

# WORKSHOP

The managers of a firm are interested in determining the extent to which advertising increases the firm's profits. More specifically, the managers want to know: (a) whether advertising has any identifiable effect on profits, and (b) if so, whether a dollar spent on advertising increases profits by at least a dollar, such that advertising is a good investment by the firm. The managers ask you to conduct a statistical analysis to answer their questions.

You obtain data from the firm on its profits, advertising expenditures, and other factors for each year 1971-1992. The variables are labeled as follows:

- AD = the advertising expenditures by the firm, in millions of dollars;
- PR = the profits of the firm, in millions of dollars;
- COMP = the combined advertising expenditures of all firms that compete with your firm, in millions of dollars;
- COST = the cost of a minute of TV advertising time, in thousands of dollars;
- T = a time trend variable that equals 1 in 1971 and increases by one each year, such that it equals 22 in 1992.

All dollars are in real terms (that is, they have been deflated by a general price index).

The data are contained in file ADDAT in the **fri** subdirectory.

## I. Single Equation

You are investigating whether profits in each year are affected by the amount of advertising that the firm does in that year. You also realize, however, that ads by competing companies hurt your firm and that it is important for your firm's managers to know this.

- (1) Run a regression with PR as the dependent variable and AD, COMP, and an intercept as explanatory variables:

```
options crt;  
in addat;  
olsq pr c, ad, comp;
```

- (2) How much is profit estimated to rise if your firm spends \$1 extra on advertising? How much are your firm's profits estimated to fall for each dollar spent on ads by your competitors?
- (3) Test for serially correlated errors.
- (4) Re-estimate the equation accounting for serial correlation:

```
ar1 pr c, ad, comp;
```

Does the estimated effect of advertising change much?

## II. Simultaneous Equations

After talking to the firm's managers for a while, you come to realize that causation actually flows in two directions in the relation between advertising and profits. The managers report that they have been more willing to spend money on advertising in years when they are making larger profits, because they had the money to spend. Conversely, in years with little profits, the managers instituted bare-bones budgets in an attempt to keep costs down; advertising was one of the first expenditures to be cut in tight years.

You specify the following simultaneous equations model to account for this.

$$\begin{aligned} PR &= \alpha + \beta AD + \lambda COMP + \varepsilon \\ AD &= \eta + \phi PR + \pi COST + \delta T + \mu \end{aligned}$$

The managers have also told you that they place more ads when the cost of each ad is less but that, independent of all else, their advertising expenditures have gone up over time just because advertising has become "the thing to do." That is why you include  $COST$  and  $T$  in the equation for advertising expenditures.

- (1) Is the structural model just, over, or under identified?
- (2) Write the reduced form equations. (You do not need to estimate the reduced form equations.)

- (3) Estimate the equations by 2SLS.
- (4) Test for serial correlation in the errors.
- (5) Re-estimate the models accounting for serial correlation.

This is done with the TSP commands

```
ar1(nofair,inst=(c,cost,t,comp,comp(-1),cost(-1))) pr c,ad,comp;
ar1(nofair,inst=(c,cost,t,comp,comp(-1),cost(-1))) ad c,pr,cost,t;
```

- (6) If your competitors spend \$1 extra on advertising, what is the immediate effect on your firm's profits (ignoring the fact that changes in profit affect your firm's advertising expenditures)? What is the **TOTAL** effect on your firm's profits, accounting for the fact that your firm spends less on advertising when its profits drop?
- (7) If your firm spends \$1 extra on advertising, what is the immediate effect on your firm's profits? What is the **TOTAL** effect?
- (8) The 2SLS estimates do not utilize the information contained in the correlation between  $\varepsilon$  and  $\mu$ . Re-estimate the model by 3SLS. Do separate estimates with and without allowing for serial correlation in the errors.

This is done with the TSP commands:

```
frml eq1 pr = a + b*ad + d*comp;
frml eq2 ad = f + g*pr + h*cost + j*t;
param a,b,d,f,g,h,j;
3sls(inst = (c,comp, cost,t)) eq1 eq2;
smp1 2 22;
form(nar = 1, coefpref = b, rhopref = r)
    eq3 pr c,ad,comp;
form(nar = 1, coefpref = d, rhopref = p)
    eq4 ad c,pr, cost,t;
3sls(inst = (c,comp, cost,t, comp(-1), cost(-1)))
    eq3 eq4;
```

Do the estimated parameters change much from the 2SLS results?