USING THE PLOT PROCEDURE TO AVOID FEAR OF CURVES IN ECONOMICS

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ABSTRACT

Many students of basic economic principles courses identify as their earliest stumbling block (which many never overcome) a lack of familiarity with graphs and their interpretation. This writer finds that the PLOT procedure can be used as an heuristic device to reinforce the learning of crucial principles in economic (and computer) literacy. Since most economics texts proceed the same way through progressively difficult concepts, the approach shown here, which requires that students demonstrate mastery of graphical analysis, and of SAS Code, to produce plots of several key concepts in economics, can be used in most beginning courses. The PLOT procedure is remarkably easy to understand and use, and has helped many students learn graphical analysis sooner.

INTRODUCTION

The lowest tail of the grade distribution for the first quiz in the elementary economics principles course is usually occupied by students who cannot grasp the connection between the principle and the graph used to explain in the textbook. Often these students are simply those who have not been exposed to graphs before, and who have trouble grasping both the theory and the graphics simultaneously. Software packaged with some of the latest texts is of little help because it is typically non-interactive (and usually written by third parties).

A method I developed to stimulate an understanding of graphs, while reinforcing the principles, uses the easily comprehended PLOT procedure to show the student how to do graphical "proofs" of selected concepts.

In order to attack "computer phobia" among students, most teachers in my department require a computer project in every lower division class, progressing in difficulty from the most elementary to the most advanced courses, for most of the teachers, SAS Code is the language of choice.

Our faculty is able to enforce this requirement, in part, because the campus Center for Academic Computing (ACC), bears most of the burden. ACC personnel teach students and faculty a series of "hands-on course" in the basic operating system for the mainframe and PC in the first few weeks of each semester. Given sufficient demand, ACC also offers a course in the fundamentals of the SAS display manager (DMS).

In the first weeks of the semester, we require that all students attend the ACC courses in OS and DMS and build on this base by using programs like the following simple plots of curves of hypothetical economic functions.

OPPORTUNITY COSTS, INTERCEPTS AND SLOPES

One of the first graphs encountered by the student in the typical text is the production
possibilities (or transformation) curve, which embodies the principle of opportunity costs: the trade-off every economy faces when choosing what to produce, given scarcity and technology. Two types of transformation curves: a linear and a concave type are generated by the following program, shown in Figure I, below:

```
DATA PRODPOSS;
  INPUT X;
  Y = 100 - 10*X;
  XSQ = X**2;
  Z = 100 - XSQ;
CARDS;
0
1
2
3
4
5
6
7
8
9
10
PROC PLOT;
  PLOT Y*X;
  PLOT Z*X;
  TITLE 'FIGURE I';
  TITLE2 'PRODUCTION POSSIBILITIES CURVES';
RUN;
```

These plots enable the professor to lead a simplistic discussion of intercepts, slopes and linear and nonlinear functions, which helps to determine where most of the students are in terms of these concepts. This discussion facilitates learning of the key economic concepts involved: the fundamental problem of choice, given scarcity, technology and efficiency. The student quickly perceives the difference between constant and increasing opportunity costs, both as shown in the plot and in the equations, by altering the parameters in the Y and Z functions.

Requisite knowledge about SAS Code is kept minimal at this point by making the program accessible by a simple command to the students external file manager, after a brief discussion of how these systems work together.

MARKET SUPPLY, DEMAND AND REVENUES

The next graphs encountered in the typical economics textbook are the market demand and supply curves. Students find it hard to distinguish "changes in demand and supply" with "changes in quantities demanded and supplied," but improve in grasping the concept immediately after an assignment requiring manipulation of the parameters of the equations in Figure II, below.

```
DATA SUPDEMN;
  INPUT X @@;
  PD 1 - .1*X;
  PS .3 + .1*X;
  TR PD*X;
  MR DIF(TR);
  AR TR/X;
CARDS;
1 2 3 4 5 6 7 8 9 10
PROC PLOT HPCT = 50 NOLEGEND;
  PLOT PD*X='d' PS*X='s'
/OVERLAY VAXIS = 0 TO 1 BY .1;
  PLOT TR*X='t' MR*X='m' AR*X='a'
/OVERLAY VREF=O VAXIS=-.1 TO 2.5 BY .1;
  TITLE 'FIGURE II'; TITLE2 'MARKET SUPPLY AND DEMAND';
  TITLE2 'AND REVENUE CURVES';
RUN;
```

The discussion of the output from this program permits an enhanced understanding of the determinants of demand, supply, equilibrium price and quantity, and deterministic vs stochastic functions (and aspects of SAS Code).
MARGINAL ANALYSIS

Later in the semester, a second lecture on the graphical analysis of supply and demand equations permits the introduction of the concept of the (derivative) function, and its relationship to the economic concepts of marginal revenue and marginal cost (which are the derivatives of total revenue and total cost respectively). This is also a good time to present some of the myriad "built-in" functions of SAS, among which are the DIF (difference) function. I explain the way in which this built-in function calculates the marginal from the total by comparing it with LAG, another built-in function.

