```
ods pdf file="C:\Users\YUXIONG\Desktop\YUXIONG_XIE_OUTPUT";
title "Marketing Effectiveness Analysis";
data MarkEff;
input Month Formulary DTC_TV Nov_Ind Dec_Ind TV PDEs Display UR Sales @@;
Sales=300*Sales;
datalines;
 1/1/2011 5 150 0 0 75 25.7 1.505594371 5.6 8.14
 2/1/2011 5.1 450 0 0 125 13.8 1.645746172 5.1 7.952
 3/1/2011 5.1 150 0 0 20 15.3 0.61681864 4.4 5.883
 4/1/2011 5.2 300 0 0 10 19.7 1.122074228 5.7 6.059
 5/1/2011 5.4 510 0 0 120 12 0.926028619 4.1 7.346
 6/1/2011 5.4 450 0 0 100 11.6 0.742634918 6 7.367
 7/1/2011 5.3 150 0 0 50 9.4 1.278152746 5.2 6.777
 8/1/2011 5 225 0 0 15 18.4 0.820908922 4.1 6.129
 9/1/2011 4.8 150 0 0 40 22.6 0.964507806 5.1 7.153
 10/1/2011 4.6 150 0 0 0 18.2 1.040427503 5 6.355
 11/1/2011 4.2 750 1 0 200 13.2 1.791742017 3.6 9.118
 12/1/2011 4.1 600 0 1 150 24.6 1.366356679 5.4 8.982
 1/1/2012 4 150 0 0 0 22.3 1.301996718 5.2 6.441
 2/1/2012 4 375 0 0 75 7.6 1.634923826 4.2 7.165
 3/1/2012 4 450 0 0 10 17 1.213442258 3.1 6.177
 4/1/2012 3.5 450 0 0 100 19.7 1.697367261 6.8 7.797
 5/1/2012 3.7 510 0 0 20 20.7 1.306341973 4.8 6.244
 6/1/2012 3.5 270 0 0 40 6.4 1.255019404 4.1 5.918
 7/1/2012 4.6 150 0 0 0 20.7 0.804678511 6.6 6.229
 8/1/2012 4.2 150 0 0 10 12.6 0.750211641 4.4 6.037
 9/1/2012 4.1 600 0 0 150 12 0.972954659 4.6 7.586
 10/1/2012 4 150 0 0 0 24.1 0.494539573 4 6.346
 11/1/2012 4 600 1 0 150 24.5 1.645918277 6 9.35
 12/1/2012 4 750 0 1 20 10.1 1.217580147 3.7 6.748
 1/1/2013 3.5 240 0 0 30 22.5 1.823837736 5.7 6.687
 2/1/2013 5 150 0 0 0 20.8 0.701993413 4.9 6.601
 3/1/2013 5.4 300 0 0 50 19 1.851489159 5.3 7.375
 4/1/2013 6.1 300 0 0 50 5.2 1.181353005 6.5 6.42
 5/1/2013 6.8 150 0 0 0 18.1 1.235798507 4.8 6.73
 6/1/2013 7 150 0 0 85 18.4 0.678308788 4.5 8.011
 7/1/2013 7.4 150 0 0 25 22.3 1.570813666 5.6 7.348
 8/1/2013 7.3 375 0 0 75 6.8 0.902261884 3.8 7.389
 9/1/2013 7.5 150 0 0 0 26.2 1.667311405 5 6.942
 10/1/2013 7.2 525 0 0 125 25.5 1.488846866 3.9 8.786
 11/1/2013 8 450 1 0 100 8.8 1.069203721 3.6 9.05
```

```
12/1/2013 8.4 450 0 1 100 25.9 0.931868705 6.6 9.899
1/1/2014 8.3 300 0 0 50 13.6 1.142174138 3.4 7.416
2/1/2014 8.5 150 0 0 30 21.4 0.646969463 5.8 7.168
3/1/2014 8.8 150 0 0 10 15.9 1.581222375 6.6 6.928
4/1/2014 8.5 675 0 0 175 9.2 0.913013018 6.8 7.968
5/1/2014 8.2 150 0 0 10 24.2 1.577213107 4.1 7.296
6/1/2014 8 690 0 0 180 22.7 1.438843328 3.6 8.784
7/1/2014 8.1 150 0 0 50 13 0.825130443 6 7.193
8/1/2014 7.9 450 0 0 25 21.8 1.61587515 4.8 6.904
9/1/2014 8.2 450 0 0 125 7.3 1.033628615 4.8 7.884
10/1/2014 8.4 750 0 0 185 20.2 1.793132756 4.4 8.595
11/1/2014 8.3 600 1 0 150 17.8 0.707572304 6.1 9.464
