```ox
#include<oxstd.h>
#import <maximize>
#import <solvenle>
#include <oxdraw.h>
#include <oxfloat.h>
#include <oxprob.h>
#import <maxsqp>
#import<blp_func_ps>

/* Global variables */
decl n,aProductID,vYear,T,mX,vPrice,vShare,mZ,aZ,mIV;
decl Sim,vDelta0,vDelta_iia,A,mG,iprint,eps1;

main()
{
  ranseed(-1);
  /*********************************************************************************/
  /* Main dataset + Panel structure */
  /*********************************************************************************/
  decl i,j,k,l;
  decl spec=1;
  decl aCharactName;
  decl
mPanelCharact=loadmat(sprint("Car_demand_characteristics_spec",spec,".dta"),&aCharactName);

  /* Panel structure */
  n=rows(mPanelCharact);
  vYear=unique(mPanelCharact[][find(aCharactName,"Year")]);
  T=columns(vYear);
  aProductID=new array[T];

  /*********************************************************************************/
  /* Outcome variables */
  /*********************************************************************************/
  vShare=mPanelCharact[][find(aCharactName,"share")];
  vDelta_iia=mPanelCharact[][find(aCharactName,"delta_iia")];
  vDelta0=vDelta_iia;
  vPrice=mPanelCharact[][find(aCharactName,"price")];

  /*********************************************************************************/
  /* Characteristics and instrumentsal variables */
  /*********************************************************************************/

  /* Load characteristics */
  decl varlist=
{"price","dpm","hp2wt","size","turbo","trans","Year_1986","Year_1987","Year_1988","Year_1989","Ye
              "Year_1995","Year_1996","Year_1997","Year_1998","Year_1999","Year_2000","Year_200
              "Year_2006","Year_2007","Year_2008","Year_2009","Year_2010","Year_2011","Year_201
              "model_class_3","model_class_4","model_class_5","cyl_2","cyl_4","cyl_6","cyl_8","
  decl exo_varlist=
{"dpm","hp2wt","size","turbo","trans","Year_1986","Year_1987","Year_1988","Year_1989","Year_1990"
                "Year_1995","Year_1996","Year_1997","Year_1998","Year_1999","Year_2000","Year
                "Year_2006","Year_2007","Year_2008","Year_2009","Year_2010","Year_2011","Year
                "model_class_3","model_class_4","model_class_5","cyl_2","cyl_4","cyl_6","cyl_
  mX=mPanelCharact[][find(aCharactName,varlist)];
  println("/* Mean product characteristics */");
  println("%r",aCharactName[find(aCharactName,varlist)],meanc(mX)');
```

```
/* Load price and differentiation IVs */
decl aIVname;
decl mDemandIV=loadmat(sprint("Car_demand_iv_spec",spec,".dta"),&aIVname);
decl aIVlist=
{"i_import","diffiv_local_0","diffiv_local_1","diffiv_local_2","diffiv_local_3","diffiv_ed_0"};
decl mExclIV=mDemandIV[][find(aIVname,aIVlist)];
println("/* Mean cost IV (import) and differentiation measures */");
println("%r",aIVname[find(aIVname,aIVlist)],meanc(mExclIV)');
mIV=mPanelCharact[][find(aCharactName,exo_varlist)]~mExclIV;

/* Non-linear attributes */
mZ=mPanelCharact[][find(aCharactName,"price")];

/* Pre-compute the row IDs for each market */
aProductID=new array[T];
for(i=0;i<T;i++) aProductID[i]=vecindex(mPanelCharact[][find(aCharactName,"Year")],vYear[i]);

/*********************************************************************************/
/* Random coefficients */
/*********************************************************************************/
decl mEta=loadmat("Simulated_type_distribution.dta");
Sim=rows(mEta);
println("distribution of eta: ",meanc(mEta)~sqrt(varc(mEta))~quantilec(mEta,
<0,1/4,1/2,3/4,1>)');

/* Pre-compute interaction between price and random-coefficient */
/* Two dimenional arrays of JxSim matrices: T x Nb of variables */
aZ=new array[T];
for(i=0;i<T;i++)
  {
    aZ[i]=new array[columns(mZ)];
    for(j=0;j<columns(mZ);j++) (aZ[i])[j]=mZ[aProductID[i]][j].*mEta[][j]';
  }


/*********************************************************************************/
/* GMM Estimator */
/*********************************************************************************/
decl Q,vLParam,vXi;
decl vParam=new matrix[columns(mZ)][1];
decl vParam0=vParam;
decl step=0;

/* 2SLS weighting matrix */
A=invert(mIV'mIV);

println("/* Plot the iteration process */");
/* Inversion algorithm */
iprint=1;
vParam[0]=0.6;
/* Contraction mapping */
inverse(&vDelta0, vParam,0,10^(-12));
 /* Newton */
vDelta0=vDelta_iia;
inverse(&vDelta0, vParam,1,10^(-12));
iprint=0;
```

```
println("/* Grid Search */");
decl vGrid=range(0,1,0.1);
decl mQgrid=new matrix[rows(vParam)][columns(vGrid)];
for(i=0;i<rows(vParam);i++)
    {
        for(j=0;j<columns(vGrid);j++)
            {
                vParam[i]=vGrid[j];
                gmm_obj(vParam,&Q, 0,0);
                println("grid: ",Q~vParam');
                if(Q!=.NaN) {
                    mQgrid[i][j]=-Q;
                }
                else {
                    Q=100;
                    vDelta0=vDelta_iia;
                }
                vParam[i]=vGrid[mincindex(mQgrid[i][]')];
            }
        DrawXMatrix(i,mQgrid[i][],"Obj",vGrid,"$\\lambda_p$");
    }
ShowDrawWindow();
SaveDrawWindow(sprint("Car_demand_grid_spec",spec,".pdf"));

println("/* Two-step GMM */");
do{
    vParam0=vParam;
    if(step>0) {
        mG=(vXi.*mIV); mG-=meanc(mG);
        A=invert(mG'mG);
    }
    MaxControl(100,1);

    //MaxSimplex(gmm_obj,&vParam,&Q,constant(1/10,vParam));
    MaxControl(1000,1);
    MaxBFGS(gmm_obj,&vParam,&Q,0,1);
    inverse(&vDelta0, vParam,1,10^(-12));
    vLParam=ivreg(vDelta0,mX,mIV,A);
    vXi=vDelta0-mX*vLParam;
    step+=1;
    println("norm: ",norm(vParam0-vParam));
}while(step<2);

println("Parameter estimates: ");
println("%r",{"price random-coefficient paramter"},vParam);
println("%r",aCharactName[find(aCharactName,varlist)],vLParam);

}
```