CASE	72	YES	NO	YES	NO	0	0	YES
CONTROL	72	NO	YES	UNK	NO	0	0	NO
CONTROL	72	NO	YES	YES	NO	0	0	YES
CONTROL	72	NO	YES	NO	YES	1	48	YES
CONTROL	72	NO	YES	YES	YES	0	0	YES
CASE	57	NO	NO	NO	YES	3	12	NO
CONTROL	57	NO	YES	YES	YES	0	0	YES
CONTROL	58	NO	NO	YES	YES	1	36	YES
CONTROL	57	NO	NO	NO	YES	1	36	NO
CONTROL	57	NO	NO	NO	YES	0	0	NO
CASE	74	YES	NO	YES	NO	0	0	YES
CONTROL	74	NO	NO	YES	NO	0	0	YES
CONTROL	73	NO	NO	YES	YES	2	2	YES
CONTROL	75	NO	NO	YES	NO	0	0	YES
CONTROL	75	NO	NO	UNK	NO	0	0	NO
CASE	62	NO	YES	YES	YES	2	6	YES
CONTROL	62	NO	NO	YES	YES	2	37	YES
CONTROL	62	NO	NO	YES	YES	2	63	YES
CONTROL	63	NO	NO	UNK	NO	0	0	NO
CONTROL	61	YES	YES	YES	YES	3	96+	YES
CASE	73	NO	YES	YES	YES	1	4	YES
CONTROL	72	NO	NO	NO	YES	2	90	YES
CONTROL	73	NO	NO	NO	YES	3	5	YES
CONTROL	73	NO	YES	NO	YES	1	15	YES
CONTROL	73	NO	YES	NO	NO	0	0	NO
CASE	71	NO	YES	YES	YES	1	UNK	YES
CONTROL	71	NO	NO	UNK	NO	0	0	NO
CONTROL	71	NO	NO	NO	NO	0	0	YES
CONTROL	71	NO	NO	NO	NO	0	0	YES
CONTROL	71	NO	YES	NO	YES	UNK	UNK	YES
CASE	64	NO	YES	YES	NO	0	0	YES
CONTROL	65	NO	NO	YES	YES	3	96+	YES
CONTROL	64	NO	NO	YES	YES	3	96+	YES
CONTROL	64	NO	NO	YES	YES	2	36	YES
CONTROL	64	NO	NO	YES	YES	3	96+	NO
CASE	63	NO	NO	NO	YES	UNK	96+	YES
CONTROL	64	NO	NO	YES	NO	0	0	YES
CONTROL	62	NO	NO	YES	NO	0	0	YES
CONTROL	64	YES	NO	NO	YES	1	18	NO
CONTROL	64	NO	YES	YES	YES	3	UNK	YES
CASE	79	YES	YES	YES	YES	1	96+	YES
CONTROL	78	YES	YES	YES	YES	1	96+	YES
CONTROL	79	NO	NO	YES	NO	0	0	YES
CONTROL	79	NO	YES	NO	YES	0	0	YES
CONTROL	78	NO	NO	YES	YES	1	24	YES

CASE OR CONTROL	AGE	GALL BLADDER DISEASE	HYPER TENSION	OBESITY	ESTROGEN (ANY) USE	CONJUGATED DOSE (SEE CODE)	ESTROGEN DURATION (MONTHS)	NON ESTROGEN DRUG
CASE	80	NO	NO	YES	YES	1	15	YES
CONTROL	81	NO	YES	YES	NO	0	0	YES
CONTROL	81	NO	YES	NO	YES	1	18	YES
CONTROL	80	NO	NO	YES	YES	2	74	YES
CONTROL	80	NO	YES	YES	NO	0	0	YES
CASE	82	NO	YES	YES	YES	2	6	YES
CONTROL	82	NO	NO	YES	NO	0	0	YES
CONTROL	81	NO	YES	UNK	NO	0	0	YES
CONTROL	81	NO	YES	YES	YES	1	12	YES
CONTROL	82	NO	YES	YES	YES	2	13	YES
CASE	71	NO	YES	NO	YES	UNK	84	YES
CONTROL	71	NO	YES	YES	NO	0	0	YES
CONTROL	71	YES	NO	YES	NO	0	0	YES
CONTROL	71	YES	NO	YES	YES	1	96+	YES
CONTROL	71	NO	NO	NO	YES	1	30	YES
CASE	83	NO	YES	YES	YES	3	14	YES
CONTROL	83	NO	YES	YES	NO	0	0	YES
CONTROL	83	NO	NO	NO	NO	0	0	YES
CONTROL	83	NO	YES	YES	YES	2	16	YES
CONTROL	83	NO	NO	NO	NO	0	0	YES
CASE	61	NO	YES	NO	YES	3	96+	YES
CONTROL	60	NO	NO	NO	NO	0	0	YES
CONTROL	61	NO	NO	NO	YES	1	24	YES
CONTROL	62	NO	NO	YES	NO	0	0	YES
CONTROL	61	NO	NO	NO	YES	0	0	YES
CASE	71	NO	NO	NO	YES	1	96+	YES
CONTROL	71	NO	NO	YES	NO	0	0	NO
CONTROL	71	NO	YES	YES	NO	0	0	NO
CONTROL	70	NO	NO	NO	NO	0	0	NO
CONTROL	71	NO	YES	YES	YES	1	3	YES
CASE	69	NO	YES	YES	YES	2	40	YES
CONTROL	69	YES	NO	YES	NO	0	0	YES
CONTROL	70	NO	YES	NO	YES	0	0	YES
CONTROL	70	NO	YES	NO	YES	1	32	YES
CONTROL	70	NO	NO	YES	YES	UNK	UNK	YES
CASE	77	NO	NO	YES	YES	3	73	YES
CONTROL	76	NO	YES	NO	YES	0	0	YES
CONTROL	76	NO	YES	YES	YES	0	0	YES
CONTROL	77	YES	YES	YES	YES	0	0	YES
CONTROL	77	NO	YES	NO	NO	0	0	YES
CASE	64	NO	NO	YES	YES	1	37	NO
CONTROL	64	NO	NO	YES	YES	3	6	NO
CONTROL	63	YES	NO	YES	NO	0	0	NO
CONTROL	63	NO	YES	NO	YES	UNK	UNK	YES
CONTROL	63	NO	YES	YES	NO	0	0	YES

CASE OR CONTROL	AGE	GALL BLADDER DISEASE	HYPER TENSION	OBESITY	ESTROGEN (ANY) USE	CONJUGATED DOSE (SEE CODE)	ESTROGEN DURATION (MONTHS)	NON ESTROGEN DRUG
CASE	79	YES	NO	NO	NO	0	0	NO
CONTROL	82	NO	NO	YES	YES	1	UNK	YES
CONTROL	78	NO	NO	NO	NO	0	0	NO
CONTROL	80	NO	NO	YES	NO	0	0	NO
CONTROL	81	NO	NO	NO	NO	0	0	NO
CASE	72	NO	NO	NO	YES	0	0	YES
CONTROL	72	NO	NO	YES	YES	2	57	YES
CONTROL	73	NO	NO	UNK	NO	0	0	NO
CONTROL	73	YES	YES	NO	YES	2	96+	YES
CONTROL	73	NO	NO	NO	NO	0	0	YES
CASE	82	YES	YES	YES	YES	3	96+	YES
CONTROL	81	NO	NO	UNK	NO	0	0	NO
CONTROL	81	NO	NO	YES	NO	0	0	NO
CONTROL	81	NO	NO	YES	YES	0	0	YES
CONTROL	81	NO	YES	YES	NO	0	0	YES
CASE	73	NO	YES	YES	YES	2	60	YES
CONTROL	74	NO	NO	YES	YES	1	1	YES
CONTROL	75	NO	NO	NO	NO	0	0	YES
CONTROL	75	NO	YES	YES	YES	1	96+	YES
CONTROL	74	NO	NO	NO	NO	0	0	NO
CASE	69	NO	NO	UNK	YES	UNK	UNK	YES
CONTROL	68	NO	NO	NO	NO	0	0	YES
CONTROL	68	NO	NO	YES	YES	2	48	YES
CONTROL	68	NO	NO	NO	YES	1	96+	NO
CONTROL	70	NO	NO	NO	NO	0	0	NO
CASE	79	NO	YES	YES	YES	1	67	YES
CONTROL	79	NO	YES	YES	NO	0	0	YES
CONTROL	79	NO	YES	YES	NO	0	0	YES
CONTROL	78	YES	NO	YES	YES	1	UNK	YES
CONTROL	79	NO	NO	YES	NO	0	0	YES
CASE	72	NO	NO	YES	YES	3	60	NO
CONTROL	71	NO	NO	NO	YES	0	0	YES
CONTROL	72	NO	NO	NO	NO	0	0	YES
CONTROL	72	NO	YES	YES	YES	3	96+	YES
CONTROL	71	NO	YES	YES	YES	3	12	YES
CASE	72	NO	YES	YES	YES	1	27	YES
CONTROL	72	NO	YES	YES	YES	1	3	YES
CONTROL	71	NO	NO	UNK	NO	0	0	NO
CONTROL	72	NO	YES	YES	NO	0	0	YES
CONTROL	72	NO	YES	YES	NO	0	0	YES
CASE	65	NO	YES	YES	YES	2	16	YES
CONTROL	67	NO	NO	NO	NO	0	0	NO
CONTROL	67	NO	NO	UNK	NO	0	0	NO
CONTROL	66	NO	NO	YES	NO	0	0	YES
CONTROL	66	NO	NO	NO	YES	2	3	NO

CASE OR CONTROL	AGE	GALL BLADDER DISEASE	HYPER TENSION	OBESITY	ESTROGEN (ANY) USE	CONJUGATED DOSE (SEE CODE)	ESTROGEN DURATION (MONTHS)	NON ESTROGEN DRUG
CASE	67	NO	YES	YES	YES	2	96+	YES
CONTROL	66	NO	NO	YES	YES	2	56	YES
CONTROL	66	NO	NO	YES	NO	0	0	NO
CONTROL	67	NO	NO	YES	YES	1	UNK	YES
CONTROL	67	NO	NO	YES	YES	2	34	YES
CASE	64	YES	NO	YES	YES	3	96+	YES
CONTROL	63	NO	NO	YES	NO	0	0	YES
CONTROL	64	NO	NO	YES	YES	1	4	YES
CONTROL	63	NO	NO	YES	NO	0	0	YES
CONTROL	65	NO	NO	UNK	NO	0	0	NO
CASE	62	NO	NO	UNK	YES	2	36	NO
CONTROL	63	NO	NO	YES	NO	0	0	NO
CONTROL	62	NO	NO	NO	NO	0	0	YES
CONTROL	62	NO	NO	UNK	YES	3	UNK	NO
CONTROL	62	NO	NO	UNK	NO	0	0	NO
CASE	83	YES	YES	UNK	NO	0	0	YES
CONTROL	83	YES	NO	UNK	NO	0	0	NO
CONTROL	82	NO	NO	NO	YES	2	6	YES
CONTROL	83	NO	NO	UNK	NO	0	0	YES
CONTROL	83	YES	NO	UNK	NO	0	0	YES
CASE	81	NO	NO	YES	YES	0	0	YES
CONTROL	79	NO	NO	UNK	NO	0	0	NO
CONTROL	80	NO	NO	YES	NO	0	0	YES
CONTROL	82	NO	NO	YES	NO	0	0	YES
CONTROL	80	NO	NO	NO	NO	0	0	NO
CASE	67	NO	NO	YES	YES	2	96+	YES
CONTROL	66	NO	NO	YES	YES	2	40	YES
CONTROL	68	NO	NO	UNK	NO	0	0	YES
CONTROL	65	NO	NO	NO	NO	0	0	YES
CONTROL	66	NO	YES	YES	YES	1	96+	YES
CASE	73	YES	YES	YES	YES	1	UNK	YES
CONTROL	72	NO	NO	YES	YES	1	12	YES
CONTROL	71	NO	NO	YES	YES	1	96+	YES
CONTROL	73	YES	NO	NO	YES	2	96+	YES
CONTROL	72	NO	NO	YES	NO	0	0	YES
CASE	67	YES	NO	NO	YES	3	96+	YES
CONTROL	67	YES	NO	YES	YES	2	96+	YES
CONTROL	68	NO	NO	YES	NO	0	0	NO
CONTROL	67	NO	NO	YES	NO	0	0	NO
CONTROL	67	NO	NO	YES	NO	0	0	YES
CASE	74	NO	YES	YES	YES	2	9	YES
CONTROL	75	NO	NO	NO	NO	0	0	YES
CONTROL	75	NO	NO	UNK	NO	0	0	NO
CONTROL	75	YES	YES	NO	NO	0	0	YES
CONTROL	75	NO	NO	NO	YES	2	41	YES
CASE	68	YES	NO	YES	YES	3	18	YES
CONTROL	69	NO	NO	YES	YES	2	96+	YES
CONTROL	70	NO	NO	UNK	NO	0	0	NO
CONTROL	69	NO	YES	YES	YES	2	92	YES
CONTROL	69	NO	YES	NO	YES	3	59	YES

APPENDIX IV

LISTING OF PROGRAM MATCH

The following main program and subroutine perform the conditional logistic regression analysis for matched sets consisting of a single case and a variable number of controls, as described in § 7.4. To illustrate how the program works we have input the data from the Los Angeles endometrial cancer study shown in Appendix III. Four different models were fit in hierarchical fashion using the variables GALL, OB, EST and GALL × EST (see Table 7.2). The last two of these correspond precisely to Models 4 and 8 of Table 7.7. Note the use of the SCORE statistic, calculated at the first iteration of each fit with the estimated regression coefficients from the previous model, to test the significance of the added variable(s).

