APPPENDIX A

Elasticities

The LAIDS model in the study is

$w_i = \alpha_i + \Sigma_j\gamma_{ij}(\log p_j + \Sigma_k d_{kj}\log A_k) + \beta_i\{\log x - \Sigma_j w_j^0 (\log p_j + \Sigma_k d_{kj} \log D_k)\}$

$+\kappa_i ww2.$ (a-1)

<u>Cross-price elasticity</u>

Generally, cross-price elasticity is calculated by

$\varepsilon_{ik} = \partial q_i/\partial p_k * p_k/q_i.$

$\partial w_i/\partial p_k = \partial w_i/\partial \log p_k * \partial \log p_k/\partial p_k.$ (a-2)

From (a-1),

$\partial w_i/\partial \log p_k = \gamma_{ik} - \beta_i w_k^0$ (a-3)

and

$\partial \log p_k/\partial p_k = 1/p_k.$ (a-4)

Thus,

$$\partial w_i/\partial p_k = \frac{\gamma_{ik} - \beta_i w_k^0}{p_k} \quad \text{(a-5)}$$

and

$\partial w_i/\partial p_k = \partial(p_i q_i/x)/\partial p_k = \partial w_i/\partial q_i * \partial q_i/\partial p_k + \partial p_i/\partial p_k * \partial w_i/\partial p_k = (p_i/x) * \partial q_i/\partial p_k$ (a-6)

$\partial q_i/\partial p_k = \partial w_i/\partial p_k * x/p_i.$ (a-7)

Substituting (a-5) into (a-7) then

$$\partial q_i/\partial p_k = \frac{\gamma_{ik} - \beta_i w_k^0}{p_k} \cdot \frac{x}{p_i}. \quad \text{(a-8)}$$

Thus, the cross-price elasticity of i good with respect to the price of good k is

$$\varepsilon_{ik} = \partial q_i/\partial p_k * p_k/q_i = \frac{\gamma_{ik} - \beta_i w_k^0}{p_k} \cdot \frac{x}{p_i} \cdot \frac{p_k}{q_i} = \frac{\gamma_{ik} - \beta_i w_k^0}{w_i}. \quad \text{(a-9)}$$

Buse (1994) suggests $w_k^0 + \sum_j \gamma_{ji} \log p_i$ to substitute for w_k^0 for precise approximation to original AIDS. Thus, the elasticity is

$\varepsilon_{ik} = \{\gamma_{ik} - \beta_i(w_k^0 + \sum_j \gamma_{ji} \log p_i)\}/w_i.$ (a-10)

Own-price elasticity

Generally, own-price elasticity is calculated by

$\varepsilon_{ii} = \partial q_i/\partial p_i * p_i/q_i.$

$\partial w_i/\partial p_i = \partial w_i/\partial \log p_i * \partial \log p_i/\partial p_i = \dfrac{\gamma_{ii} - \beta_i w_i^0}{p_i}$ (a-11)

and

$\partial w_i/\partial p_i = \partial(p_i q_i/x)/\partial p_i = \partial w_i/\partial q_i * \partial q_i/\partial p_i + \partial p_i/\partial p_i * \partial w_i/\partial p_i = (p_i/x) * \partial q_i/\partial p_i + q_i/x$

$\partial q_i/\partial p_i = \partial w_i/\partial p_i * x/p_i - q_i/x * x/p_i.$ (a-12)

Substituting (a-10) into (a-11),

$\partial q_i/\partial p_i = \dfrac{\gamma_{ii} - \beta_i w_i^0}{p_i} \cdot \dfrac{x}{p_i} - \dfrac{x}{p_i} \cdot \dfrac{q_i}{x}.$ (a-13)

Thus, the own-price elasticity of good i with respect to the price of i good is

$\varepsilon_{ii} = \partial q_i/\partial p_i * p_i/q_i = -1 + \dfrac{\gamma_{ii} - \beta_i w_i^0}{w_i}.$ (a-14)

Buse (1994) suggests $w_i^0 + \sum_k \gamma_{ki} \log p_i$ to substitute for w_i^0 for precise approximation of the original AIDS. Thus, the elasticity is

$\varepsilon_{ii} = -1 + \{\gamma_{ii} - \beta_i(w_i^0 + \sum_k \gamma_{ki} \log p_i)\}/w_i.$ (a-15)

Expenditure elasticity

Generally, expenditure elasticity is calculated by

$\eta_i = \partial q_i/\partial x * x/q_i.$

$\partial w_i/\partial x = \partial w_i/\partial \log x * \partial \log x/\partial x = \beta_i \cdot \dfrac{1}{x}$ (a-16)

and

$\partial w_i/\partial x = \partial(p_i q_i/x)/\partial x = \{p_i x(\partial q_i/\partial x) - p_i q_i\}/x^2$ (a-17)

$\partial q_i/\partial x = (\partial w_i/\partial x)(x^2/p_i x) + p_i q_i/p_i x.$ (a-18)