12/1/2014 8.5 600 0 1 190 8.1 1.626550155 4.5 9.628
run;
proc sort data=MarkEff out=foo NODUPKEY;
by Month;
run;
title2 "Summary measures of raw variables";
proc summary data=MarkEff min mean max std print;
var
Sales
Formulary
DTC_TV
TV
PDEs
Display
UR
Nov_Ind
Dec_Ind
;
run;
title3 "Naive Linear Regression Model";
proc reg data=MarkEff;
model
Sales=Formulary DTC_TV TV PDEs Display UR Nov_Ind Dec_Ind/VIF DW;
output out=MarkEff_out
predicted=yhat
residual=resid;
run;
proc print data=MarkEff_out;
run;
```

```
 proc NLIN data=MarkEff
 best=10
 maxiter=2000
 method=gauss
 converge=1.0E-6
 LIST
 ALPHA=0.10
 ;
 ID
 Month;
 Parms
 B_Int=1508.73096
 B_Formulary=41.82768
 B_UR=-5.85931
 B_Nov_Ind=359.09986
 B_Dec_Ind=364.47564
 B_DTC_TV=-0.41607
 B1_TV=700
 B2_TV=0.43
 B3_TV=0.01
 B_PDEs=12.00214
 B_Display=68.30121
;
 model
  Sales=
  B_Int+
  B_Formulary*Formulary+
  B_UR*UR+
  B_Nov_Ind*Nov_Ind+
  B_Dec_Ind*Dec_Ind+
  B_DTC_TV*log(DTC_TV)+
  B1_TV*exp(-B2_TV*exp(-B3_TV*TV))+
  B_Display*log(Display)+
  B_PDEs*log(PDEs)
  ;
  output out=MarkEff_NLIN_out
  predicted=yhat
  residual=resid
  stdr=std_dev_r
  ;
  run;
```

```
  data MarkEff_NLIN_out;
  set MarkEff_NLIN_out;
  label std_residual="standardized residuals";
  std_residual=resid/std_dev_r;
  run;
  proc rank data=MarkEff_NLIN_out normal=blom out=MarkEff_NLIN_out;
  var std_residual;
  ranks rresid;
  run;
  goptions reset=all border;
  symbol1 color=blue value=dot;
  symbol2 color=red interpol=join;
  proc GPLOT data=MarkEff_NLIN_out;
  plot std_residual*rresid rresid*rresid/overlay;
  run;
  quit;
  goptions reset=all border;
  symbol1 color=blue value=dot;
  proc gplot data=MarkEff_NLIN_out;
  plot resid*yhat;
  run;
  quit;
  goptions reset=all border;
  symbol1 color=blue value=dot;
  symbol2 color=red interpol=join;
  proc GPLOT data=MarkEff_NLIN_out;
  plot yhat*Sales Sales*Sales/overlay;
  run;
  quit;
  proc reg data=MarkEff_NLIN_out;
  model resid=/dw dwprob;
  run;
  quit;
title "Marketing Effectiveness Holdout Test";
data H_Test;
input Month Formulary DTC_TV Nov_Ind Dec_Ind TV PDEs Display UR Sales @@;
Sales=300*Sales;
datalines;
1/1/2011 5 150 0 0 75 25.7 1.505594371 5.6 8.14
 2/1/2011 5.1 450 0 0 125 13.8 1.645746172 5.1 7.952
 3/1/2011 5.1 150 0 0 20 15.3 0.61681864 4.4 5.883
```

4/1/2011 5.2 300 0 0 10 19.7 1.122074228 5.7 6.059
5/1/2011 5.4 510 0 0 120 12 0.926028619 4.1 7.346
6/1/2011 5.4 450 0 0 100 11.6 0.742634918 6 7.367
7/1/2011 5.3 150 0 0 50 9.4 1.278152746 5.2 6.777
8/1/2011 5 225 0 0 15 18.4 0.820908922 4.1 6.129
9/1/2011 4.8 150 0 0 40 22.6 0.964507806 5.1 7.153
10/1/2011 4.6 150 0 0 0 18.2 1.040427503 5 6.355