The subprogram calls the IBM scientific subroutine SINV for inversion of symmetric matrices.

MAIN PROGRAM

(READS DATA, SETS UP RISK VARIABLES, CALLS SUBROUTINE)

```
C      MASTER MAIN
       DIMENSION NR(63),IVAR(6),W(6),EZB(6),
      * Z(6,5,63),B(6),SCORE(6),COV(21),COVI(21)
C
C      DIMENSION IVAR(NM),NCA(NS),NCT(NS),IP(NMAX2),W(NM),WW(NM),
C     *Z(NM,NRMAX,NS),B(NM),SCORE(NM),COV(NM1),COVI(NM1)
C      SEE SUBROUTINE FOR DEFINITIONS
C
       DATA NR/63*5/,B/6*0.0/,IVAR/1,2,3,4,5,6/,NP/6/
       DATA NM,NRMAX,NIT,EPS/6,5,10,0.0001/
       NM1=NM*(NM+1)/2
       I-0
       READ(1,100) GALL,OB,EST
 1000  CONTINUE
 100   FORMAT(10X,F5.0,5X,F5.0,15X,F5.0)
C
C   I IS THE ORDER NUMBER OF THE SET
C
       I=I+1
       K=0
       DO 6 KK-1,5
       K=K+1
       Z(1,K,I)=2-GALL
       IF (OB.EQ.9)  OB=2
       Z(2,K,I)=2-OB
       Z(3,K,I)=2-EST
       Z(4,K,I)=(2-GALL)*(2-EST)
       Z(5,K,I)=(2-OB)*(2-EST)
       Z(6,K,I)=(2-GALL)*(2-OB)
       READ(1,100,END=2000) GALL,OB,EST
6      CONTINUE
       GOTO 1000
 2000  CONTINUE
       NS = I
       DO 2 I=1,NP
       B(I)=0.0
2      CALL MATCH(NS,NR,NRMAX,NM,I,NIT,B,Z,SCORE,COVI,COV,
      * EZB,IVAR,NM1,EPS,W)
       STOP
       END
```

SUBPROGRAM MATCH

```
C
C  REFERENCES:
C  N. E. BRESLOW,N.E. DAY,K. T. HALVORSEN, R. L. PRENTICE,C. SABAI :
C    ESTIMATION OF MULTIPLE RELATIVE RISK FUNCTIONS IN MATCHED
C    CASE-CONTROL STUDIES.  AMERICAN JOURNAL OF EPIDEMIOLOGY
C    VOL108,NO4, P 299-307 , 1978
C
C    THIS SUBROUTINE COMPUTES A LINEAR LOGISTIC REGRESSION ANALYSIS FOR
C    MATCHED SETS OF 1  CASE A VARIABLE NO. OF CONTROLS PER CASE
C    THE VARIABLES APPEARING IN THE CALL STATEMENT ARE DEFINED AS FOLLO
C    NS  NUMBER OF MATCHED SETS
C    NR  VECTOR OF NO. OF CONTROLS IN EACH SET + 1
C    NRMAX  (MAX NO. OF CONTROLS PER CASE)+1
C    NM  MAXIMUM NUMBER OF VARIABLES TO BE ANALYZED
C    NP  NUMBER OF VARIABLES ANALYZED IN THIS RUN
C    NIT   MAXIMUM NUMBER OF ITERATIONS OF THE NEWTON-RAPHSON TYPE
C    B  PARAMETER VECTOR OF LENGTH NM
C    Z  NM BY NRMAX BY NS MATRIX CONTAINING COVARIATES
C    SCORE FIRST DERIVATIVE OF THE LN-LIKELIHOOD OF LENGTH NM
C    COVI INFORMATION MATRIX(2ND DERIVATIVE OF LN-LIKELIHOOD)
C    COV INVERSE INFORMATION MATRIX(ESTIMATED COVARIANCE MATRIX)
C    EZB WORKING VECTOR OF LENGTH NRMAX
C    IVAR VECTOR OF VARIABLES USED IN THIS RUN (DIMENSION NM)
C    NM1 = NM*(NM+1)/2 DIMENSION OF COVI AND COV
C    EPS   CHANGE IN LIKELIHOOD BELOW WHICH ITERATION STOPS
C    W  WORKING VECTOR OF LENGTH NM
C
C    NOTE(Z,J,K,I) IS THE VALUE OF THE JTH COVARIATE FOR THE KTH
C    MEMBER IN THE ITH SET.IT IS ASSUMED THAT THE FIRST MEMBER IS THE
C    CASE AND THAT THE REMAINING NR(I)-1 MEMBERS ARE CONTROLS.
C
C    NOTE(Z MUST BE DIMENSIONED TO HAVE NM ROWS,NRMAX COLUMNS
C    AND AT LEAST NS SLICES IN THE MAIN PROGRAM,
C    COVI AND COV ARE ARRAYS OF LENGTH NM*(NM+1)/2 SINCE THEY USE
C    THE SYMMETRIC STORAGE MODE.
C
      SUBROUTINE MATCH(NS,NR,NRMAX,NM,NP,NIT,B,Z,SCORE,COVI,COV,
     * EZB,IVAR,NM1,EPS,W)
      DIMENSION Z(NM,NRMAX,NS),B(NM),EZB(NRMAX),SCORE(NM),COV(NM1),
     * COVI(NM1),IVAR(NM),NR(NS),W(NM)
      REAL LOGLIK
      DATA TEST/1.0/,ISUB/1/
      WRITE(6,100)
100   FORMAT(///' LOGISTIC REGRESSION ANALYSIS FOR MATCHED SETS',/)
      WRITE(6,101)NS
101   FORMAT(1H ,'NUMBER OF MATCHED SETS',I4)
      WRITE(6,102)((I,NR(I)),I=1,NS)
102   FORMAT(1H ,'SET NUMBER AND NUMBER OF MEMBERS',
     *' IN EACH SET,(INCLUDING CASE)',/,50(1X,10(I4,I3),/))
      WRITE(6,103)NP,(IVAR(J),J=1,NP)
```

```
103   FORMAT(1H ,'NUMBER OF VARIABLES IN THIS ANALYSIS=',I3,
     */,' THESE VARIABLES ARE NUMBERS',30I3)
      WRITE(6,104)NIT
104   FORMAT(1H ,'MAXIMUM NUMBER OF ITERATIONS',I4)
      WRITE(6,106)
106   FORMAT('  ITER  LOG-LIKELIHOOD   SCORE',8X,'PARAMETER ESTIMATES')
      ITS=0
      IF(ISUB.NE.1)GOTO 1
C     SUBTRACT VALUE OF COVARIATES FOR THE CASE  FROM THOSE OF CONTROLS
C     THIS ONLY NEEDS TO BE DONE AT THE FIRST CALL OF THE SUBROUTINE
      L=1
      DO 99 I=1,NS
      NRI=NR(I)
      DO 99 J=2,NRI
      DO 99 K=1,NM
      Z(K,J,I)=Z(K,J,I)-Z(K,L,I)
99    CONTINUE
      ISUB=0
1     CONTINUE
      ITS= ITS+1
C  CLEAR ARRAYS PRIOR TO NEXT ITERATION
      LOGLIK=0.0
      K=0
      DO 2 J=1,NP
      SCORE(J)=0.0
      DO 2 JJ=J,NP
      K=K+1
2     COVI(K)=0.0
C  CALCULATE LOGLIK,SCORE,COVI
      DO 7 I=1,NS
      DENOM=0.0
      NRI=NR(I)
      DO 4 K=2,NRI
      ZB=0.0
      DO 3 J=1,NP
      L=IVAR(J)
3     ZB=ZB+B(J)*Z(L,K,I)
      EZB(K)=EXP(ZB)
4     DENOM=DENOM+EZB(K)
      DENOM=1.0+DENOM
      LOGLIK=LOGLIK-ALOG(DENOM)
      KJ=0
      DO 7 J=1,NP
      L=IVAR(J)
      EZJ=0.0
      NRI=NR(I)
      DO 5 K=2,NRI
5     EZJ=EZJ+EZB(K)*Z(L,K,I)
      SCORE(J)=SCORE(J)-EZJ/DENOM
```

```
      DO 7 JJ=1,J
      LL=IVAR(JJ)
      EZJJ=0.0
      EZZ=0.0
      NRI=NR(I)
      DO 6 K=2,NRI
      EZJJ=EZJJ+EZB(K)*Z(LL,K,I)
6     EZZ=EZB(K)*Z(L,K,I)*Z(LL,K,I)+EZZ
      KJ=KJ+1
      COVI(KJ)=COVI(KJ)+(EZZ/DENOM)-EZJ*EZJJ/(DENOM*DENOM)
7     CONTINUE
      DO 500 I=1,NM1
      COV(I)=COVI(I)
500   CONTINUE
      CALL SINV(COV,NP,EPS,IER)
      IF (IER.NE.0) WRITE (6,501)IER
501   FORMAT(' IER = ',I3)
      TEMP=0.0
      K=0
      DO 51 J=1,NP
      DO 51 JJ=1,J
      K=K+1
      G=1.0
      IF (J.NE.JJ) G=2.0
      TEMP=TEMP+G*SCORE(J)*SCORE(JJ)*COV(K)
 51   CONTINUE
C  WRITE OUT ITERATION NUMBER AND LOG-LIKELIHOOD AND B'S
      WRITE(6,107)ITS,LOGLIK,TEMP,(B(J),J=1,NP)
107   FORMAT(1X,I4,F14.4,F11.3,2X,8F12.4,20(/,21X,8F12.4)
C  TEST FOR CONVERGENCE
      TEST=ABS(TEST-LOGLIK)
      IF(TEST.LE.EPS.OR.ITS.GE.NIT)GO TO 9
      TEST=LOGLIK
C  CALCULATE NEW VALUE OF PARAMETER ESTIMATE AND REPEAT
C     CALL SYMINV(COVI,NP,COV,W,NULLTY,IFAULT,NM1)
      DO 180 I=1,NP
      W(I)=0.0
      DO 181 J=1,I
      K=I*(I-1)/2+J
181   W(I)=W(I)+SCORE(J)*COV(K)
      I1=I+1
      IF(I1.GT.NP)GOTO 180
      DO 182 K=I1,NP
      J=K*(K-1)/2+I
182   W(I)=W(I)+SCORE(K)*COV(J)
180   CONTINUE
      DO 183 I=1,NP
183   SCORE(I)=W(I)
      DO 8 J=1,NP
8     B(J)=B(J)+SCORE(J)
```

```
C  UPON CONVERGENCE OF MAXIMUM ITERATIONS WRITE OUT RESULTS
      GO TO 1
9     WRITE(6,108)(B(J),J=1,NP)
108   FORMAT(' ESTIMATED PARAMETER VECTOR',(/1X,10F12.6))
      WRITE(6,109)(SCORE(J),J=1,NP)
109   FORMAT(' FIRST DERIVATIVE LOG-LIKELIHOOD',(/1X,10F12.6))
      WRITE(6,110)
110   FORMAT(' INFORMATION MATRIX')
      DO 10 J=1,NP
      K=J*(J-1)/2+1
      JJ=J*(J+1)/2
10    WRITE(6,111) (COVI(I),I=K,JJ)
111   FORMAT(1X,10F12.6)
C  INVERT INFORMATION MATRIX AND WRITE OUT
C     CALL SYMINV(COVI,NP,COV,W,NULLTY,IFAULT,NM1)
      DO 600 I=1,NM1
      COV(I)=COVI(I)
600   CONTINUE
      CALL SINV(COV,NP,EPS,IER)
      IF (IER.NE.0) WRITE (6,501)IER
      WRITE(6,112)
112   FORMAT(' ESTIMATED COVARIANCE MATRIX')
      DO 11 J=1,NP
      K=J*(J-1)/2+1
      JJ=J*(J+1)/2
      SCORE(J)=B(J)/SQRT(COV(JJ))
11    WRITE(6,111)(COV(I),I=K,JJ)
      WRITE(6,113)(SCORE(J),J=1,NP)
113   FORMAT(' STANDARDIZED REGRESSION COEFFICIENTS',(/1X,100F12.6))
      RETURN
      END
```

