

BOND MARKETS IN MONEY AND BANKING

*David Gillette**

Students have expressed their enthusiasm for two bond market experiments that are now a regular part of my Money and Banking classes. These experiments are not designed for the principles level, but rather for upper division finance and economics majors.

The first experiment is an adaption of the Double Oral Auction market introduced to participants of the NSF workshop in Tucson (summer of 1991). Bond buyers (households with money to lend) have endowments of money that they can either leave in the bank and earn next to nothing on, or they can try and buy higher yielding bonds in the market. Bond sellers (firms with investment projects to finance) begin the game with an option to issue a bond on which they would have to pay some outrageous interest rate. Both buyers and sellers are given reservation interest rates that, as part of the experiment, they must convert to dollar prices. All bidding is conducted in prices, not interest rates. Bonds may be either zero-coupon or interest bearing. The buyer with the highest average yield after the final trading period and the seller with the lowest average borrowing costs are the winners of the experiment. Since they are required to bid in dollar prices yet win according to average interest rates, this version of the DOA experiment has been successful in driving home the inverse relationship students often find so difficult to grasp.

The second experiment is a classroom version of the Treasury's Sealed Bid Auction for Treasury Bills. It is a bit more complicated to run because of the sorting process and average price calculations that must be rapidly performed if several rounds are to transpire in a

matter of a few minutes in the classroom. But spreadsheets are wonderful and it can be done. The motivation is similar to that of the bond market described above. Students are given an initial endowment on which they may earn next to nothing by leaving it in the bank or they may attempt to increase their earnings by submitting bids to the Fed (the instructor) which accepts them on behalf of the Treasury. Bids may be competitive or non-competitive in accordance with actual bidding rules. Spreadsheets also make it possible for the bank's interest rate and the Treasury's borrowing needs to vary "according to market conditions" through the use of random number generation and to instantly check whether bidders have violated either their reservation prices or the market share restrictions. Various features such as 3, 6, or 12 month durations and comparison of shorter issues rates to annualized rates can be incorporated into the experiment. Besides gaining a better understanding of the Treasury Bill Market, students are able to gain insights into the Treasury's borrowing costs in both thick and thin markets.

Readers interested in further details regarding either of these experiments are welcome to contact me.

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VARIATIONS ON THE PUBLIC GOODS EXPERIMENT

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Most academics who do a classroom experiment to illustrate the theory of public goods use some variation of the original experiment designed by Marwell and Ames [1981] or the later presentation by Brock [1991]. Briefly, the experiment goes as follows. In successive decision-making rounds students are endowed with tokens to be invested in either a private account, a group account (public good), or in both accounts. The private account pays a return to the individual for each token he/she invests in each round. The group account pays each individual an equal portion of the total number of tokens invested in the group account in each round. The private account is considered rival and excludable. The group account is considered nonrival and nonexcludable. The experiment is designed so that the private optimal point is to invest completely in the private account and free-ride on the group's investment in the public good. The socially optimal point requires 100 percent investment in the group account (public good).

Conversations with other academics performing this experiment led the authors to hypothesize that variations in the institutional structure of the experiment would alter the outcomes of the experiment. Changing the institutional structure included changing the participant characteristics, public good description, and manner of reporting investment decisions. Eight variations of the experiment were performed to try to influence the outcomes of the experiment. The first group consisted of students taking an introduction to economics course (a one semester course). The experimenters believed these students would show a propensity for

economic thinking. The second group was taken from freshman English composition classes. These students had never taken or were not currently taking an economics course. The third group of students were in an introduction to economics course who were given a lecture on public goods before experimenting began. The fourth group consisted of upper-level business majors. School of business majors made up group five. In this experiment after each decision round, each participant was asked to disclose his/her investment in the group account. Group six consisted of school of business majors who were given a verbal description of a hypothetical group account before the experiment began. Group seven also consisted of business majors who were given the same description of the hypothetical group account; however, during the experiment, each participant disclosed his/her group investment and the presenter of the group account tried to persuade each to invest in the group account. Group eight consisted of business majors who were allowed three minutes between investment rounds to discuss their investment strategies. The experimenters left the room during the three minutes. This was the only experiment in which discussion was allowed.