Substituting (a-14) into (a-16),

$\partial q_i/\partial x = (\beta_i/x)(x/p_i) + q_i/x.$ (a-19)

Thus, the expenditure elasticity of good i is

$\eta_i = \partial q_i/\partial x * x/q_i = (\beta_i/p_i + q_i/x)(x/q_i) = \beta_i/w_i + 1.$ (a-20)

<u>Elasticity for demographic variables</u>

Elasticity for demographic variables is calculated by

$\varepsilon_{Dki} = \partial q_i/\partial D_k * D_k/q_i.$

$$\partial w_i/\partial D_k = \partial w_i/\partial \log D_k * \partial \log D_k/\partial D_k = \frac{\sum_j \gamma_{ij} d_{kj} - \beta_i \sum_j w_j^0 d_{kj}}{D_k} \quad \text{(a-21)}$$

and

$\partial w_i/\partial D_k = \partial(p_i q_i/x)/\partial D_k = \partial w_i/\partial q_i * \partial q_i/\partial D_k + \partial w_i/\partial D_k * \partial p_i/\partial D_k = (p_i/x) * \partial q_i/\partial D_k$ (a-22)

$\partial q_i/\partial D_k = (x/p_i) * \partial w_i/\partial D_k.$ (a-23)

Substituting (a-19) into (a-21),

$$\partial q_i/\partial D_k = \frac{x(\sum_j \gamma_{ij} d_{kj} - \beta_i \sum_j w_j^0 d_{kj})}{P_i D_k}. \quad \text{(a-24)}$$

Thus, the elasticity of good i with respect to the demographic variable k is

$$\varepsilon_{Dki} = \partial q_i/\partial D_k * D_k/q_i = \frac{x(\sum_j \gamma_{ij} d_{kj} - \beta_i \sum_j w_j^0 d_{kj})}{P_i q_i} = \frac{\sum_j \gamma_{ij} d_{kj} - \beta_i \sum_j w_j^0 d_{kj}}{w_i}. \quad \text{(a-25)}$$

Formula for Median of Grouped Data

The median of grouped data is calculated by

$$\text{Median} = L + \frac{w}{f_m}(0.5n - cf_b)$$

L = lower class limit of the interval that contains the median
n = total frequency
cf_b = the sum of frequencies (cumulative frequency) for all classes before the median class

f_m = frequency of the class interval containing the median
w = interval width.

The Rao Test

H_{01}: variance variable = 0 vs H_{a1}: variance variable ≠ 0

H_{02}: skewness variable = 0 vs H_{a2}: skewness variable ≠ 0

$F = [(1-\Lambda^{1/t})/(\Lambda^{1/t})][(rt-2z)/pq] \sim \underline{F}(pq, rt-2z)$

<u>Models 29A and 29B</u>

Unrestricted Model 29A includes the demographic variables of median age, non-White proportion, and variance of the age distribution of the U.S. population. Restricted Model 29A includes the demographic variables of median age and non-White proportion.

$F = [(1-\Lambda^{1/t})/(\Lambda^{1/t})][(rt-2z)/pq] = 3.491$

$\underline{F}$ (3.99, 64.32, 0.05) = 2.525 (critical value)

H_{01} was rejected, indicating that the variance variable should not be dropped from the model. Unrestricted Model 29B includes the demographic variables of median age, non-White proportion, and skewness of the age distribution of the U.S. population. Restricted Model 29B includes the demographic variables of median age and non-White proportion.

$F = [(1-\Lambda^{1/t})/(\Lambda^{1/t})][(rt-2z)/pq] = 0.572$

$\underline{F}$ (3.99, 64.32, 0.05) = 2.525 (critical value)

H_{02} was not rejected, indicating that the skewness variable should be dropped from the model. Thus, of the Models 29A and 29B, only Model 29A was selected for further analysis.

<u>Models 48A and 48B</u>

Unrestricted Model 48A includes the demographic variables of median age and variance of the age distribution of the U.S. population as well as women’s labor force participation rate. Restricted Model 48A includes the demographic variables of median age and women’s labor force participation rate.

$F = [(1-\Lambda^{1/t})/(\Lambda^{1/t})][(rt-2z)/pq] = 12.006$

$\underline{F}$ (3.99, 64.32, 0.05) = 2.606 (critical value)

H_{01} was rejected, indicating that the variance variable should not be dropped from the model. Unrestricted Model 48B includes the demographic variables of median age and skewness of the age distribution of the U.S. population as well as women's labor force participation rate. Restricted Model 48B includes the demographic variables of median age and women's labor force participation rate.

$F = [(1-\Lambda^{1/t})/(\Lambda^{1/t})][(rt-2z)/pq] = 1.394$

$\underline{F}$ (3.99, 64.32, 0.05) = 2.606 (critical value)

H_{02} was not rejected, indicating that the skewness variable should be dropped from the model. Thus, of the Models 48A and 48B, only Model 48A was selected for further analysis.