DATA MARGREV;
  INPUT Q @@;
  Pd = 10 - Q;
  Ps = 1 + .5Q;
  TR = Pd*Q;
  MR = DIF(TR);
  AR = TR/Q;
CARDS;
  1 2 3 4 5 6 7 8 9 10;
RUN;
PROC PLOT;
  PLOT TR*Q='T' AR*Q='A' MR*Q='M'
/ OVERLAY;
RUN;

At this point, the discussion covers the important relationships between marginal, average and total quantities, and ultimately, the concept of price (and other) elasticities.

SHORT RUN COSTS OF PRODUCTION

The relationship between marginal, average and total quantities are also important in the study of production and costs of the firm. The following program is one of a variety given to the students for a hands-on introduction to these principles. At this point they are expected to be able to conclude, from the data (which differs for each student), where the firm will produce in the short run (where marginal revenue—the competitive firm’s price—equals marginal cost of production). Alternative prices are included in the program, which the student alters and plots against the firms cost structure, in order to answer the questions: will the firm produce the product and if so, how many units, when the price rises or falls (See Figures IV through X, below).

DATA ONE;
  INPUT L X @@;
  PLC = 5;
  PKC = 4;
  K = 10;
  P1 = .80;
  P2 = .70;
  P3 = .40;
  TR1 = P1*X;
  TR2 = P2*X;
  TR3 = P3*X;
  APL = X/L;
  DL = DIF(L);
  DX = DIF(X);
  MPL = DX/DL;
  TVC = PLC*L;
  TFC = PKC*K;
  AVC = TVC/X;
  TC = TVC+TFC;
  ATC = TC/X;
  DC = DIF(TC);
  MC = DC/DX;
  AFC = TFC/X;
CARDS;
  1 5 2 12 3 21 4 33
  5 48 6 66 7 82 8 96
  9 107 10 118 11 127 12 134
  13 139 14 143 15 146 16 148
  17 149 18 149.5 19 149.8 20 150,
PROC PRINT;
  TITLE 'DATA FOR PRODUCT, COST
  AND REVENUE CURVES';
A not too subtle bonus of this economic literacy training through printer graphics is simultaneous training in the SAS language. Students invariably want to understand the effects of the many options suggested in the programs, such as NOLEGEND, VPCT, HPCT, and VAXIS, most of which were used to permit more than one diagram per page, but which help to enhance their understanding of the versatility and ease of use of the product.

MACROECONOMIC PRINCIPLES

The distinction between micro- and macro-economics is made by means of a simple income determination model:

```
DATA INCOME;
  INPUT Y @@;
  A = 50;
  MPC = .75;
  C = A + MPC*Y;
  I = 30;
  AD = C + I;
CARDS;
9 50 100 150 200 250 300
350 400 450 500;
;
PROC PLOT;
  PLOT C*Y='c' AD*Y='a' y*y='*'
       / OVERLAY;
RUN;
```

A discussion of the economic interpretation of the vertical intercept (A) and slope (MPC), of the consumption equation and the exogenous nature of Investment, I, in this model helps the student understand still more about interpreting graphs. In addition, one of the lines, the 45 degree line, is plotted in PROC PLOT in an especially instructive way. It helps the understanding of the student to verify the often elusive idea that all loci of equal quantities reside on the line, if both axes are scaled alike.

Additional homework assignments, for those needing more practice, consist of changing the parameters in both the micro- and macro-models and a graphical evaluation of their effects on the solutions; or of adding exogenous variables (e.g., Go, Xo and Mo), which leads to further insights regarding the relationship between their effect on the vertical intercept and consequent effect on equilibrium. In addition, the effect of a lump-sum tax, which does not depend on income is shown, using the following model:
PRODUCTION POSSIBILITIES CURVE

Plot of Y*X. Legend: A = 1 obs, B = 2 obs, etc.

Plot of Z*X. Legend: A = 1 obs, B = 2 obs, etc.
FIGURE II
MARKET SUPPLY AND DEMAND
AND REVENUE CURVES

NOTE: 14 hidden. 4 out of range.

NOTE: 3 obs were out of range.
FIGURE III
TOTAL AND AVERAGE PRODUCT CURVES

NOTE: 1 obs had missing values. 2 obs were out of range.

1205
FIGURE IV
TOTAL AND AVERAGE COST CURVES

NOTE: 19 obs hidden. 13 obs were out of range.

AVC
1.9 +
1.8 +
1.7 +
1.6 +
1.5 +
1.4 +
1.3 +
1.2 +
1.1 +
1.0 +
0.9 +
0.8 +
0.7 +
0.6 +
0.5 +
0.4 +
0.3 +
0.2 +
0.1 +
0.0 +

NOTE: 109 obs hidden. 8 obs were out of range.