The results of the eight variations led to differing degrees of free-riding. Experiments two and three displayed the most free-riding. Experiments one, four, five, six, and seven all displayed minor levels of free-riding. Only in the final round of experiment eight did the participants reach the socially optimal point of 100 percent group investment.

In an attempt to determine what type of learning, if any, took place during the experiment, participants were asked to complete a written exit interview immediately following the completion of the experiment. The questionnaire asked for a description of each participant's investment strategy.

Beginning with the fifth experiment, two questions regarding individual return to tokens invested in the private account and to tokens invested in the group account were added to the questionnaire. The most common investment strategy was the belief that an individual could influence his/her personal return from group investment, that this return was variable. Individuals learning to free-ride was the second most frequent strategy, followed closely by the strategy of thinking that an individual's return from group investment was more than that from private investment; individuals looked at the group's return to tokens invested in the group account versus his/her return per token invested in the private account. Few participants correctly understood the returns to the private and group accounts and, thus, did not free-ride. Several lacked a strategy. They simply chose their investments randomly. With regard to the questions on private and group return, several participants misinterpreted individual return per token invested in the group account; they didn't see that individuals had to share in the returns to the group account. Instead, they looked at an "average private social benefit." They added all their returns from group investment, then divided by the total number of tokens they had invested in the group individually.

Many who have performed this experiment in their classes will attest that students enjoy taking part in the experiment, particularly if there are monetary rewards involved. The authors, however, wish to caution those who are considering incorporating this experiment into their curriculum. It is our finding that the experiment itself will not teach the theory of public goods and the free-rider problem. The experiment must be supplemented with a post-experiment explanation to be beneficial to all students.

References

Brock, John. "A Public Goods Experiment for the Classroom." *Economic Inquiry*, 29, 1991, 395-401.

Marwell, Gerald and Ruth E. Ames. "Economists Free Ride, Does Anyone Else? Experiments on the Provision of Public Goods, IV." *Journal of Public Economics*, 15, 1981, 295-310.

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An expanded version of this paper, entitled "The Public Goods Experiment: Variations in the Institutional Structure," is available from the authors upon request.

WIDGET PRODUCTION IN THE CLASSROOM

*John Neral**

SUMMER, FALL NSF WORKSHOPS SET

Donald Wells of the University of Arizona has just informed us that the National Science Foundation will once again sponsor two workshops on the use of experimental methods in undergraduate instruction in economics. The workshops will be held August 19-21 and October 28-30, 1993, at the University of Arizona. Each workshop will accommodate thirty-five participants. Application information is available from:

Professor Donald Wells
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University of Arizona
Tucson, AZ 85721
(602) 621-6240/621-6224

Readers of this newsletter who have not previously participated in these workshops are encouraged to apply.

For many students, the standard principles-level treatment of production and cost is an incomprehensible maze of definitions and formulas, all of which can be very difficult to relate to real world production relationships. The following classroom exercise can be helpful in bridging this gap between theory and experience.

Students participate in a short-run production exercise in which they produce "widgets." Fixed inputs include a stack of paper (to conserve paper, I use 8-1/2" x 11" sheets which I have cut in half prior to class), a stapler, and a work surface (generally half of the desk or table at the front of the classroom).

The variable input is, of course, labor, which is provided by students. The per unit prices of the inputs are fixed and specified in advance. A widget is produced by taking a sheet of paper, folding it twice, and stapling it. Widgets, by the way, are very fragile and break if they drop onto the floor at any time during the production process.

Production proceeds over a number of production periods of a set length (30 or 45 seconds). In each period, the fixed capital (which is normalized as $K = 1$) is combined with an increasing number of units of labor. Students are provided with a form (reproduced below) upon which to record the level of employment of labor and the level of production of widgets in each period. I generally run the first period with zero units of labor (but be prepared for some strange looks from your students as you wait 45 seconds to observe how many widgets will be produced with no labor). In each succeeding period, one additional unit of labor (i.e., one student) is added to the production process and the level of production of widgets is observed and recorded.