The Wu-Hausman Test

H_0: no endogeneity of total nondurables expenditures vs H_1: endogeneity of total nondurables expenditures

$m = (\hat{b}_{OLS} - \hat{b}_{IV})'(\hat{V}_{OLS} - \hat{V}_{IV})^{-1}(\hat{b}_{OLS} - \hat{b}_{IV}) \sim \underline{x}^2$ (k), where $\hat{V}_{IV}$ is multiplied by error of IV equation/error of OLS; error of IV equation = e`e/T-k.

The calculated values of $m = (\hat{b}_{OLS} - \hat{b}_{IV})'(\hat{V}_{OLS} - \hat{V}_{IV})^{-1}(\hat{b}_{OLS} - \hat{b}_{IV}) = 4.631$ (WC budget share), 10.333 (MB budget share), and –4.046 (SH budget share). Because these values are less than critical value 27.587 of $\underline{x}^2$(17, 0.05), we fail to reject the null hypothesis (H_0). Thus, the test indicates no endogeneity of the total nondurables expenditures in the LAIDS Model 29A.

SAS Program

```
/* Nonlinear ITSUR parameter estimations for LAIDS MODEL29A*/
libname one 'c:\sas\mydata';
data demo;
set sasuser.nonmun1;
lpw=log(pw);lpm=log(pm);lps=log(ps);lpo=log(po);vc=va/1000;
ld1=log(md);ld2=log(nw);ld3=log(vc);
nexp=ndo+csexp-forn;nd=ndo-forn;
```

```
lx=log(capi);ww=wexp/nexp;wm=mexp/nexp;ws=sexp/nexp;wo=nd/nexp;
wo1=lag(ww);wo2=lag(wm);wo3=lag(ws);wo4=lag(wo);
if 1941<yr<1946 then ww2=1;
else ww2=0;
proc model data=demo itsur nestit maxit=1000 converge=.001;
var ww wm ws wo1 wo2 wo3 wo4 lpw lpm lps lpo lx ld1 ld2 ld3 ww2;
parm  d11 d12  d13 d14 d21 d22 d23  d24 d31 d32 d33 d34 c1 c2 c3 b11 b12 b13 b22
b23 b33
a1 a2 a3 dum1 dum2 dum3;
ww=a1+b11*(lpw-lpo+(d11-d14)*ld1+(d21-d24)*ld2+(d31-d34)*ld3)
    +b12*(lpm-lpo+(d12-d14)*ld1+(d22-d24)*ld2+(d32-d34)*ld3)
    +b13*(lps-lpo+(d13-d14)*ld1+(d23-d24)*ld2+(d33-d34)*ld3)
    +c1*(lx-wo1*(lpw+d11*ld1+d21*ld2+d31*ld3-59.198)-
wo2*(lpm+d12*ld1+d22*ld2+d32*ld3-54.265)
    -wo3*(lps+d13*ld1+d23*ld2+d33*ld3-50.632)-
wo4*(lpo+d14*ld1+d24*ld2+d34*ld3-43.783))
    +dum1*ww2;
wm=a2+b12*(lpw-lpo+(d11-d14)*ld1+(d21-d24)*ld2+(d31-d34)*ld3)
    +b22*(lpm-lpo+(d12-d14)*ld1+(d22-d24)*ld2+(d32-d34)*ld3)
    +b23*(lps-lpo+(d13-d14)*ld1+(d23-d24)*ld2+(d33-d34)*ld3)
    +c2*(lx-wo1*(lpw+d11*ld1+d21*ld2+d31*ld3-59.198)-
wo2*(lpm+d12*ld1+d22*ld2+d32*ld3-54.265)
    -wo3*(lps+d13*ld1+d23*ld2+d33*ld3-50.632)-
wo4*(lpo+d14*ld1+d24*ld2+d34*ld3-43.783))
    +dum2*ww2;
ws=a3+b13*(lpw-lpo+(d11-d14)*ld1+(d21-d24)*ld2+(d31-d34)*ld3)
    +b23*(lpm-lpo+(d12-d14)*ld1+(d22-d24)*ld2+(d32-d34)*ld3)
    +b33*(lps-lpo+(d13-d14)*ld1+(d23-d24)*ld2+(d33-d34)*ld3)
    +c3*(lx-wo1*(lpw+d11*ld1+d21*ld2+d31*ld3-59.198)-
wo2*(lpm+d12*ld1+d22*ld2+d32*ld3-54.265)
    -wo3*(lps+d13*ld1+d23*ld2+d33*ld3-50.632)-
wo4*(lpo+d14*ld1+d24*ld2+d34*ld3-43.783))
    +dum3*ww2;
fit ww wm ws;
/*elasticity*/
w1=0.1;w2=0.058;w3=0.03;w4=0.811;
w11=0.1;w22=0.058;w33=0.03;w44=0.81;
p1=log(59.1987);p2=log(54.2653);p3=log(50.6322);p4=log(43.7833);