MODEL WITH SINGLE VARIABLE: GALL

LOGISTIC REGRESSION ANALYSIS FOR MATCHED SETS

NUMBER OF MATCHED SETS 63
SET NUMBER AND NUMBER OF MEMBERS IN EACH SET,(INCLUDING CASE)

1	5	2	5	3	5	4	5	5	5	6	5	7	5	8	5	9	5	10	5
11	5	12	5	13	5	14	5	15	5	16	5	17	5	18	5	19	5	20	5
21	5	22	5	23	5	24	5	25	5	26	5	27	5	28	5	29	5	30	5
31	5	32	5	33	5	34	5	35	5	36	5	37	5	38	5	39	5	40	5
41	5	42	5	43	5	44	5	45	5	46	5	47	5	48	5	49	5	50	5
51	5	52	5	53	5	54	5	55	5	56	5	57	5	58	5	59	5	60	5
61	5	62	5	63	5														

NUMBER OF VARIABLES IN THIS ANALYSIS = 1
THESE VARIABLES ARE NUMBERS 1
MAXIMUM NUMBER OF ITERATIONS 10

ITER	LOG-LIKELIHOOD	SCORE	PARAMETER ESTIMATES
1	-101.3945	13.829	0.0
2	-95.6566	0.512	1.5714
3	-95.4043	0.000	1.3011
4	-95.4043	0.000	1.3061

ESTIMATED PARAMETER VECTOR
1.306142
FIRST DERIVATIVE LOG-LIKELIHOOD
0.000010
INFORMATION MATRIX
7.232518
ESTIMATED COVARIANCE MATRIX
0.138264
STANDARDIZED REGRESSION COEFFICIENTS
3.512652

MODEL WITH 2 VARIABLES: GALL + OB

```
LOGISTIC REGRESSION ANALYSIS FOR MATCHED SETS

NUMBER OF MATCHED SETS  63
SET NUMBER AND NUMBER OF MEMBERS IN EACH SET,(INCLUDING CASE)
   1  5   2  5   3  5   4  5   5  5   6  5   7  5   8  5   9  5  10  5
  11  5  12  5  13  5  14  5  15  5  16  5  17  5  18  5  19  5  20  5
  21  5  22  5  23  5  24  5  25  5  26  5  27  5  28  5  29  5  30  5
  31  5  32  5  33  5  34  5  35  5  36  5  37  5  38  5  39  5  40  5
  41  5  42  5  43  5  44  5  45  5  46  5  47  5  48  5  49  5  50  5
  51  5  52  5  53  5  54  5  55  5  56  5  57  5  58  5  59  5  60  5
  61  5  62  5  63  5
NUMBER OF VARIABLES IN THIS ANALYSIS = 2
THESE VARIABLES ARE NUMBERS  1  2
MAXIMUM NUMBER OF ITERATIONS  10
 ITER  LOG-LIKELIHOOD   SCORE       PARAMETER ESTIMATES
   1        -95.4043    5.031       1.3061       0.0
   2        -92.8562    0.016       1.2673       0.7044
   3        -92.8483    0.000       1.3085       0.7254
   4        -92.8484    0.000       1.3086       0.7255
ESTIMATED PARAMETER VECTOR
    1.308584     0.725526
FIRST DERIVATIVE LOG-LIKELIHOOD
   -0.000000     0.000001
INFORMATION MATRIX
    7.115846
   -0.413175     9.369903
ESTIMATED COVARIANCE MATRIX
    0.140892
    0.006213     0.106999
STANDARDIZED REGRESSION COEFFICIENTS
    3.486248     2.218012
```

MODEL WITH 3 VARIABLES: GALL + OB + EST
(model 4, Table 7.7)

```
LOGISTIC REGRESSION ANALYSIS FOR MATCHED SETS

NUMBER OF MATCHED SETS  63
SET NUMBER AND NUMBER OF MEMBERS IN EACH SET,(INCLUDING CASE)
   1  5   2  5   3  5   4  5   5  5   6  5   7  5   8  5   9  5  10  5
  11  5  12  5  13  5  14  5  15  5  16  5  17  5  18  5  19  5  20  5
  21  5  22  5  23  5  24  5  25  5  26  5  27  5  28  5  29  5  30  5
  31  5  32  5  33  5  34  5  35  5  36  5  37  5  38  5  39  5  40  5
  41  5  42  5  43  5  44  5  45  5  46  5  47  5  48  5  49  5  50  5
  51  5  52  5  53  5  54  5  55  5  56  5  57  5  58  5  59  5  60  5
  61  5  62  5  63  5
NUMBER OF VARIABLES IN THIS ANALYSIS = 3
THESE VARIABLES ARE NUMBERS  1  2  3
MAXIMUM NUMBER OF ITERATIONS  10
 ITER  LOG-LIKELIHOOD   SCORE    PARAMETER ESTIMATES
   1       -92.8484    26.837    1.3086   0.7255   0.0
   2       -78.4750     1.213    1.0256   0.4851   1.6166
   3       -77.8264     0.017    1.2543   0.5086   1.9860
   4       -77.8179     0.000    1.2746   0.5113   2.0394
   5       -77.8179     0.000    1.2748   0.5113   2.0403
ESTIMATED PARAMETER VECTOR
    1.274839   0.511342   2.040298
FIRST DERIVATIVE LOG-LIKELIHOOD
    0.000004   0.000002   0.000004
INFORMATION MATRIX
    5.996700
   -0.295261   7.917870
   -0.581349   0.554122   5.222640
ESTIMATED COVARIANCE MATRIX
    0.168775
    0.005016   0.127390
    0.018255  -0.012958   0.194881
STANDARDIZED REGRESSION COEFFICIENTS
    3.103139   1.432659   4.621776
```

MODEL WITH 4 VARIABLES: GALL + OB + EST + GALL×EST

(model 8, Table 7.5)

```
LOGISTIC REGRESSION ANALYSIS FOR MATCHED SETS

NUMBER OF MATCHED SETS  63
SET NUMBER AND NUMBER OF MEMBERS IN EACH SET,(INCLUDING CASE)
   1  5    2  5    3  5    4  5    5  5    6  5    7  5    8  5    9  5   10  5
  11  5   12  5   13  5   14  5   15  5   16  5   17  5   18  5   19  5   20  5
  21  5   22  5   23  5   24  5   25  5   26  5   27  5   28  5   29  5   30  5
  31  5   32  5   33  5   34  5   35  5   36  5   37  5   38  5   39  5   40  5
  41  5   42  5   43  5   44  5   45  5   46  5   47  5   48  5   49  5   50  5
  51  5   52  5   53  5   54  5   55  5   56  5   57  5   58  5   59  5   60  5
  61  5   62  5   63  5
NUMBER OF VARIABLES IN THIS ANALYSIS = 4
THESE VARIABLES ARE NUMBERS  1  2  3  4
MAXIMUM NUMBER OF ITERATIONS  10
 ITER  LOG-LIKELIHOOD    SCORE   PARAMETER ESTIMATES
   1        -77.8179     4.392   1.2748    0.5113    2.0403    0.0
   2        -75.9031     0.221   3.0331    0.4859    2.5096   -2.2027
   3        -75.7909     0.000   2.8467    0.4901    2.6172   -2.0003
   4        -75.7910     0.000   2.8446    0.4901    2.6206   -1.9975
ESTIMATED PARAMETER VECTOR
    2.844563   0.490130   2.620620   -1.997451
FIRST DERIVATIVE LOG-LIKELIHOOD
   -0.000001   0.000004   0.000020    0.000006
INFORMATION MATRIX
    6.692919
   -0.287091   7.667604
   -1.389089   0.432648   4.504435
    4.758762  -0.133908   0.584442    4.981014
ESTIMATED COVARIANCE MATRIX
    0.774399
   -0.003830   0.131275
    0.340368  -0.014950   0.376377
   -0.779885   0.008943  -0.369744    0.989473
STANDARDIZED REGRESSION COEFFICIENTS
    3.232460   1.352757   4.271620   -2.008047
```

APPENDIX V

LISTING OF PROGRAM STRAT

The following main program and subroutine perform the conditional logistic regression analysis for matched sets consisting of a variable number of cases and a variable number of controls, using the general likelihood (7.1). It was written by Mr Peter Smith as a generalization of the program MATCH. To illustrate its operation we have used exactly the same data as used with MATCH, namely those corresponding to several of the models in Table 7.7. Slight differences in the numerical output are due to the use of different computing formulae.

The program is completely self-contained, with the subroutines SYMINV, CHOL, and TWIDL which it calls being listed also.

MAIN PROGRAM

```
      DIMENSION NCT(63),NCA(63),IVAR(6),IP(7),W(20),WW(20),
     * Z(6,5,63)    ,B(6),SCORE(6),COV(21),COVI(21)
      DATA NCA/63*1/,NCT/63*4/,NS,NM,NMAX,NIT,EPS/63,6,5,10,0.0001/
      DATA B/6*0.0/,IVAR/1,2,3,4,5,6/,NP/6/
      NMAX2=NMAX+2
      NM1=NM*(NM+1)/2
      DO 6 I=1,NS
      N=NCT(I)+NCA(I)
      DO 6 J=1,N
      L=N+1-J
      READ(1,100) GALL,OB,EST
  100 FORMAT(10X,F5.0,5X,F5.0,15X,F5.0)
      Z(1,L,I)=2-GALL
      IF (OB.EQ.9) OB=2
      Z(2,L,I)=2-OB
      Z(3,L,I)=2-EST
      Z(4,L,I)=(2-GALL)*(2-EST)
      Z(5,L,I)=(2-OB)*(2-EST)
      Z(6,L,I)=(2-GALL)*(2-OB)
6     CONTINUE
      DO 2 I=1,NP
      B(I)=0.0
2     CALL STRAT(NS,NCA,NCT,NMAX,NM,I,NIT,B,Z,SCORE,COVI,COV,
     *IVAR,EPS,NM1,W,WW,IP,NMAX2)
99    STOP
      END
```