11/1/2011 4.2 750 1 0 200 13.2 1.791742017 3.6 9.118
12/1/2011 4.1 600 0 1 150 24.6 1.366356679 5.4 8.982
1/1/2012 4 150 0 0 0 22.3 1.301996718 5.2 6.441
2/1/2012 4 375 0 0 75 7.6 1.634923826 4.2 7.165
3/1/2012 4 450 0 0 10 17 1.213442258 3.1 6.177
4/1/2012 3.5 450 0 0 100 19.7 1.697367261 6.8 7.797
5/1/2012 3.7 510 0 0 20 20.7 1.306341973 4.8 6.244
6/1/2012 3.5 270 0 0 40 6.4 1.255019404 4.1 5.918
7/1/2012 4.6 150 0 0 0 20.7 0.804678511 6.6 6.229
8/1/2012 4.2 150 0 0 10 12.6 0.750211641 4.4 6.037
9/1/2012 4.1 600 0 0 150 12 0.972954659 4.6 7.586
10/1/2012 4 150 0 0 0 24.1 0.494539573 4 6.346
11/1/2012 4 600 1 0 150 24.5 1.645918277 6 9.35
12/1/2012 4 750 0 1 20 10.1 1.217580147 3.7 6.748
1/1/2013 3.5 240 0 0 30 22.5 1.823837736 5.7 6.687
2/1/2013 5 150 0 0 0 20.8 0.701993413 4.9 6.601
3/1/2013 5.4 300 0 0 50 19 1.851489159 5.3 7.375
4/1/2013 6.1 300 0 0 50 5.2 1.181353005 6.5 6.42
5/1/2013 6.8 150 0 0 0 18.1 1.235798507 4.8 6.73
6/1/2013 7 150 0 0 85 18.4 0.678308788 4.5 8.011
7/1/2013 7.4 150 0 0 25 22.3 1.570813666 5.6 7.348
8/1/2013 7.3 375 0 0 75 6.8 0.902261884 3.8 7.389
9/1/2013 7.5 150 0 0 0 26.2 1.667311405 5 6.942
10/1/2013 7.2 525 0 0 125 25.5 1.488846866 3.9 8.786
11/1/2013 8 450 1 0 100 8.8 1.069203721 3.6 9.05
12/1/2013 8.4 450 0 1 100 25.9 0.931868705 6.6 9.899
1/1/2014 8.3 300 0 0 50 13.6 1.142174138 3.4 .
2/1/2014 8.5 150 0 0 30 21.4 0.646969463 5.8 .
3/1/2014 8.8 150 0 0 10 15.9 1.581222375 6.6 .
4/1/2014 8.5 675 0 0 175 9.2 0.913013018 6.8 .
5/1/2014 8.2 150 0 0 10 24.2 1.577213107 4.1 .
6/1/2014 8 690 0 0 180 22.7 1.438843328 3.6 .
7/1/2014 8.1 150 0 0 50 13 0.825130443 6 .
8/1/2014 7.9 450 0 0 25 21.8 1.61587515 4.8 .

```
 9/1/2014 8.2 450 0 0 125 7.3 1.033628615 4.8  .
 10/1/2014 8.4 750 0 0 185 20.2 1.793132756 4.4  .
 11/1/2014 8.3 600 1 0 150 17.8 0.707572304 6.1  .
 12/1/2014 8.5 600 0 1 190 8.1 1.626550155 4.5  .
;
run;
proc sort data=H_Test out=foo NODUPKEY;
by Month;
run;
proc NLIN data=H_Test
best=10
maxiter=2000
method=gauss
converge=1.0E-6
list
alpha=0.10
;
ID
Month
;
Parms
B_Int=1508.73096
B_Formulary=41.82768
B_UR=-5.85931
B_Nov_Ind=359.09986
B_Dec_Ind=364.47564
B_DTC_TV=-0.41607
B1_TV=700
B2_TV=0.43
B3_TV=0.01
B_PDEs=12.00214
B_Display=68.30121
;
model
Sales=
B_Int+
B_Formulary*Formulary+
B_UR*UR+
B_Nov_Ind*Nov_Ind+
B_Dec_Ind*Dec_Ind+
B_DTC_TV*log(DTC_TV)+
```

```
B1_TV*exp(-B2_TV*exp(-B3_TV*TV))+
B_Display*log(Display)+
B_PDEs*log(PDEs)
;
output out=H_Test_out
predicted=yhat
residual=resid
stdr=std_dev_r
;
run;
proc print data=H_Test_out;
run;
proc reg data=H_Test_out;
model resid=\dw dwprob;
run;
quit;
ods pdf close;
```