b14=-(b11+b12+b13);b24=-(b12+b22+b23);b34=-(b13+b23+b33);
b44=-(b14+b24+b34);
c4=-(c1+c2+c3);
estimate'n1'1+(c1/w1);
estimate'n2'1+(c2/w2);
```

```
estimate'n3'1+(c3/w3);
estimate'n4'1+(c4/w4);
estimate'e11'-1+(b11-c1*(w11+b11*p1+b12*p1+b13*p1
        +b14*p1))/w1;
estimate'e22'-1+(b22-c2*(w22+b12*p2+b22*p2+b23*p2
        +b24*p2))/w2;
estimate'e33'-1+(b33-c3*(w33+b13*p3+b23*p3+b33*p3
        +b34*p3))/w3;
estimate'e44'-1+(b44-c4*(w44+b14*p4+b24*p4+b34*p4
        +b44*p4))/w4;

estimate'e12'(b12-c1*(w22+b11*p1+b12*p1+b13*p1
        +b14*p1))/w1;
estimate'e13'(b13-c1*(w33+b11*p3+b12*p3+b13*p3
        +b14*p3))/w1;
estimate'e14'(b14-c1*(w44+b11*p4+b12*p4+b13*p4
        +b14*p4))/w1;

estimate'e21'(b12-c2*(w11+b12*p2+b22*p2+b23*p2
        +b24*p2))/w2;
estimate'e23'(b23-c2*(w33+b12*p2+b22*p2+b23*p2
        +b24*p2))/w2;
estimate'e24'(b24-c2*(w44+b12*p2+b22*p2+b23*p2
        +b24*p2))/w2;

estimate'e31'(b13-c3*(w11+b13*p3+b23*p3+b33*p3
        +b34*p3))/w3;
estimate'e32'(b23-c3*(w22+b13*p3+b23*p3+b33*p3
        +b34*p3))/w3;
estimate'e34'(b34-c3*(w44+b13*p3+b23*p3+b33*p3
        +b34*p3))/w3;

estimate'e41'(b14-c4*(w11+b14*p4+b24*p4+b34*p4
        +b44*p4))/w4;
estimate'e42'(b24-c4*(w22+b14*p4+b24*p4+b34*p4
        +b44*p4))/w4;
estimate'e43'(b34-c4*(w33+b14*p4+b24*p4+b34*p4
        +b44*p4))/w4;

estimate'g11'(b11*d11+b12*d12+b13*d13+b14*d14-c1*(w11*d11+w22*d12
        +w33*d13+w44*d14))/w1;
estimate'g12'(b12*d11+b22*d12+b23*d13+b24*d14-c2*(w11*d11+w22*d12
        +w33*d13+w44*d14))/w2;
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```
estimate'g13'(b13*d11+b23*d12+b33*d13+b34*d14-c3*(w11*d11+w22*d12
        +w33*d13+w44*d14))/w3;
estimate'g14'(b14*d11+b24*d12+b34*d13+b44*d14-c4*(w11*d11+w22*d12
        +w33*d13+w44*d14))/w4;
estimate'g21'(b11*d21+b12*d22+b13*d23+b14*d24-c1*(w11*d21+w22*d22
        +w33*d23+w44*d24))/w1;
estimate'g22'(b12*d21+b22*d22+b23*d23+b24*d24-c2*(w11*d21+w22*d22
        +w33*d23+w44*d24))/w2;
estimate'g23'(b13*d21+b23*d22+b33*d23+b34*d24-c3*(w11*d21+w22*d22
        +w33*d23+w44*d24))/w3;
estimate'g24'(b14*d21+b24*d22+b34*d23+b44*d24-c4*(w11*d21+w22*d22
        +w33*d23+w44*d24))/w4;

estimate'g31'(b11*d31+b12*d32+b13*d33+b14*d34-c1*(w11*d31+w22*d32
        +w33*d33+w44*d34))/w1;
estimate'g32'(b12*d31+b22*d32+b23*d33+b24*d34-c2*(w11*d31+w22*d32
        +w33*d33+w44*d34))/w2;
estimate'g33'(b13*d31+b23*d32+b33*d33+b34*d34-c3*(w11*d31+w22*d32
        +w33*d33+w44*d34))/w3;
estimate'g34'(b14*d31+b24*d32+b34*d33+b44*d34-c4*(w11*d31+w22*d32
        +w33*d33+w44*d34))/w4;
run;

/* Nonlinear ITSUR parameter estimations for LAIDS MODEL48A*/
libname one 'c:\sas\mydata';
data demo;
set sasuser.nonmun2;
lpw=log(pw);lpm=log(pm);lps=log(ps);lpo=log(po);
vc=va/1000;
ld1=log(md);ld2=log(vc);ld3=log(fp);
nexp=ndo+csexp-forn;nd=ndo-forn;
lx=log(capi);ww=wexp/nexp;wm=mexp/nexp;ws=sexp/nexp;wo=nd/nexp;