SUBPROGRAM STRAT

```
      SUBROUTINE STRAT(NS,NCA,NCT,NMAX,NM,NP,NIT,B,Z,SCORE,COVI,COV,
     *IVAR,EPS,NM1,W,WW,IP,NMAX2)
C     THIS SUBROUTINE COMPUTES A LINEAR LOGISTIC REGRESSION ANALYSIS
C     FOR STRATIFIED SETS CONSISTING OF NCA(I) CASES AND NCT(I) CONTROLS
C     THE ITH STRATUM
C     THE VARIABLES APPEARING INTHE CALL STATEMENT ARE DEFINED AS FOLLO
C     NS   NUMBER OF STRATA
C     NCA  VECTOR OF THE NUMBER OF CASES IN EACH STRATUM
C     NCT  VECTOR OF THE NUMBER OF CONTROLS IN EACH STRATUM
C     NMAX MAXIMUM NUMBER OF CASES + CONTROLS IN ANY STRATUM
C     NM   MAXIMUM NUMBER OF VARIABLES TO BE ANALYSED
C     NP   NUMBER OF VARIABLES TO BE ANALYSED IN THIS RUN
C     NIT  MAXIMUM NUMBER OF ITERATIONS OF THE NEWTON-RAPHSON TYPE
C     B    PARAMETER VECTOR OF LENGTH NM
C     Z    NM BY NMAX BY NS MATRIX CONTAINING COVARIATES
C     SCORE FIRST DERIVATIVE OF THE LN-LIKELIHOOD OF LENGTH NM
C     COVI INFORMATION MATRIX (2ND DERIVATIVE OF LN-LIKELIHOOD)
C     COV  INVERSE INFORMATION MATRIX : ESTIMATED COVARIANCE MATRIX
C     IVAR VECTOR OF VARIABLE NUMBERS USED IN THIS RUN
C     EPS  CHANGE IN LIKELIHOOD BELOW WHICH ITERATION STOPS
C     NM1  NM*(NM+1)/2
C     WW   WORKING VECTOR OF LENGTH NM
C     IP   WORKING VECTOR OF LENGTH NMAX2
C     NMAX2 NMAX+2
C     NOTE: IN THE ARRAY Z INDIVIDUALS ARE INDEXED BY THE 2ND
C     SUBSCRIPT,WITHIN EACH STRATUM DATA ON CONTROLS MUST BE STORED
C     FIRST FOLLOWED BY THOSE ON CASES.
```

```
C  REFERENCES:
C   N. E.BRESLOW, N.E. DAY, K. T. HALVORSEN,R. L. PRENTICE,C. SABAI:
C     ESTIMATION OF MULTIPLE RELATIVE RISK FUNCTIONS IN MATCHED
C       CASE CONTROL STUDIES . AM. J EPIDEMIOL 108:299-307, 1978
      DIMENSION Z(NM,NMAX,NS),B(NM),SCORE(NM),COV(NM1),COVI(NM1)
     *,IVAR(NM),NCA(NS),NCT(NS),W(NM),WW(NM),IP(NMAX2)
      REAL LOGLIK
      DATA TEST/1.0/
      WRITE(6,100)
100   FORMAT(1H1,///' LOGISTIC REGRESSION ANALYSIS IN STRATA',/)
      WRITE(6,101)NS
101   FORMAT(1H ,'NUMBER OF STRATA',I4)
      WRITE(6,102)(I,NCA(I),NCT(I),I=1,NS)
102   FORMAT(1H ,'STRATUM NUMBER AND NUMBERS OF CASES AND CONTROLS',
     *50(1X,10(I4,I3,I3),/))
      WRITE(6,103)NP,(IVAR(J),J=1,NP)
103   FORMAT(1H ,'NUMBER OF VARIABLES IN THIS ANALYSIS',I3,/,
     *' THESE VARIABLES ARE',30I3)
      WRITE(6,104)NIT
104   FORMAT(1H ,'MAXIMUM NUMBER OF ITERATIONS',I4)
      WRITE(6,106)
106   FORMAT(1H ,'ITER LOG-LIKELIHOOD  SCORE  PARAMETER ESTIMATES')
      ITS=0
1     ITS=ITS+1
      LOGLIK=0.0
      K=0
      DO 2 J=1,NP
      SCORE(J)=0.0
      DO 2 JJ=1,J
      K=K+1
2     COVI(K)=0.0
C     CALCULATE LOGLIK,SCORE AND COVI
      DO 27 I=1,NS
      IFG=0
      SX=0.0
      K=0
      DO 8 J=1,NP
      W(J)=0.0
      WW(J)=0.0
      DO 8 JJ=1,J
      K=K+1
8     COV(K)=0.0
      M=NCA(I)
      N=M+NCT(I)
      XX=1.0
      X=0.0
      IP(1)=N+1
      IP(N+2)=-2
      NMX=N-M+1
      DO 30 J=2,NMX
```

```
30    IP(J)=0
      DO 31 J=1,M
31    IP(NMX+J)=J
      KK=N-M+1
      DO 12 J=KK,N
      DO 12 K=1,NP
      L=IVAR(K)
      W(K)=W(K)+Z(L,J,I)
12    X=X+B(K)*Z(L,J,I)
11    XX=EXP(X)
      SX=SX+XX
      IF(IFG.NE.0)GOTO 13
      LOGLIK=LOGLIK+ALOG(SX)
      DO 17 K=1,NP
17    SCORE(K)=SCORE(K)+W(K)
      IFG=1
13    L=0
      DO 14 K=1,NP
      WW(K)=WW(K)+XX*W(K)
      DO 14 KK=1,K
      L=L+1
14    COV(L)=COV(L)+XX*W(K)*W(KK)
      ID=0
      CALL TWIDL(IPS,IM,IZ,ID,IP,NMAX2)
      IF(ID.EQ.1)GOTO 20
      DO 15 K=1,NP
      L=IVAR(K)
      ZC=Z(L,IPS,I)-Z(L,IM,I)
      W(K)=W(K)+ZC
15    X=X+B(K)*ZC
      GOTO 11
20    LOGLIK=LOGLIK-ALOG(SX)
      L=0
      DO 21 J=1,NP
      SCORE(J)=SCORE(J)-WW(J)/SX
      DO 21 K=1,J
      L=L+1
21    COVI(L)=COVI(L)+(SX*COV(L)-WW(J)*WW(K))/SX**2
27    CONTINUE
```

```
      CALL SYMINV(COVI,NP,COV,W,NULLTY,IFAULT,NM1)
      TEMP=0.0
      K=0
      DO 51 J=1,NP
      DO 51 JJ=1,J
      K=K+1
      G=1.0
      IF (J.NE.JJ) G=2.0
      TEMP=TEMP+G*SCORE(J)*SCORE(JJ)*COV(K)
51    CONTINUE
C     WRITE OUT ITERATION NUMBER AND LOG-LIKELIHOOD AND B'S
      WRITE (6,107)ITS,LOGLIK,TEMP,(B(J),J=1,NP)
107   FORMAT(1X,I4,F14.4,F11.3,2X,8F12.4,20(/,21X,8F12.4))
C     TEST FOR CONVERGENCE
      TEST=ABS(TEST-LOGLIK)
      IF (TEST.LE.EPS.OR.ITS.GE.NIT)GOTO 9
      TEST=LOGLIK
C     CALCULATE NEW VALUE OF PARAMETER ESTIMATE AND REPEAT
      DO 180 I=1,NP
      W(I)=0.0
      DO 181 J=1,I
      K=I*(I-1)/2+J
181   W(I)=W(I)+SCORE(J)*COV(K)
      I1=I+1
      IF(I1.GT.NP)GOTO 180
      DO 182 K=I1,NP
      J=K*(K-1)/2+I
182   W(I)=W(I)+SCORE(K)*COV(J)
180   CONTINUE
      DO 183 I=1,NP
183   SCORE(I)=W(I)
      DO 18 J=1,NP
18    B(J)=B(J)+SCORE(J)
C     UPON CONVERGENCE OR MAXIMUM ITERATIONS WRITE OUT RESULTS
      GOTO 1
9     WRITE(6,108)(B(J),J=1,NP)
108   FORMAT(1H0,'ESTIMATED PARAMETER VECTOR',(/1X,10F12.6))
      WRITE(6,109)(SCORE(J),J=1,NP)
109   FORMAT(1H0,'FIRST DERIVATIVE LOG-LIKELIHOOD',(/1X,10F12.6))
      WRITE(6,110)
110   FORMAT(1H0,'INFORMATION MATRIX')
      DO 10 J=1,NP
      K=J*(J-1)/2+1
      JJ=J*(J+1)/2
10    WRITE (6,111) (COVI(I),I=K,JJ)
111   FORMAT(1X,10F12.6)
C     INVERT INFORMATION MATRIX AND WRITE OUT
      CALL SYMINV(COVI,NP,COV,W,NULLTY,IFAULT,NM1)
      WRITE(6,112)
```

```
112   FORMAT(1H0,'ESTIMATED COVARIANCE MATRIX')
      DO 19 J=1,NP
      K=J*(J-1)/2+1
      JJ=J*(J+1)/2
      SCORE(J)=B(J)/SQRT(COV(JJ))
19    WRITE(6,111)(COV(I),I=K,JJ)
      WRITE(6,113)(SCORE(J),J=1,NP)
113   FORMAT(1H0,'STNDIZED REGRESSION COEFFICIENTS',(/1X,100F12.6))
      RETURN
      END
```

```
      SUBROUTINE SYMINV(A,N,C,W,NULLTY,IFAULT,NFAC)
      DIMENSION A(NFAC),C(NFAC),W(N)
C
C     ALGORITHM AS7 J.R. STATIST.SOC.C.(1968) VOL.17,NO.2
C
      NROW=N
      IFAULT=1
      IF(NROW.LE.0)GOTO 100
      IFAULT=0
      CALL CHOL(A,NROW,C,NULLTY,IFAULT,NFAC)
      IF(IFAULT.NE.0)GOTO 100
      NN=(NROW*(NROW+1))/2
      IROW=NROW
      NDIAG=NN
16    IF(C(NDIAG).EQ.0.0)GOTO 11
      L=NDIAG
      DO 10 I=IROW,NROW
      W(I)=C(L)
      L=L+1
10    CONTINUE
      ICOL=NROW
      JCOL=NN
      MDIAG=NN
15    L=JCOL
      X=0.0
      IF(ICOL.EQ.IROW)X=1.0/W(IROW)
      K=NROW
13    IF(K.EQ.IROW)GOTO12
      X=X-W(K)*C(L)
      K=K-1
      L=L-1
      IF(L.GT.MDIAG)L=L-K+1
      GOTO 13
12    C(L)=X/W(IROW)
      IF(ICOL.EQ.IROW)GOTO 14
      MDIAG=MDIAG-ICOL
      ICOL=ICOL-1
      JCOL=JCOL-1
      GOTO 15
11    L=NDIAG
      DO 17 J=IROW,NROW
      C(L)=0.0
      L=L+J
17    CONTINUE
14    NDIAG=NDIAG-IROW
      IROW=IROW-1
      IF(IROW.NE.0)GOTO 16
100   RETURN
      END
```

```
      SUBROUTINE CHOL(A,N,U,NULLTY,IFAULT,NFAC)
      DIMENSION A(NFAC),U(NFAC)
      REAL ETA
      DATA ETA/0.000001/
C
C     ALGORITHM AS6 J.R.STATIS. SOC. C. (1968). VOL.17, NO.2
C
      IFAULT=1
      IF(N.LE.0)GOTO 100
      IFAULT=2
      NULLTY=0
      J=1
      K=0
      DO 10 ICOL=1,N
      L=0
      DO 11 IROW=1,ICOL
      K=K+1
      W=A(K)
      M=J
      DO 12 I=1,IROW
      L=L+1
      IF(I.EQ.IROW-GOTO 13
      W=W-U(L)*U(M)
      M=M+1
12    CONTINUE
13    IF(IROW.EQ.ICOL)GOTO 14
      IF(U(L).EQ.0.0)GOTO 21
      U(K)=W/U(L)
      GOTO 11
21    U(K)=0.0
11    CONTINUE
14    IF(ABS(W).LT.ABS(ETA*A(K))) GOTO 20
      IF(W.LT.0.0)GOTO 100
      U(K)=SQRT(W)
      GOTO 15
20    U(K)=0.0
      NULLTY=NULLTY+1
15    J=J+ICOL
10    CONTINUE
      IFAULT=0
100   RETURN
      END
```

```
      SUBROUTINE TWIDL(X,Y,Z,DONE,P,N2)
      INTEGER X,Y,Z,DONE,N2,P(N2)
C
C     THIS SUBROUTINE IS A FORTRAN VERSION OF CACM 382
C     FOR SELECTING ALL POSSIBLE COMBINATIONS OF M THINGS
C     OUT OF N OBJECTS.OUTSIDE OF THE SUBROUTINE
C     INITIALLY SET P(1)=N+1,P(N+2)=-2,P(2) TO
C     P(N-M+1-)0,P(N-M+2) TO P(N+1)=1 TO M
C     RESPECTIVELY.IF M=0,P(2)=1
C     INITIALLY SET DONE =0 AND THE S/R SETS THIS TO
C     1 WHEN ALL COMBINATIONS HAVE BEEN SELECTED
C     SUPPOSE THE N OBJECTS ARE IN A(1:N) AND
C     SUCCESSIVE COMBINATIONS ARE STORED IN C(1:M)
C     INITIALLY SET C(1) TO C(M)=A(N-M+1) TO A(N)
C     THEN CALL TWIDL IF DONE=1 ALL COMBINATIONS
C     HAVE BEEN GENERATED,OTHERWISE SET C(Z)=A(X)
C     ALTERNATIVELY STORE (N-M) 0'S AND M 1'S IN
C     B(1:N) IN THAT ORDER THEN CALL TWIDL.
C     IF DONE.NE.1 SET B(X)=1 AND B(Y)=0
C     AND CONTINUE IN THIS WAY UNTIL DONE=1
C
      J=0
1     J=J+1
      IF(P(J+1).LE.0)GOTO 1
      IF(P(J).NE.0)GOTO 5
      J1=J-1
      IF(J1.LT.2)GOTO 6
      DO 7 I=2,J1
      K=J1-I+2
7     P(K+1)=-1
6     P(J+1)=0
      P(2)=1
      X=1
      Z=1
      Y=J
      GOTO 4
5     CONTINUE
      IF(J.GT.1)P(J)=0
2     J=J+1
      IF(P(J+1).GT.0)GOTO 2
      I=J-1
      K=J-1
3     I=I+1
      IF(P(I+1).NE.0)GOTO 8
      P(I+1)=-1
      GOTO 3
8     CONTINUE
```

```
      IF(P(I+1).NE.-1)GOTO 9
      P(I+1)=P(K+1)
      Z=P(K+1)
      X=I
      Y=K
      P(K+1)=-1
      GOTO 4
9     CONTINUE
      IF(I.NE.P(1)) GOTO 10
      DONE=1
      GOTO 4
10    Z=P(I+1)
      P(J+1)=Z
      P(I+1)=0
      X=J
      Y=I
4     RETURN
      END
```