I generally try to terminate the exercise after diminishing marginal returns have set in, but before negative marginal returns have set in. This usually occurs around the fourth or fifth period, but varies with the group of students and the size of the work surface provided (the smaller the surface, the more quickly congestion and diminishing returns set in). If you observe negative returns, you'll have to spend some time explaining why some of our formulas don't work well with negative changes in output.

K	L	TPP	APP	MPP	TFC	TVC	TC	MC	AFC	AVC	AC
1	_____	_____	_____	_____	_____	_____	_____	_____	_____	_____	_____
1	_____	_____	_____	_____	_____	_____	_____	_____	_____	_____	_____
1	_____	_____	_____	_____	_____	_____	_____	_____	_____	_____	_____
1	_____	_____	_____	_____	_____	_____	_____	_____	_____	_____	_____
1	_____	_____	_____	_____	_____	_____	_____	_____	_____	_____	_____
1	_____	_____	_____	_____	_____	_____	_____	_____	_____	_____	_____

Once the levels of labor input and their associated total physical products of widgets are observed, the calculations of average and marginal physical product are routine. But the concept of marginal physical product becomes clearer to most students when they realize that the marginal physical product of the third unit of labor is just the increase in output that resulted when the third student was brought into the experiment.

Once the prices per unit of capital and labor have been specified (\$10 and \$5 seem to work pretty well for me), students can proceed with the calculation of total, average, and marginal costs. But now these costs can be related to the production process which has just been observed.

A word of caution is in order at this point. Students who participate in this exercise will exhibit dramatically different levels of motivation, physical coordination, and, hence, marginal productivity. As a result, any attempt to graph the production and cost curves generated by this exercise may generate bizarre results. However, it may be possible to reduce this problem somewhat through the use of "creative timekeeping" during the course of the production exercise. This is simply a matter of counting the number of times you hear the stapler used during a particular period and then adjusting the length of the current period upward or downward slightly so that the exercise generates the desired results (say, increasing marginal returns due to specialization in early periods followed by decreasing marginal returns due to congestion in later periods). As long as these "dynamic adjustments" are small (say, five seconds or less), students are unlikely to notice them and you may be able to avoid spending time explaining why the textbook theory did not perfectly describe the data generated in the classroom. And even if you employ this bit of deviousness, you may still occasionally

encounter cases where you are unable to make the cost curves generated by the exercise look like the cost curves contained in the textbook. Fortunately, a moment's glance at the cost data will reveal when this is the case and allow you to suggest to your students that they need not try to use the data generated during the exercise to graph the production and cost curves.

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This exercise was first described to me by Margaret Ray of Texas Christian University at the October, 1991, NSF Experimental Workshop. She borrowed it from Paul Nelson of Northeast Louisiana University, and is under the impression that its lineage traces back to Texas A&M.

MORE ON THE ESLBBS

A significant number of our readers have expressed an interest in the Economic Science Laboratory Bulletin Board System. We have refrained from distributing more detailed information about the ESLBBS in deference to the fact that a certain critical mass of interested individuals is needed to make this sort of endeavor successful. In the hope that this critical mass has now been achieved, we have appended to this issue instructions for accessing the ESLBBS and the "TEACHING" Special Interest Group (SIG) which has been set up to complement this newsletter. We have placed several messages on the SIG in an effort to get things started. We urge anyone who has access to InterNet to check out the ESLBBS, and to leave some sort of message on the "TEACHING" SIG to let everyone else know what's on your mind.

ECONOMIC SCIENCE LABORATORY BULLETIN BOARD SYSTEM

ESLBBS

The ESLBBS is an electronic exchange system designed specifically for use by the Economic Science Association and interested parties. Access to this system is FREE and available through the "internet", or via a modem phone call to Tucson, Arizona. The primary motivation for this central exchange is to provide a clearing house for experimental software applications that may be released to the public domain, and to promote discussion and interaction by those that use, or attempt to use, these software packages.