wo1=lag(ww);wo2=lag(wm);wo3=lag(ws);wo4=lag(wo);
proc model data=demo itsur nestit maxit=1000 converge=.0001;
var ww wm ws wo1 wo2 wo3 wo4 lpw lpm lps lpo lx ld1 ld2 ld3;
parm  d11 d12  d13 d14 d21 d22 d23 d24 d31 d32 d33 d34 c1 c2 c3 b11 b12 b13 b22 b23
b33
a1 a2 a3;
ww=a1+b11*(lpw-lpo+(d11-d14)*ld1+(d21-d24)*ld2+(d31-d34)*ld3)
     +b12*(lpm-lpo+(d12-d14)*ld1+(d22-d24)*ld2+(d32-d34)*ld3)
     +b13*(lps-lpo+(d13-d14)*ld1+(d23-d24)*ld2+(d33-d34)*ld3)
     +c1*(lx-wo1*(lpw+d11*ld1+d21*ld2+d31*ld3-72.093)-
wo2*(lpm+d12*ld1+d22*ld2+d32*ld3-67.032)
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    -wo3*(lps+d13*ld1+d23*ld2+d33*ld3-64.532)-
wo4*(lpo+d14*ld1+d24*ld2+d34*ld3-55.959));
wm=a2+b12*(lpw-lpo+(d11-d14)*ld1+(d21-d24)*ld2+(d31-d34)*ld3)
    +b22*(lpm-lpo+(d12-d14)*ld1+(d22-d24)*ld2+(d32-d34)*ld3)
    +b23*(lps-lpo+(d13-d14)*ld1+(d23-d24)*ld2+(d33-d34)*ld3)
    +c2*(lx-wo1*(lpw+d11*ld1+d21*ld2+d31*ld3-72.093)-
wo2*(lpm+d12*ld1+d22*ld2+d32*ld3-67.032)
    -wo3*(lps+d13*ld1+d23*ld2+d33*ld3-64.532)-
wo4*(lpo+d14*ld1+d24*ld2+d34*ld3-55.959));
ws=a3+b13*(lpw-lpo+(d11-d14)*ld1+(d21-d24)*ld2+(d31-d34)*ld3)
    +b23*(lpm-lpo+(d12-d14)*ld1+(d22-d24)*ld2+(d32-d34)*ld3)
    +b33*(lps-lpo+(d13-d14)*ld1+(d23-d24)*ld2+(d33-d34)*ld3)
    +c3*(lx-wo1*(lpw+d11*ld1+d21*ld2+d31*ld3-72.093)-
wo2*(lpm+d12*ld1+d22*ld2+d32*ld3-67.032)
    -wo3*(lps+d13*ld1+d23*ld2+d33*ld3-64.532)-
wo4*(lpo+d14*ld1+d24*ld2+d34*ld3-55.959));
fit ww wm ws;
w1=0.097;w2=0.053;w3=0.0276;w4=0.821;
w11=0.097;w22=0.053;w33=0.0277;w44=0.821;
p1=log(72.0934);p2=log(67.0327);p3=log(64.5325);p4=log(55.9591);
b14=-(b11+b12+b13);b24=-(b12+b22+b23);b34=-(b13+b23+b33);
b44=-(b14+b24+b34);
c4=-(c1+c2+c3);
estimate'n1'1+(c1/w1);
estimate'n2'1+(c2/w2);
estimate'n3'1+(c3/w3);
estimate'n4'1+(c4/w4);

estimate'e11'-1+(b11-c1*(w11+b11*p1+b12*p1+b13*p1
      +b14*p1))/w1;
estimate'e22'-1+(b22-c2*(w22+b12*p2+b22*p2+b23*p2
      +b24*p2))/w2;
estimate'e33'-1+(b33-c3*(w33+b13*p3+b23*p3+b33*p3
      +b34*p3))/w3;
estimate'e44'-1+(b44-c4*(w44+b14*p4+b24*p4+b34*p4
      +b44*p4))/w4;

estimate'e12'(b12-c1*(w22+b11*p1+b12*p1+b13*p1
      +b14*p1))/w1;
estimate'e13'(b13-c1*(w33+b11*p3+b12*p3+b13*p3
      +b14*p3))/w1;
estimate'e14'(b14-c1*(w44+b11*p4+b12*p4+b13*p4
      +b14*p4))/w1;
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```
estimate'e21'(b12-c2*(w11+b12*p2+b22*p2+b23*p2
        +b24*p2))/w2;
estimate'e23'(b23-c2*(w33+b12*p2+b22*p2+b23*p2
        +b24*p2))/w2;
estimate'e24'(b24-c2*(w44+b12*p2+b22*p2+b23*p2
        +b24*p2))/w2;

estimate'e31'(b13-c3*(w11+b13*p3+b23*p3+b33*p3
        +b34*p3))/w3;
estimate'e32'(b23-c3*(w22+b13*p3+b23*p3+b33*p3
        +b34*p3))/w3;
estimate'e34'(b34-c3*(w44+b13*p3+b23*p3+b33*p3
        +b34*p3))/w3;

estimate'e41'(b14-c4*(w11+b14*p4+b24*p4+b34*p4