MODEL WITH SINGLE VARIABLE: GALL

```
LOGISTIC REGRESSION ANALYSIS IN STRATA

NUMBER OF STRATA  63
STRATUM NUMBER AND NUMBERS OF CASES AND CONTROLS
  1  1  4   2  1  4   3  1  4   4  1  4   5  1  4   6  1  4   7  1  4   8  1  4
  9  1  4  10  1  4  11  1  4  12  1  4  13  1  4  14  1  4  15  1  4  16  1  4
 17  1  4  18  1  4  19  1  4  20  1  4  21  1  4  22  1  4  23  1  4  24  1  4
 25  1  4  26  1  4  27  1  4  28  1  4  29  1  4  30  1  4  31  1  4  32  1  4
 33  1  4  34  1  4  35  1  4  36  1  4  37  1  4  38  1  4  39  1  4  40  1  4
 41  1  4  42  1  4  43  1  4  44  1  4  45  1  4  46  1  4  47  1  4  48  1  4
 49  1  4  50  1  4  51  1  4  52  1  4  53  1  4  54  1  4  55  1  4  56  1  4
 57  1  4  58  1  4  59  1  4  60  1  4  61  1  4  62  1  4  63  1  4
NUMBER OF VARIABLES IN THIS ANALYSIS  1
THESE VARIABLES ARE  1
MAXIMUM NUMBER OF ITERATIONS  10
ITER LOG-LIKELIHOOD  SCORE    PARAMETER ESTIMATES
  1     -101.3945   13.829          0.0
  2      -95.6567    0.512          1.5714
  3      -95.4042    0.000          1.3011
  4      -95.4041    0.000          1.3061
  5      -95.4041    0.000          1.3061
ESTIMATED PARAMETER VECTOR
   1.306143
FIRST DERIVATIVE LOG-LIKELIHOOD
   0.000002
INFORMATION MATRIX
   7.232529
ESTIMATED COVARIANCE MATRIX
   0.138264
STNDIZED REGRESSION COEFFICIENTS
   3.512656
```

MODEL WITH 2 VARIABLES: GALL + OB

```
LOGISTIC REGRESSION ANALYSIS IN STRATA

NUMBER OF STRATA  63
STRATUM NUMBER AND NUMBERS OF CASES AND CONTROLS
  1  1  4   2  1  4   3  1  4   4  1  4   5  1  4   6  1  4   7  1  4   8  1  4
  9  1  4  10  1  4  11  1  4  12  1  4  13  1  4  14  1  4  15  1  4  16  1  4
 17  1  4  18  1  4  19  1  4  20  1  4  21  1  4  22  1  4  23  1  4  24  1  4
 25  1  4  26  1  4  27  1  4  28  1  4  29  1  4  30  1  4  31  1  4  32  1  4
 33  1  4  34  1  4  35  1  4  36  1  4  37  1  4  38  1  4  39  1  4  40  1  4
 41  1  4  42  1  4  43  1  4  44  1  4  45  1  4  46  1  4  47  1  4  48  1  4
 49  1  4  50  1  4  51  1  4  52  1  4  53  1  4  54  1  4  55  1  4  56  1  4
 57  1  4  58  1  4  59  1  4  60  1  4  61  1  4  62  1  4  63  1  4
NUMBER OF VARIABLES IN THIS ANALYSIS  2
THESE VARIABLES ARE  1  2
MAXIMUM NUMBER OF ITERATIONS  10
ITER LOG-LIKELIHOOD  SCORE    PARAMETER ESTIMATES
  1      -95.4041    5.031    1.3061    0.0
  2      -92.8559    0.016    1.2673    0.7044
  3      -92.8481    0.000    1.3085    0.7254
  4      -92.8483    0.000    1.3086    0.7255
  5      -92.8483    0.000    1.3086    0.7255
ESTIMATED PARAMETER VECTOR
    1.308584    0.725525
FIRST DERIVATIVE LOG-LIKELIHOOD
   -0.000006    0.000004
INFORMATION MATRIX
    7.115862
   -0.413175    9.369920
ESTIMATED COVARIANCE MATRIX
    0.140892
    0.006213    0.106998
STNDIZED REGRESSION COEFFICIENTS
    3.486253    2.218013
```

MODEL WITH 3 VARIABLES: GALL + OB + EST

(Model 4, Table 7.7)

```
LOGISTIC REGRESSION ANALYSIS IN STRATA

NUMBER OF STRATA  63
STRATUM NUMBER AND NUMBERS OF CASES AND CONTROLS
  1  1  4   2  1  4   3  1  4   4  1  4   5  1  4   6  1  4   7  1  4   8  1  4
  9  1  4  10  1  4  11  1  4  12  1  4  13  1  4  14  1  4  15  1  4  16  1  4
 17  1  4  18  1  4  19  1  4  20  1  4  21  1  4  22  1  4  23  1  4  24  1  4
 25  1  4  26  1  4  27  1  4  28  1  4  29  1  4  30  1  4  31  1  4  32  1  4
 33  1  4  34  1  4  35  1  4  36  1  4  37  1  4  38  1  4  39  1  4  40  1  4
 41  1  4  42  1  4  43  1  4  44  1  4  45  1  4  46  1  4  47  1  4  48  1  4
 49  1  4  50  1  4  51  1  4  52  1  4  53  1  4  54  1  4  55  1  4  56  1  4
 57  1  4  58  1  4  59  1  4  60  1  4  61  1  4  62  1  4  63  1  4
NUMBER OF VARIABLES IN THIS ANALYSIS  3
THESE VARIABLES ARE  1  2  3
MAXIMUM NUMBER OF ITERATIONS  10
ITER  LOG-LIKELIHOOD  SCORE   PARAMETER ESTIMATES
  1      -92.8483    26.837   1.3086    0.7255    0.0
  2      -78.4745     1.213   1.0256    0.4851    1.6166
  3      -77.8259     0.017   1.2543    0.5085    1.9860
  4      -77.8176     0.000   1.2746    0.5113    2.0394
  5      -77.8177     0.000   1.2748    0.5113    2.0403
  6      -77.8178     0.000   1.2748    0.5113    2.0403
ESTIMATED PARAMETER VECTOR
    1.274838     0.511341     2.040295
FIRST DERIVATIVE LOG-LIKELIHOOD
   -0.000002    -0.000016    -0.000012
INFORMATION MATRIX
    5.996716
   -0.295262     7.917883
   -0.581353     0.554115     5.222651
ESTIMATED COVARIANCE MATRIX
    0.168775
    0.005016     0.127390
    0.018255    -0.012958     0.194880
STNDIZED REGRESSION COEFFICIENTS
    3.103141     1.432656     4.621776
```

MODEL WITH 4 VARIABLES: GALL + OB + EST + GALL×EST

(Model 8, Table 7.7)

```
LOGISTIC REGRESSION ANALYSIS IN STRATA

NUMBER OF STRATA  63
STRATUM NUMBER AND NUMBERS OF CASES AND CONTROLS
  1  1  4   2  1  4   3  1  4   4  1  4   5  1  4   6  1  4   7  1  4   8  1  4
  9  1  4  10  1  4  11  1  4  12  1  4  13  1  4  14  1  4  15  1  4  16  1  4
 17  1  4  18  1  4  19  1  4  20  1  4  21  1  4  22  1  4  23  1  4  24  1  4
 25  1  4  26  1  4  27  1  4  28  1  4  29  1  4  30  1  4  31  1  4  32  1  4
 33  1  4  34  1  4  35  1  4  36  1  4  37  1  4  38  1  4  39  1  4  40  1  4
 41  1  4  42  1  4  43  1  4  44  1  4  45  1  4  46  1  4  47  1  4  48  1  4
 49  1  4  50  1  4  51  1  4  52  1  4  53  1  4  54  1  4  55  1  4  56  1  4
 57  1  4  58  1  4  59  1  4  60  1  4  61  1  4  62  1  4  63  1  4
NUMBER OF VARIABLES IN THIS ANALYSIS  4
THESE VARIABLES ARE NUMBERS  1  2  3  4
MAXIMUM NUMBER OF ITERATIONS  10
ITER  LOG-LIKELIHOOD  SCORE   PARAMETER ESTIMATES
  1      -77.8178     4.392   1.2748    0.5113    2.0403     0.0
  2      -75.9028     0.221   3.0330    0.4859    2.5096    -2.2027
  3      -75.7904     0.000   2.8467    0.4901    2.6172    -2.0003
  4      -75.7906     0.000   2.8446    0.4901    2.6206    -1.9974
  5      -75.7907     0.000   2.8446    0.4901    2.6206    -1.9974
  6      -75.7904     0.000   2.8446    0.4901    2.6206    -1.9975
  7      -75.7906     0.000   2.8446    0.4901    2.6206    -1.9974
  8      -75.7906     0.000   2.8446    0.4901    2.6206    -1.9974
ESTIMATED PARAMETER VECTOR
    2.844558    0.490128    2.620618   -1.997445
FIRST DERIVATIVE LOG-LIKELIHOOD
    0.000001   -0.000002    0.000000    0.000002
INFORMATION MATRIX
    6.692931
   -0.287092    7.667618
   -1.389091    0.432643    4.504441
    4.758771   -0.133909    0.584442    4.981022
ESTIMATED COVARIANCE MATRIX
    0.774393
   -0.003830    0.131275
    0.340365   -0.014950    0.376375
   -0.779880    0.008943   -0.369741    0.989468
STNDIZED REGRESSION COEFFICIENTS
    3.232466    1.352753    4.271628   -2.008047
```

APPENDIX VI

LISTING OF PROGRAM LOGODD

The following main program and subroutine perform the regression analysis of a set of 2×2 tables as described in § 7.5. For illustration we have used the data from the Oxford Childhood Cancer Survey published by Kneale (1971) and listed in Appendix II. Two different models were fit, the first with just the coefficient β representing the overall log relative risk for radiation, and the second with both β and the coefficient γ_1 representing the linear change in the log relative risk with year. The option for an 'exact' analysis was selected, giving numerical results as shown in § 7.5. (The last line in Table 6.17 shows the results which are obtained using the option for an 'approximate' analysis.) Following the fitting of the two parameter model, the programme was instructed (IPRINT = 1) to print out the observed and fitted entries for each table, the variance associated with that table (equation 4.13), the contribution it makes to the log likelihood, the estimated value of the odds ratio, and the associated covariates of which the first is the constant term and the second the coded year.

