APPENDIX SEVEN

MATHEMATICA CODE FOR CALCULATING THE ASYMPTOTIC COVARIANCE MATRIX OF THE ESTIMATES

*pm is a matrix of parameters.

```
bb=Table[0,{11},{11}];
pm={{v1},{v2},{e[1,1]},{e[1,2]},{e[1,3]},{e[2,1]},
{e[2,2]},{e[2,3]},{e[3,1]},{e[3,2]},{e[3,3]}};
e[4,1]=-e[3,1]-e[2,1]-e[1,1];e[4,2]=-e[3,2]-e[2,2]-e[1,2];
e[4,3]=-e[3,3]-e[2,3]-e[1,3];
```

*Next the covariance matrix w is created.

```
 h={{4.8, 2.1, 1.0},
    {2.1, 3.3, 1.4},
    {1.0, 1.4, 2.9}};
hw=h*0.5;
qw=h*0.25;
w=Join[Transpose[Join[h,hw,qw]],Transpose[Join[hw,h,hw]],
  Transpose[Join[qw,hw,h]]];
ssi=Inverse[w];
Do[si[i,j]=ssi[[Range[3i-2,3i],Range[3j-2,3j] ]],{i,3},{j,3}];
```

*The group means are set up.

```
v={{v1},{v2},{(1-v1^2-v2^2)^0.5}};
eg={{1,0,1},{0.5,1,-0.5},{-0.5,0,0.5},{-1,-1,-1}};
vf={0.5,0.5,(0.5^0.5)};
Do[x[i,j]=eg[[i,j]]vf,{i,4},{j,3}];
```

*The maximum likelihood equations are set up.

```
bb=Table[0,{11},{11}];
f=e[g,q]e[g,s]Transpose[v].si[q,s].v-
  2e[g,q]Transpose[v].si[q,s].x[g,s];
kk=Sum[f,{g,1,4},{q,1,3},{s,1,3}];
```

*The matrix of second order derivatives is obtained, then evaluated.

```
Do[bb[[i,j]]=D[kk,pm[[i,1]],pm[[j,1]]],{i,11},{j,11}];
tt=bb /. {v1->0.5, v2->0.5, e[1,1]->1, e[1,2]->0, e[1,3]->1,
    e[2,1]->0.5, e[2,2]->1, e[2,3]->-0.5, e[3,1]->-0.5,
    e[3,2]->0, e[3,3]->0.5};
```

*In the remaining code the information matrix is inverted and the asymptotic covariances are printed.

```
bbbb=tt;
bflat=Flatten[bbbb];
cd=Table[0,{11},{11}];
Do[cd[[i,j]]=bflat[[11(i-1)+j]], {i,11},{j,11}];
cdinv=Inverse[50cd];
Do[Print[cdinv[[i,i]]],{i,11}];
```