        +b44*p4))/w4;
estimate'e42'(b24-c4*(w22+b14*p4+b24*p4+b34*p4
        +b44*p4))/w4;
estimate'e43'(b34-c4*(w33+b14*p4+b24*p4+b34*p4
        +b44*p4))/w4;

estimate'g11'(b11*d11+b12*d12+b13*d13+b14*d14-c1*(w11*d11+w22*d12
        +w33*d13+w44*d14))/w1;
estimate'g12'(b12*d11+b22*d12+b23*d13+b24*d14-c2*(w11*d11+w22*d12
        +w33*d13+w44*d14))/w2;
estimate'g13'(b13*d11+b23*d12+b33*d13+b34*d14-c3*(w11*d11+w22*d12
        +w33*d13+w44*d14))/w3;
estimate'g14'(b14*d11+b24*d12+b34*d13+b44*d14-c4*(w11*d11+w22*d12
        +w33*d13+w44*d14))/w4;

estimate'g21'(b11*d21+b12*d22+b13*d23+b14*d24-c1*(w11*d21+w22*d22
        +w33*d23+w44*d24))/w1;
estimate'g22'(b12*d21+b22*d22+b23*d23+b24*d24-c2*(w11*d21+w22*d22
        +w33*d23+w44*d24))/w2;
estimate'g23'(b13*d21+b23*d22+b33*d23+b34*d24-c3*(w11*d21+w22*d22
        +w33*d23+w44*d24))/w3;
estimate'g24'(b14*d21+b24*d22+b34*d23+b44*d24-c4*(w11*d21+w22*d22
        +w33*d23+w44*d24))/w4;

estimate'g31'(b11*d31+b12*d32+b13*d33+b14*d34-c1*(w11*d31+w22*d32
        +w33*d33+w44*d34))/w1;
estimate'g32'(b12*d31+b22*d32+b23*d33+b24*d34-c2*(w11*d31+w22*d32
        +w33*d33+w44*d34))/w2;
```

```
estimate'g33'(b13*d31+b23*d32+b33*d33+b34*d34-c3*(w11*d31+w22*d32
        +w33*d33+w44*d34))/w3;
estimate'g34'(b14*d31+b24*d32+b34*d33+b44*d34-c4*(w11*d31+w22*d32
        +w33*d33+w44*d34))/w4;
run;

/* Wu-Hausman Test for LAIDS MODEL29A in ww wm ws*/
libname one 'c:\sas\mydata';
data demo;
set sasuser.nonmun1;
lpw=log(pw);lpm=log(pm);lps=log(ps);lpo=log(po);vc=va/1000;
ld1=log(md);ld2=log(nw);ld3=log(vc);
nexp=ndo+csexp-forn;nd=ndo-forn;lcx=log(tcx);lpd=log(pd);lpv=log(pv);lpn=log(pnd);
lx=log(capi);ww=wexp/nexp;wm=mexp/nexp;ws=sexp/nexp;wo=nd/nexp;
wo1=lag(ww);wo2=lag(wm);wo3=lag(ws);wo4=lag(wo);
if 1941<yr<1946 then ww2=1;
else ww2=0;
proc model data=demo it2sls nestit maxit=1000 converge=.0001;
exo  wo1 wo2 wo3 wo4 lpw lpm lps lpo lpd lpn lpv ld1 ld2 ld3 ww2 lcx;
endo ww lx;
parm  d11 d12  d13 d14 d21 d22 d23  d24 d31 d32 d33 d34 c1 b11 b12 b13
a1 a2 y1 y2 y3 y4 dum1;
ww=a1+b11*(lpw-lpo+(d11-d14)*ld1+(d21-d24)*ld2+(d31-d34)*ld3)
     +b12*(lpm-lpo+(d12-d14)*ld1+(d22-d24)*ld2+(d32-d34)*ld3)
     +b13*(lps-lpo+(d13-d14)*ld1+(d23-d24)*ld2+(d33-d34)*ld3)
     +c1*(lx-wo1*(lpw+d11*ld1+d21*ld2+d31*ld3-59.198)-
wo2*(lpm+d12*ld1+d22*ld2+d32*ld3-54.265)
     -wo3*(lps+d13*ld1+d23*ld2+d33*ld3-50.632)-
wo4*(lpo+d14*ld1+d24*ld2+d34*ld3-43.783))
     +dum1*ww2;
lx=a2+y1*lcx+y2*lpn+y3*lpd+y4*lpv;
fit ww lx/outcov outest=cov1 ;
run;
proc model data=demo;
var ww lx wo1 wo2 wo3 wo4 lpw lpm lps lpo ld1 ld2 ld3 ww2 ;
parm  d11 d12  d13 d14 d21 d22 d23  d24 d31 d32 d33 d34 c1 b11 b12 b13
a1 dum1;
ww=a1+b11*(lpw-lpo+(d11-d14)*ld1+(d21-d24)*ld2+(d31-d34)*ld3)
     +b12*(lpm-lpo+(d12-d14)*ld1+(d22-d24)*ld2+(d32-d34)*ld3)
     +b13*(lps-lpo+(d13-d14)*ld1+(d23-d24)*ld2+(d33-d34)*ld3)