MAIN PROGRAM

```
      INTEGER P
      DOUBLE PRECISION INFO(10,10),LOGLIK,B(10),SCORE(10),SCORE1(10)
      DOUBLE PRECISION Z(10,120),T(4,120),PROB,E,V,DETER,CHIS,ULL
      REAL FMT(60),RT(4),RZ(10)
      DIMENSION IVAR(10)
      DATA NM/10/
      EQUIVALENCE(P,NP)
      EPS=1. E-4
 1000 READ(5,150,END=900) P,NFORMT,ITS,ITAPE,IME,IBETA,IPRINT
  150 FORMAT(15I5)
  999 INF=20*INFORMT
      READ(5,155) (FMT(I),I=1,INF)
  155 FORMAT(20A4)
      IF(P.GT.10.OR.P.LT.1.OR.ITS.GT.20.OR.NFORMT.GT.3)GO TO 996
C NOW READ DATA ONE TABLE AND ASSOCIATED COVARIATES PER LINE
      K=0
    7 K=K+1
      READ(ITAPE,FMT,END=10)(RT(I),I=1,4)Z1,Z2
      RZ(1)=Z1
      RZ(2)=Z2
   86 IF(K.GT.120)GO TO 9
      IF(RT(1).EQ.0.0.AND.RT(2).EQ.0.0.AND.RT(3).EQ.0.0.AND.RT(4).EQ.0.0
     A)GO TO 10
      DO 8 I=1,4
    8 T(I,K)=RT(I)
      DO 85 I=1,2
   85 Z(I,K)=RZ(I)
      GO TO 7
    9 WRITE(6,154)
  154 FORMAT('ODATA EXCEEDS MAXIMUM OF 120 TABLES')
      GO TO 900
   10 NTAB = K-1
      NP=1
      DO 14 K=1,NP
   14 B(K)=0.0
      IVAR(1)=1
      JPRINT=0
      CALL LOGODD(NM,NP,NTAB,B,SCORE,ITS,EPS,IME,JPRINT,Z,INFO,T,IVAR,
     *SCORE1)
      IVAR(1)=1
      IVAR(2)=2
      NP=2
      CALL LOGODD(NM,NP,NTAB,B,SCORE,ITS,EPS,IME,IPRINT,Z,INFO,T,IVAR,
     *SCORE1)
  900 CONTINUE
  996 STOP
      END
```

SUBPROGRAM LOGODD

```
      SUBROUTINE LOGODD(NM,NP,NTAB,B,SCORE,ITS,EPS,IME,IPRINT,Z,INFO,T,
     * IVAR,SCORE1)
C    PROGRAM FOR THE REGRESSION ANALYSIS OF THE LOG ODDS RATIO
      DOUBLE PRECISION INFO(NM,1),LOGLIK,B(1),SCORE(1)
      DOUBLE PRECISION Z(NM,1),T(4,1),PROB,E,V,DETER,CHIS,ULL
      DOUBLE PRECISION TEMP,SCORE1(1)
      DIMENSION IVAR(1)
C     ITS = MAXIMUM NUMBER OF ITERATIONS
C      IME = 1 IF WANT EXACT CALCULATIONS
C      IME = 2 IF WANT APPROXIMATE CALCULATIONS
C      IPRINT = 1 IF WANT OBSERVED AND FITTED TABLES
C      PRINTED OUT AT IST AND LAST ITERATIONS
      WRITE(6,149)
  149 FORMAT('1REGRESSION ANALYSIS OF LOG ODDS RATIO'/)
      WRITE(6,151)NTAB
 151  FORMAT(' NUMBER OF TABLES = ',I3)
      IF(IME.EQ.1)WRITE(6,152)
      IF(IME.EQ.2)WRITE(6,153)
  152 FORMAT(' EXACT ANALYSIS')
  153 FORMAT(' APPROXIMATE ANALYSIS')
      WRITE(6,150)NP,(IVAR(K),K=1,NP)
 150  FORMAT(' NUMBER OF VARIABLES IN THIS ANALYSIS =',I3,
     */,' THESE VARIABLES ARE NUMBERS',30I3)
      WRITE(6,154)ITS
 154  FORMAT(' MAXIMUM NUMBER OF ITERATIONS',I4)
C INITIALIZE BETA TO ZERO
   15 NFLAG=0
      DO 60 II=1,ITS
      IF(II.EQ.ITS)NFLAG=1
        I1=0
      CALL CALC(NTAB,NP,NM,IME,I1,SCORE,INFO,LOGLIK,B,CHIS,ULL,Z,T,IVAR)
      TEST=0.0
      DO 20 K=1,NP
      S=SNGL(SCORE(K))
      SCORE1(K)=SCORE(K)
   20 TEST=TEST+ABS(S)
      IF(TEST.LT.EPS)NFLAG=1
      IF(NFLAG.EQ.1) GOTO 47
   48 CALL INVR(INFO,NP,SCORE,1,DETER,NM,NP)
      TEMP=0.0
      DO 10 I=1,NP
      TEMP=TEMP+SCORE(I)*SCORE1(I)
 10   CONTINUE
      IF(II.EQ.1)WRITE(6,116)
 116  FORMAT('  ITER     LOG-LIKELIHOOD    SCORE          PARAMETER ESTIMA
     *TES')
 47   CONTINUE
```

```
      WRITE(6,107)II,LOGLIK,TEMP,(B(J),J=1,NP)
  107 FORMAT(1X,I4,F17.4,F13.4,2X,8F12.4,20(/,36X,8F12.4))
      IF(NFLAG.EQ.1)GO TO 99
CALCULATE NEW VALUE OF BETA
   52 CONTINUE
      DO 55 K=1,NP
   55 B(K)=B(K)-SCORE(K)
   60 CONTINUE
   99 CONTINUE
      WRITE(6,101)(B(J),J=1,NP)
  101 FORMAT(' ESTIMATED PARAMETER VECTOR'/,(1X,10F12.6)
      WRITE(6,102)(SCORE(J),J=1,NP)
  102 FORMAT(' FIRST DERIVATIVE LOG-LIKELIHOOD'/,(1X,10F12.6))
      WRITE(6,103)
  103 FORMAT(' INFORMATION MATRIX')
      DO 11 I=1,NP
      WRITE(6,104)(INFO(I,J),J=1,I)
  11  CONTINUE
  104 FORMAT(1X,10F12.6)
      CALL INVR(INFO,NP,SCORE,1,DETER,NM,NP)
      WRITE(6,105)
  105 FORMAT(' ESTIMATED COVARIANCE MATRIX')
      DO 12 I=1,NP
      SCORE1(I)=B(I)/DSQRT(INFO(I,I))
C   SCORE1 IS USED TO CALCULATE STANDARDISED COEFFICIENTS
      WRITE(6,104)(INFO(I,J),J=1,I)
  12  CONTINUE
      WRITE(6,106)(SCORE1(I),I=1,NP)
  106 FORMAT('OSTANDARDISED REGRESSION COEFFICIENTS'/(1X,10F12.6))
  4   CONTINUE
      WRITE(6,156)CHIS
  156 FORMAT('OCHI-SQUARE GOODNESS OF FIT ',F12.4)
      WRITE(6,157)ULL
  157 FORMAT('02XLR RATIO GOODNESS OF FIT ',F12.4)
      I=NTAB-NP
      WRITE(6,158)I
  158 FORMAT('ODEGREES OF FREEDOM ',I5)
      IF(IPRINT.NE.1)GO TO 899
      WRITE(6,290)(B(J),J=1,NP)
  290 FORMAT('1 FITTED VALUES EACH TABLE FOR BETA VALUES :', 9F9.4/(43X,
     * 9F9.4))
      CALL CALC(NTAB,NP,NM,IME,1,SCORE,INFO,LOGLIK,B,CHIS,ULL,Z,T,IVAR)
  899 CONTINUE
  900 WRITE(6,667)
  667 FORMAT('0'//'ORUN TERMINATES SUCCESSFULLY')
      RETURN
      END
```

```
      SUBROUTINE CALC(NTAB,P,NM,IME,IPRINT,SCORE,INFO,LOGLIK,B,CHIS,ULL
     * Z,T,IVAR)
      DOUBLE PRECISION SCORE(1),INFO(NM,1),LOGLIK,Z(NM,1)B(1)
      DOUBLE PRECISION T(4,1),SUM,PROB,E,V,CHIS,ULL,T1,T2,T3,T4,T5,
     *T6,T7,T8
      DIMENSION IVAR(1)
      INTEGER P
      CHIS=0.0
      LOGLIK=0.0
      ULL=0.0
      IF(IPRINT.NE.1) GOTO 1
      WRITE(6,290)
290   FORMAT(//'0 TABLE',5X,'A',11X,'B',11X,'C',11X,'D', 8X,'VARIANCE  L
     *OG-LIKE',4X,  'PSI      COVARIATES'/6X,4(4X,'0',4X,'E',2X))
1     CONTINUE
      DO 5 K=1,P
      SCORE(K)=0.0
      DO 5 KK=1,P
    5 INFO(K,KK)=0.0
      DO 20 I=1,NTAB
      SUM=0.0
      DO 10 K=1,P
      L=IVAR(K)
   10 SUM=SUM-Z(L,I)*B(K)
      CALL MYST(T(1,I),SUM,PROB,E,V,P,IME)
      PROB=DLOG(PROB)
      LOGLIK=LOGLIK+PROB
      CHIS=CHIS+((T(2,I)-E)*(T(2,I)-E))/V
      DO 15 K=1,P
      L=IVAR(K)
      SCORE(K)=SCORE(K)+Z(L,I)*(T(2,I)-E)