     +c1*(lx-wo1*(lpw+d11*ld1+d21*ld2+d31*ld3-59.198)-
wo2*(lpm+d12*ld1+d22*ld2+d32*ld3-54.265)
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```
     -wo3*(lps+d13*ld1+d23*ld2+d33*ld3-50.632)-
wo4*(lpo+d14*ld1+d24*ld2+d34*ld3-43.783))
     +dum1*ww2;
fit ww/outcov outest=cov2;
run;
proc iml ;
use cov1;
read point 1 var{d11 d12  d13 d14 d21 d22 d23  d24 d31 d32 d33 d34 c1 b11 b12 b13
a1 dum1 } into y;
p={2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 24};
read  point p
var{d11 d12  d13 d14 d21 d22 d23  d24 d31 d32 d33 d34 c1 b11 b12 b13
a1 dum1} into bi;
use cov2;
read point 1 var{d11 d12  d13 d14 d21 d22 d23  d24 d31 d32 d33 d34 c1 b11 b12 b13
a1 dum1} into x;
p={2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19};
read point p
var{d11 d12  d13 d14 d21 d22 d23  d24 d31 d32 d33 d34 c1 b11 b12 b13
a1 dum1} into b1;
b2=4.63#bi;
A=(x-y)*inv(b1-b2)*(x-y)`;
print A;
/*************************************/
libname one 'c:\sas\mydata';
data demo;
set sasuser.nonmun1;
lpw=log(pw);lpm=log(pm);lps=log(ps);lpo=log(po);vc=va/1000;
ld1=log(md);ld2=log(nw);ld3=log(vc);
nexp=ndo+csexp-forn;nd=ndo-forn;lcx=log(tcx);lpd=log(pd);lpv=log(pv);lpn=log(pnd);
lx=log(capi);ww=wexp/nexp;wm=mexp/nexp;ws=sexp/nexp;wo=nd/nexp;
wo1=lag(ww);wo2=lag(wm);wo3=lag(ws);wo4=lag(wo);
if 1941<yr<1946 then ww2=1;
else ww2=0;
proc model data=demo it2sls nestit maxit=1000 converge=.001;
exo  wo1 wo2 wo3 wo4 lpw lpm lps lpo lpd lpn lpv ld1 ld2 ld3 ww2 lcx;
endo wm lx;
parm  d11 d12  d13 d14 d21 d22 d23  d24 d31 d32 d33 d34 c1 b11 b12 b13
a1 a2 y1 y2 y3 y4 dum1;
wm=a1+b11*(lpw-lpo+(d11-d14)*ld1+(d21-d24)*ld2+(d31-d34)*ld3)
     +b12*(lpm-lpo+(d12-d14)*ld1+(d22-d24)*ld2+(d32-d34)*ld3)
     +b13*(lps-lpo+(d13-d14)*ld1+(d23-d24)*ld2+(d33-d34)*ld3)
```

```
    +c1*(lx-wo1*(lpw+d11*ld1+d21*ld2+d31*ld3-59.198)-
wo2*(lpm+d12*ld1+d22*ld2+d32*ld3-54.265)
    -wo3*(lps+d13*ld1+d23*ld2+d33*ld3-50.632)-
wo4*(lpo+d14*ld1+d24*ld2+d34*ld3-43.783))
    +dum1*ww2;
lx=a2+y1*lcx+y2*lpn+y3*lpd+y4*lpv;
fit lx wm/outcov outest=cov1 ;
run;
proc model data=demo;
var wm lx wo1 wo2 wo3 wo4 lpw lpm lps lpo ld1 ld2 ld3 ww2 ;
parm  d11 d12  d13 d14 d21 d22 d23  d24 d31 d32 d33 d34 c1 b11 b12 b13
a1 dum1;
wm=a1+b11*(lpw-lpo+(d11-d14)*ld1+(d21-d24)*ld2+(d31-d34)*ld3)
    +b12*(lpm-lpo+(d12-d14)*ld1+(d22-d24)*ld2+(d32-d34)*ld3)
    +b13*(lps-lpo+(d13-d14)*ld1+(d23-d24)*ld2+(d33-d34)*ld3)
    +c1*(lx-wo1*(lpw+d11*ld1+d21*ld2+d31*ld3-59.198)-
wo2*(lpm+d12*ld1+d22*ld2+d32*ld3-54.265)
    -wo3*(lps+d13*ld1+d23*ld2+d33*ld3-50.632)-
wo4*(lpo+d14*ld1+d24*ld2+d34*ld3-43.783))
    +dum1*ww2;
fit wm/outcov outest=cov2;
run;
proc iml ;
use cov1;
read point 1 var{d11 d12  d13 d14 d21 d22 d23  d24 d31 d32 d33 d34 c1 b11 b12 b13
a1 dum1 } into y;
p={2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 24};
read  point p
var{d11 d12  d13 d14 d21 d22 d23  d24 d31 d32 d33 d34 c1 b11 b12 b13
a1 dum1} into b2;
use cov2;
read point 1 var{d11 d12  d13 d14 d21 d22 d23  d24 d31 d32 d33 d34 c1 b11 b12 b13
a1 dum1} into x;
p={2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19};
read point p
var{d11 d12  d13 d14 d21 d22 d23  d24 d31 d32 d33 d34 c1 b11 b12 b13
a1 dum1} into b1;
b3=14.28#b2;
A=(x-y)*inv(b1-b3)*(x-y)`;
print A;
/*****************************/
libname one 'c:\sas\mydata';
data demo;
```

```
set sasuser.nonmun1;
lpw=log(pw);lpm=log(pm);lps=log(ps);lpo=log(po);vc=va/1000;
ld1=log(md);ld2=log(nw);ld3=log(vc);
nexp=ndo+csexp-forn;nd=ndo-forn;lcx=log(tcx);lpd=log(pd);lpv=log(pv);lpn=log(pnd);
lx=log(capi);ww=wexp/nexp;wm=mexp/nexp;ws=sexp/nexp;wo=nd/nexp;
wo1=lag(ww);wo2=lag(wm);wo3=lag(ws);wo4=lag(wo);
po1=59.195;po2=54.265;po3=50.632;po4=43.738;
if 1941<yr<1946 then ww2=1;
else ww2=0;
proc model data=demo it2sls nestit maxit=1000 converge=.0001;
exo  wo1 wo2 wo3 wo4 lpw lpm lps lpo lpd lpn lpv ld1 ld2 ld3 ww2 lcx po1 po2 po3
po4;
endo ws lx;
parm  d11 d12  d13 d14 d21 d22 d23  d24 d31 d32 d33 d34 c1 b11 b12 b13
a1 a2 y1 y2 y3 y4 dum1;
ws=a1+b11*(lpw-lpo+(d11-d14)*ld1+(d21-d24)*ld2+(d31-d34)*ld3)
    +b12*(lpm-lpo+(d12-d14)*ld1+(d22-d24)*ld2+(d32-d34)*ld3)
    +b13*(lps-lpo+(d13-d14)*ld1+(d23-d24)*ld2+(d33-d34)*ld3)
    +c1*(lx-wo1*(lpw+d11*ld1+d21*ld2+d31*ld3-po1)-
wo2*(lpm+d12*ld1+d22*ld2+d32*ld3-po2)
    -wo3*(lps+d13*ld1+d23*ld2+d33*ld3-po3)-wo4*(lpo+d14*ld1+d24*ld2+d34*ld3-
po4))
    +dum1*ww2;
lx=a2+y1*lcx+y2*lpn+y3*lpd+y4*lpv;
fit ws lx/outcov outest=cov1 ;
run;
proc model data=demo maxit=1500 converge=0.001;
var ws lx wo1 wo2 wo3 wo4 lpw lpm lps lpo ld1 ld2 ld3 ww2 po1 po2 po3 po4;
parm  d11 d12  d13 d14 d21 d22 d23  d24 d31 d32 d33 d34 c1 b11 b12 b13
a1 dum1;
ws=a1+b11*(lpw-lpo+(d11-d14)*ld1+(d21-d24)*ld2+(d31-d34)*ld3)
    +b12*(lpm-lpo+(d12-d14)*ld1+(d22-d24)*ld2+(d32-d34)*ld3)
    +b13*(lps-lpo+(d13-d14)*ld1+(d23-d24)*ld2+(d33-d34)*ld3)
    +c1*(lx-wo1*(lpw+d11*ld1+d21*ld2+d31*ld3-po1)-
wo2*(lpm+d12*ld1+d22*ld2+d32*ld3-po2)
    -wo3*(lps+d13*ld1+d23*ld2+d33*ld3-po3)-wo4*(lpo+d14*ld1+d24*ld2+d34*ld3-
po4))
    +dum1*ww2;
fit ws/outcov outest=cov2;
run;
proc iml ;
use cov1;
read point 1 var{d11 d12  d13 d14 d21 d22 d23  d24 d31 d32 d33 d34 c1 b11 b12 b13
```

```
a1 dum1 } into y;
p={2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 24};
read  point p
var{d11 d12  d13 d14 d21 d22 d23  d24 d31 d32 d33 d34 c1 b11 b12 b13
a1 dum1} into bi;
use cov2;
read point 1 var{d11 d12  d13 d14 d21 d22 d23  d24 d31 d32 d33 d34 c1 b11 b12 b13
a1 dum1} into x;
p={2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19};
read point p
var{d11 d12  d13 d14 d21 d22 d23  d24 d31 d32 d33 d34 c1 b11 b12 b13
a1 dum1} into b1;
b2=11.45#bi;
A=(x-y)*inv(b1-b2)*(x-y)`;
print A;
```