      DO 15 KK=1,P
      LL=IVAR(KK)
   15 INFO(K,KK)=INFO(K,KK)+Z(L,I)*Z(LL,I)*V
      T1=T(1,I)
      T2=T(2,I)
      T3=T(3,I)
      T4=T(4,I)
      T6=E
      T5=T(1,I)+T(2,I)-T6
      T7=T(1,I)+T(3,I)-T5
      T8=T(3,I)  +T(4,I)-T7
      IF(T1.GT.0.0)ULL=ULL+T1*DLOG(T5/T1)
      IF(T2.GT.0.0)ULL=ULL+T2*DLOG(T6/T2)
      IF(T3.GT.0.0)ULL=ULL+T3*DLOG(T7/T3)
      IF(T4.GT.0.0)ULL=ULL+T4*DLOG(T8/T4)
      IF(IPRINT.EQ.1)GO TO 21
      GO TO 20
21    CONTINUE
```

```
      I1=T1
      I2=T2
      I3=T3
      I4=T4
      WRITE(6,291) I,I1,T5,I2,T6,I3,T7,I4,T8,V,PROB,SUM,(Z(IVAR(K),I),K=
     *1,P)
  291 FORMAT(I4,2X,4(1X,I4,F7.2),3F10.3,8F6.2,20(/,84X,8F6.2))
   20 CONTINUE
      ULL=-2.0*ULL
      RETURN
      END
```

```
      SUBROUTINE MYST(T,SUM,PROB,E,V,P,IME)
C   THE EXTERNALS **QUAD** AND **BINCOF** ARE NECESSARY TO USE THIS
C                                                            SUBROUTINE
      INTEGER P
      DOUBLE PRECISION T,PROB,E,V,TOT,BINCOF,PI
      DIMENSION T(4)
      DOUBLE PRECISION SUM,EM,EN,TEE ,ENMT,A,B,C,U,G,H,HH
      PI= 3.14159 26535 89793 23846 26433
      U=0.
      H=0.
      G=0.
      HH=0.
      EM   = T(1) + T(3)
      EN   = T(2) + T(4)
      TEE = T(1) + T(2)
      ENMT = T(3) + T(4)
C   VARIABLE *IME* IS THE FLAT TO DETERMINE EXACT OR ASYMPTOTIC COMP
C     IME = 1 GIVES EXACT
C     IME = 2 GIVES ASYMPTOTIC
      IF(IME.LT.2) GO TO 100
      GO TO 101
C   EXACT CALCULATIONS
  100 SAP=SNGL(DEXP(SUM))
      IF(SAP .EQ.1.0)GO TO 403
      A=BINCOF (EM,TEE-T(2))
      B=BINCOF(EN,T(2))
      C = DEXP(T(2) * SUM)
      FNUM  = A*B*C
      KK = IDINT(TEE + 1.)
      DO 14 J=1,KK
      A=BINCOF(EM,TEE-U)
      B=BINCOF(EN,U)
      C =DEXP(U*SUM)
      H = A * B *C + H
      G = A*B*C*U + G
      HH = A*B*C*U**2 + HH
   14 U = U + 1.
      PROB= FNUM/H
      E = G/H
      V = HH/H - E**2
      SUM=DEXP(SUM)
      GO TO 677
  403 A=BINCOF(TEE,T(2))
      B=BINCOF(ENMT,T(4))
      TOT = ENMT + TEE
      C = BINCOF(TOT,EN)
      PROB = (A*B)/C
      EN   = T(2) + T(4)
      E = TEE * (EN/(TOT))
      V = (EM*EN*TEE*ENMT)/(TOT*TOT*(TOT-1))
      SUM=DEXP(SUM)
      GO TO 677
```

```
C    ASYMPTOTIC METHOD
 101 SUM =DEXP(SUM)
     SAP =SNGL(SUM)
     IF(SAP-1.0)16,15,16
  15 E = TEE * (EN/(ENMT + TEE))
     GO TO 102
  16 A = (1. - SUM)
     B = EM - TEE + (SUM*TEE) + (SUM*EN)
     C = -(SUM*TEE*EN)
     E = QUAD(A,B,C,TEE,EN)
 102 V = 1./((1./E) + (1./(TEE-E)) + (1./(EN-E)) + (1./(EM-TEE+E)))
     PROB= 1./(DSQRT(2.*PI*V))
     PROB=PROB*DEXP(-(0.50* ((T(2) - E)**2/V)))
 677 CONTINUE
     RETURN
     END
```

```
      DOUBLE PRECISION FUNCTION QUAD(A,B,C,TEE,EN)
      DOUBLE PRECISION A,B,C,TEE,EN
      C =      B**2 - (4.*A*C)
      GA = SNGL(TEE)
      GB = SNGL(EN)
      G = SNGL(C)
      IF(G) 32,40,40
   40 C = DSQRT(C)
      QUAD = ((-B) -C)/(2. * A)
      G = SNGL(QUAD)
      IF(G.GT.0.0.AND.G.LT.AMIN1(GA,GB)) RETURN
      QUAD = ((-B) + C)/(2. * A)
      G = SNGL(QUAD)
      IF(G.GT.0.0.AND.G.LT.AMIN1(GA,GB)) RETURN
   32 WRITE(6,100)
  100 FORMAT(' ERROR IN QUAD COMPLEX SOLUTION')
      STOP
      END
```

```
      DOUBLE PRECISION FUNCTION BINCOF(X,Y)
      DOUBLE PRECISION UPPER,BELOW,X,Y
      UUPER=X
      BELOW=Y
      BINCOF=0.
      A = SNGL(UPPER)
      B = SNGL(BELOW)
      IF(A-B.LT.B) BELOW= UPPER - BELOW
      K = IDINT(BELOW)
      IF(K.LT.0)GO TO 2
      BINCOF = 1.
      IF(K.EQ.0)GO TO 2
      DO 41 I=1,K
      BINCOF =(UPPER/BELOW) * BINCOF
      UPPER = UPPER - 1.
   41 BELOW = BELOW - 1.
    2 RETURN
      END
```

```
      SUBROUTINE INVR(A,N,B,M,DETERM,ISIZE,JSIZE)
      DIMENSION IPIVOT(100),INDEX(100,2)
      DOUBLE PRECISION A(ISIZE,JSIZE),B(ISIZE,M),PIVOT(100),AMAX,T
     ASWAP,DETERM
      EQUIVALENCE (IROW,JROW),(ICOLUM,JCOLUM),(AMAX,T,SWAP)
C
   10 DETERM=1.0
   15 DO 20 J=1,N
   20 IPIVOT(J)=0
   30 DO 550 I=1,N
C
C     SEARCH FOR PIVOT ELEMENT
C
   40 AMAX=0.0
   45 DO 105 J=1,N
   50 IF (IPIVOT(J)-1) 60, 105, 60
   60 DO 100 K=1,N
   70 IF (IPIVOT(K)-L) 80, 100, 740
   80 IF(DABS(AMAX)-DABS(A(J,K)))85,100,100
   85 IROW=J
   90 ICOLUM=K
   95 AMAX=A(J,K)
  100 CONTINUE
  105 CONTINUE
  110 IPIVOT(ICOLUM)=IPIVOT(ICOLUM)+1
C
C     INTERCHANGE ROWS TO PUT PIVOT ELEMENT ON DIAGONAL
C
  130 IF (IROW-ICOLUM) 140, 260, 140
  140 DETERM=-DETERM
  150 DO 200 L=1,N
  160 SWAP=A(IROW,L)
  170 A(IROW,L)=A(ICOLUM,L)
  200 A(ICOLUM,L)=SWAP
  205 IF(M) 260, 260, 210
  210 DO 250 L=1, M
  220 SWAP=B(IROW,L)
  230 B(IROW,L)=B(ICOLUM,L)
  250 B(ICOLUM,L)=SWAP
  260 INDEX(I,1)=IROW
  270 INDEX(I,2)=ICOLUM
  310 PIVOT(I)=A(ICOLUM,ICOLUM)
  320 DETERM-DETERM*PIVOT(I)
C
C     DIVIDE PIVOT ROW BY PIVOT ELEMENT
C
  330 A(ICOLUM,ICOLUM)=1.0
  340 DO 350 L=1,N
  350 A(ICOLUM,L)=A(ICOLUM,L)/PIVOT(I)
  355 IF(M) 380, 380, 360
  360 DO 370 L=1,M
  370 B(ICOLUM,L)=B(ICOLUM,L)/PIVOT(I)
```

```
C
C      REDUCE NON-PIVOT ROWS
C
  380 DO 550 L1=1,N
  390 IF(L1-ICOLUM) 400, 550, 400
  400 T=A(L1,ICOLUM)
  420 A(L1,ICOLUM=0.0
  430 DO 450 L=1,N
  450 A(L1,L)=A(L1,L)-A(ICOLUM,L)*T
  455 IF(M) 550, 550, 460
  460 DO 500 L=1,M
  500 B(L1,L)=B(L1,L)-B(ICOLUM,L)*T
  550 CONTINUE
C
C      INTERCHANGE COLUMNS
C
  600 DO 710 I=1,N
  610 L=N+1-I
  620 IF (INDEX(L,I)-INDEX(L,2)) 630, 710, 630
  630 JROW=INDEX(L,1)
  640 JCOLUM=INDEX(L,2)
  650 DO 705 K=1,N
  660 SWAP=A(K,JROW)
  670 A(K,JROW)=A(K,JCOLUM)
  700 A(K,JCOLUM)=SWAP
  705 CONTINUE
  710 CONTINUE
  740 RETURN
      END
```

MODEL WITH CONSTANT TERM ONLY

```
REGRESSION ANALYSIS OF LOG ODDS RATIO

NUMBER OF TABLES = 120
EXACT ANALYSIS
NUMBER OF VARIABLES IN THIS ANALYSIS = 1
THESE VARIABLES ARE NUMBERS  1
MAXIMUM NUMBER OF ITERATIONS  15
 ITER      LOG-LIKELIHOOD      SCORE      PARAMETER ESTIMATES
   1         -261.4516       82.1955     0.0
   2         -220.0785        0.0152     0.4982
   3         -220.0708        0.0000     0.5051
   4         -220.0708        0.0000     0.5051
ESTIMATED PARAMETER VECTOR
    0.505080
FIRST DERIVATIVE LOG-LIKELIHOOD
   -0.000000
INFORMATION MATRIX
  313.718469
ESTIMATED COVARIANCE MATRIX
    0.003147
STANDARDISED REGRESSION COEFFICIENTS
    9.002886
CHI-SQUARE GOODNESS OF FIT        117.3498
2XLR RATIO GOODNESS OF FIT        124.1829
DEGREES OF FREEDOM    119
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MODEL WITH LINEAR EFFECT OF YEAR

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REGRESSION ANALYSIS OF LOG ODDS RATIO

NUMBER OF TABLES = 120
EXACT ANALYSIS
NUMBER OF VARIABLES IN THIS ANALYSIS = 2
THESE VARIABLES ARE NUMBERS  1  2
MAXIMUM NUMBER OF ITERATIONS  15
 ITER      LOG-LIKELIHOOD     SCORE     PARAMETER ESTIMATES
   1          -220.0708       7.2135    0.5051          0.0
   2          -216.4595       0.0013    0.5144       -0.0384
   3          -216.4588       0.0000    0.5165       -0.0385
   4          -216.4588       0.0000    0.5165       -0.0385
ESTIMATED PARAMETER VECTOR
    0.516496    -0.038542
FIRST DERIVATIVE LOG-LIKELIHOOD
   -0.000000     0.000000
INFORMATION MATRIX
  316.476245
  110.182468 4876.820615
ESTIMATED COVARIANCE MATRIX
    0.003185
   -0.000072     0.000207
STANDARDISED REGRESSION COEFFICIENTS
    9.152142    -2.680950
CHI-SQUARE GOODNESS OF FIT      111.2280
2XLR RATIO GOODNESS OF FIT      116.8751
DEGREES OF FREEDOM    118
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OBSERVED AND EXPECTED VALUES FOR MODEL 2

FITTED VALUES EACH TABLE FOR BETA VALUES : 0.5165 -0.0385

TABLE	A		B		C		D		VARIANCE	LOG-LIKE	PSI	COVARIATES	
	O	E	O	E	O	E	O	E					
1	3	2.11	0	0.89	25	25.89	28	27.11	0.605	-1.068	2.464	1.00	-10.00
2	5	4.74	2	2.26	16	16.26	19	18.74	1.331	-1.094	2.371	1.00	-9.00
3	2	2.78	2	1.22	30	29.22	30	30.78	0.813	-1.295	2.371	1.00	-9.00
4	7	5.42	1	2.58	28	29.58	34	32.42	1.590	-1.816	2.281	1.00	-8.00
5	7	6.08	2	2.92	28	28.92	33	32.08	1.770	-1.390	2.281	1.00	-8.00
6	2	1.39	0	0.61	36	36.61	38	37.39	0.421	-0.738	2.281	1.00	-8.00
7	5	4.04	1	1.96	25	25.96	29	28.04	1.221	-1.304	2.195	1.00	-7.00
8	3	2.73	1	1.27	40	40.27	42	41.73	0.842	-0.892	2.195	1.00	-7.00
9	5	4.07	1	1.93	44	44.93	48	47.07	1.250	-1.280	2.195	1.00	-7.00
10	11	8.69	2	4.31	42	44.31	51	48.69	2.587	-2.357	2.195	1.00	-7.00
11	6	6.55	4	3.45	25	24.45	27	27.55	1.955	-1.375	2.112	1.00	-6.00
12	6	6.58	4	3.42	29	28.42	31	31.58	1.984	-1.392	2.112	1.00	-6.00
13	11	8.55	2	4.45	35	37.45	44	41.55	2.576	-2.498	2.112	1.00	-6.00
14	4	3.36	1	1.64	49	49.64	52	51.36	1.064	-1.084	2.112	1.00	-6.00
15	4	7.32	7	3.68	57	53.68	54	57.32	2.267	-3.633	2.112	1.00	-6.00
16	2	3.96	4	2.04	38	36.04	36	37.96	1.269	-2.495	2.112	1.00	-5.00
17	8	7.07	3	3.93	21	21.93	26	25.07	2.113	-1.466	2.032	1.00	-5.00
18	8	8.43	5	4.57	36	35.57	39	39.43	2.585	-1.462	2.032	1.00	-5.00
19	6	5.93	3	3.07	46	46.07	49	48.93	1.882	-1.259	2.032	1.00	-5.00
20	5	4.63	2	2.37	50	50.37	53	52.63	1.489	-1.163	2.032	1.00	-5.00
21	15	12.30	4	6.70	46	48.70	57	54.30	3.741	-2.509	2.032	1.00	-5.00
22	4	3.26	1	1.74	27	27.74	30	29.26	1.067	-1.145	1.956	1.00	-4.00
23	9	8.36	4	4.64	39	39.64	44	43.36	2.635	-1.469	1.956	1.00	-4.00
24	9	8.95	5	5.05	35	35.05	39	38.95	2.778	-1.443	1.956	1.00	-4.00
25	4	3.92	2	2.08	38	38.08	40	39.92	1.285	-1.081	1.956	1.00	-4.00
26	12	12.08	7	6.92	41	40.92	46	46.08	3.691	-1.585	1.956	1.00	-4.00
27	8	8.39	5	4.61	48	47.61	51	51.39	2.677	-1.472	1.956	1.00	-4.00
28	8	10.33	8	5.67	63	60.67	63	65.33	3.300	-2.361	1.956	1.00	-4.00
29	6	5.13	2	2.87	37	37.87	41	40.13	1.700	-1.364	1.882	1.00	-3.00
30	8	7.00	3	4.00	35	36.00	40	39.00	2.266	-1.514	1.882	1.00	-3.00

TABLE	A O	A E	B O	B E	C O	C E	D O	D E	VARIANCE	LOG-LIKE	PSI	COVARIATES	
31	12	10.64	5	6.36	31	32.36	38	36.64	3.269	-1.765	1.882	1.00	-3.00
32	4	5.12	4	2.88	36	34.88	36	37.12	1.691	-1.604	1.882	1.00	-3.00
33	7	5.13	1	2.87	37	38.87	43	41.13	1.703	-2.107	1.882	1.00	-3.00
34	16	13.89	6	8.11	54	56.11	64	61.89	4.392	-2.127	1.882	1.00	-3.00
35	12	10.84	5	6.16	63	64.16	70	68.84	3.534	-1.713	1.882	1.00	-3.00
36	9	12.68	11	7.32	62	58.32	60	63.68	4.055	-3.259	1.882	1.00	-3.00
37	4	5.67	5	3.33	33	31.33	32	33.67	1.883	-1.991	1.810	1.00	-2.00
38	7	5.64	2	3.36	24	25.36	29	27.64	1.846	-1.666	1.810	1.00	-2.00
39	8	8.12	5	4.88	34	33.88	37	37.12	2.631	-1.425	1.810	1.00	-2.00
40	11	11.73	8	7.27	35	34.27	38	38.73	3.639	-1.659	1.810	1.00	-2.00
41	5	6.31	5	3.69	42	40.69	42	43.31	2.117	-1.740	1.810	1.00	-2.00
42	12	11.22	6	6.78	43	43.78	49	48.22	3.602	-1.635	1.810	1.00	-2.00
43	8	8.82	6	5.18	55	54.18	57	57.82	2.944	-1.609	1.810	1.00	-2.00
44	17	16.87	10	10.13	74	74.13	81	80.87	5.469	-1.775	1.810	1.00	-2.00
45	9	9.92	7	6.08	34	33.08	36	36.92	3.135	-1.653	1.810	1.00	-2.00
46	3	4.99	5	3.01	36	34.01	34	35.99	1.717	-2.327	1.742	1.00	-1.00
47	2	4.37	5	2.63	33	30.63	30	32.37	1.507	-2.902	1.742	1.00	-1.00
48	7	5.57	2	3.43	25	26.43	30	28.57	1.867	-1.716	1.742	1.00	-1.00
49	6	8.67	8	5.33	47	44.33	45	47.67	2.912	-2.671	1.742	1.00	-1.00
50	5	3.77	1	2.23	44	45.23	48	46.77	1.333	-1.528	1.742	1.00	-1.00
51	11	14.77	13	9.23	64	60.23	62	65.77	4.842	-3.165	1.742	1.00	-1.00
52	14	14.10	9	8.90	50	49.90	55	55.10	4.550	-1.687	1.742	1.00	-1.00
53	13	14.73	11	9.27	56	54.27	58	59.73	4.775	-2.036	1.742	1.00	-1.00
54	8	10.53	9	6.47	56	53.47	55	57.53	3.529	-2.463	1.742	1.00	-1.00
55	6	6.24	4	3.76	43	42.76	45	45.24	2.142	-1.344	1.742	1.00	-1.00
56	4	4.89	4	3.11	25	24.11	25	25.89	1.678	-1.455	1.676	1.00	0.0
57	8	9.65	8	6.35	32	30.35	32	33.65	3.127	-1.947	1.676	1.00	0.0
58	4	6.06	6	3.94	23	20.94	21	23.06	1.998	-2.319	1.676	1.00	0.0
59	8	9.72	8	6.28	40	38.28	40	41.72	3.237	-1.983	1.676	1.00	0.0
60	7	7.92	6	5.08	36	35.08	37	37.92	2.676	-1.600	1.676	1.00	0.0

TABLE	A		B		C		D		VARIANCE	LOG-LIKE	PSI	COVARIATES	
	O	E	O	E	O	E	O	E					
61	15	13.90	8	9.10	46	47.10	53	51.90	4.535	-1.797	1.676	1.00	0.0
62	15	17.52	14	11.48	62	59.48	63	65.52	5.710	-2.362	1.676	1.00	0.0
63	9	9.16	6	5.84	46	45.84	49	49.16	3.127	-1.511	1.676	1.00	0.0
64	9	8.59	5	5.41	51	51.41	55	54.59	2.975	-1.495	1.676	1.00	0.0
65	5	6.14	5	3.86	41	39.86	41	42.14	2.146	-1.643	1.676	1.00	0.0
66	6	4.82	2	3.18	22	23.18	26	24.82	1.681	-1.542	1.613	1.00	1.00
67	3	4.25	4	2.75	30	28.75	29	30.25	1.522	-1.669	1.613	1.00	1.00
68	9	6.59	2	4.41	23	25.41	30	27.59	2.236	-2.569	1.613	1.00	1.00
69	12	12.44	9	8.56	34	33.56	37	37.44	3.985	-1.648	1.613	1.00	1.00
70	14	11.39	5	7.61	43	45.61	52	49.39	3.860	-2.443	1.613	1.00	1.00
71	16	13.11	6	8.89	40	42.89	50	47.11	4.325	-2.588	1.613	1.00	1.00
72	17	14.41	7	9.59	61	63.59	71	68.41	4.932	-2.365	1.613	1.00	1.00
73	8	7.87	5	5.13	50	50.13	53	52.87	2.794	-1.448	1.613	1.00	1.00
74	8	10.78	10	7.22	44	41.22	42	44.78	3.634	-2.623	1.613	1.00	1.00
75	9	7.16	3	4.84	22	23.84	28	26.16	2.383	-2.017	1.613	1.00	1.00
76	5	4.18	2	2.82	23	23.82	26	25.18	1.507	-1.322	1.552	1.00	2.00
77	9	5.98	1	4.02	37	40.02	45	41.98	2.175	-3.416	1.552	1.00	2.00
78	11	10.56	7	7.44	31	31.44	35	34.56	3.492	-1.574	1.552	1.00	2.00
79	6	8.88	9	6.12	39	36.12	36	38.88	3.070	-2.810	1.552	1.00	2.00
80	14	15.83	13	11.17	49	47.17	50	51.83	5.218	-2.080	1.552	1.00	2.00
81	21	17.60	9	12.40	50	53.40	62	58.60	5.813	-2.775	1.552	1.00	2.00
82	16	15.88	11	11.12	53	53.12	58	57.88	5.329	-1.762	1.552	1.00	2.00
83	6	5.97	4	4.03	37	37.03	39	38.97	2.160	-1.324	1.552	1.00	2.00
84	9	10.05	8	6.95	41	39.95	42	43.05	3.463	-1.721	1.552	1.00	2.00
85	8	5.85	2	4.15	23	25.15	29	26.85	2.079	-2.346	1.493	1.00	3.00
86	9	7.00	3	5.00	25	27.00	31	29.00	2.449	-2.142	1.493	1.00	3.00
87	8	8.80	7	6.20	46	45.20	47	47.80	3.175	-1.619	1.493	1.00	3.00
88	4	4.73	4	3.27	42	41.27	42	42.73	1.789	-1.399	1.493	1.00	3.00
89	11	10.52	7	7.48	47	47.48	51	50.52	3.741	-1.611	1.493	1.00	3.00
90	11	9.40	5	6.60	51	52.60	57	55.40	3.418	-1.883	1.493	1.00	3.00

TABLE	A O	A E	B O	B E	C O	C E	D O	D E	VARIANCE	LOG-LIKE	PSI	COVARIATES	
91	6	7.06	6	4.94	46	44.94	46	47.06	2.604	-1.642	1.493	1.00	3.00
92	9	8.73	6	6.27	32	32.27	35	34.73	3.032	-1.492	1.493	1.00	3.00
93	4	5.21	5	3.79	30	28.79	29	30.21	1.938	-1.651	1.437	1.00	4.00
94	4	5.82	6	4.18	48	46.18	46	47.82	2.226	-2.067	1.437	1.00	4.00
95	9	10.40	9	7.60	54	52.60	54	55.40	3.807	-1.862	1.437	1.00	4.00
96	9	9.25	7	6.75	50	49.75	52	52.25	3.412	-1.558	1.437	1.00	4.00
97	10	9.89	7	7.11	78	78.11	81	80.89	3.768	-1.594	1.437	1.00	4.00
98	14	12.08	7	8.92	48	49.92	55	53.08	4.312	-2.055	1.437	1.00	4.00
99	6	5.81	4	4.19	41	41.19	43	42.81	2.204	-1.337	1.437	1.00	4.00
100	3	2.89	2	2.11	50	50.11	51	50.89	1.175	-1.045	1.382	1.00	5.00
101	4	4.03	3	2.97	53	52.97	54	54.03	1.621	-1.194	1.382	1.00	5.00
102	6	5.75	4	4.25	68	68.25	70	69.75	2.297	-1.363	1.382	1.00	5.00
103	10	11.38	10	8.62	58	56.62	58	59.38	4.225	-1.882	1.382	1.00	5.00
104	4	4.03	3	2.97	57	56.97	58	58.03	1.626	-1.197	1.382	1.00	5.00
105	3	4.02	4	2.98	42	40.98	41	42.02	1.598	-1.510	1.382	1.00	5.00
106	3	2.84	2	2.16	42	42.16	43	42.84	1.173	-1.046	1.330	1.00	6.00
107	10	11.20	10	8.80	52	50.80	52	53.20	4.176	-1.820	1.330	1.00	6.00
108	4	5.10	5	3.90	69	67.90	68	69.10	2.090	-1.603	1.330	1.00	6.00
109	10	7.87	4	6.13	43	45.13	49	46.87	3.025	-2.187	1.330	1.00	6.00
110	5	5.63	5	4.37	34	33.37	34	34.63	2.177	-1.424	1.330	1.00	6.00
111	4	4.45	4	3.55	41	40.55	41	41.45	1.821	-1.306	1.280	1.00	7.00
112	3	5.01	6	3.99	48	45.99	45	47.01	2.047	-2.242	1.280	1.00	7.00
113	13	9.93	5	8.07	42	45.07	50	46.93	3.764	-2.805	1.280	1.00	7.00
114	1	2.24	3	1.76	40	38.76	38	39.24	0.950	-1.663	1.280	1.00	7.00
115	7	4.93	2	4.07	46	48.07	51	48.93	2.061	-2.263	1.231	1.00	8.00
116	5	3.84	2	3.16	46	47.16	49	47.84	1.631	-1.542	1.231	1.00	8.00
117	7	6.00	4	5.00	35	36.00	38	37.00	2.401	-1.557	1.231	1.00	8.00
118	6	6.45	6	5.55	40	39.55	40	40.45	2.625	-1.457	1.185	1.00	9.00
119	3	3.78	4	3.22	51	50.22	50	50.78	1.642	-1.377	1.185	1.00	9.00
120	7	4.23	1	3.77	25	27.77	31	28.23	1.772	-3.338	1.140	1.00	10.00

SUBJECT INDEX TO VOLUMES I AND II

A

B