In addition to a software exchange, this system can be used to exchange abstracts along with comments and discussions about specific topics. This BBS software provides the facility for Special Interest Groups (SIGs). The current list of SIGs (as of 2/11/93) is:

SIG	Msgs	Files	SIG-Op	Description
/Hello	2	0	Sysop	Questions and Answers about this BBS
/Utils	4	3	Sysop	File archive/compression utilities
/MAC	1	0	Rkw	Apple Macintosh applications
/Oligop	3	1	Sysop	U of Az Oligopoly Package
/Methods	22	0	Sysop	Experimental Methodology
/MUDA	1	0	Sysop	Cal Tech Multiple Unit Double Auction
/Assign	1	0	Sysop	Assignment Problems
/LABS	2	1	Sysop	Laboratories
/FINANCE	2	0	Markw	Financial Science
/TEACHING	5	0	Neral	Classroom Expernomics
/MONOP	2	1	Sysop	Cybernomics MICRO Monop

For every message you leave on the system, you always have the option of uploading a file to be "attached" to the message. Therefore, every message you read may have a file attached to it and you will be prompted to see if you wish to download the attached file. Currently, there is a problem downloading files other than ASCII over the internet. If you wish to download a file, either dial up through a regular phone line, or contact Shawn Lamaster (see below) to arrange an alternative method to get the file(s).

The following services are available:

- T ... Teleconferencing
- I ... Information Center
- S ... SIGs (Special Interest Groups)
- C ... Classified ads
- E ... Electronic Mail
- A ... Account display/edit
- P ... Polls & Questionnaires
- R ... Registry of Users
- X ... Exit (terminate session)

This software currently supports TWO simultaneous users. Therefore, you can have an interactive chat with someone else on-line through the Teleconferencing option, if they are connected to the system. This software can be expanded to support 64 simultaneous users if desired. Feel free to leave a Classified ad, or fill out one of the Polls or Questionnaires that came with the system. Design your own poll or questionnaire for the ESLBBS!

Currently, there are two ways to connect to the ESLBBS. One is to dial up on a 2400 baud (or less) modem to (602) 621-4240. The other is connect via the international "internet" computer network. Practically every university and college is connected to the internet. The internet address for the connection to the ESLBBS is:

```
idx.telcom.arizona.edu
```

Typically, from a VAX VMS (\$) prompt, or an IBM VM/CMS machine, you would type

```
telnet idx.telcom.arizona.edu
```

to establish a telnet session over the internet. Assuming you have gotten this far, you will receive the following on your screen:

```
University of Arizona IDX-3000g
Communication Problems? Call 621-7999.
Select host: VML, VMS, or VMSPLUS
```

```
Thu Feb 11 12:50:13 1993
Port ID: IDX_IN lin_05 at 9600 baud
>ESLBBS (you type ESLBBS)
Connecting IDX_IN lin_05 to ESLBBS 100_5
Auto-sensing ANSI..... (you press the RETURN key here)
```

```
Welcome to the Economic Science Lab's Electronic BBS
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```
The Economic Science Laboratory BBS (#72793409)
Running The Major BBS by GALACTICOM
ONLINE 9600 BAUD AT 15:20 25-OCT-90
```

```
If you already have a User-ID on this
system, type it in and press RETURN
Otherwise type "new":
```

At this point please type **new** and answer the questions asked. Also, please go into the Registry of Users, option R from the main menu, and enter your information so others can communicate with you. You may use a "handle" for your user id if you wish, but please enter your correct name and address, etc. in the Registry of Users.

To access the Classroom Expernomics SIG, enter S from the menu, enter S again to select a SIG, and then enter "TEACHING" to attach yourself to this SIG. Follow the instructions to read and/or

send messages to others who are interested in this SIG.

When you are finished, enter X from the main menu to exit the ESLBBS. The following message will be returned.

```
You are about to terminate
this telephone connection!
```

```
Are you sure (Y/N, or R to re-logon)? Y          (You type Y)
```

```
Ok, thanks for calling the Economic Science Laboratory BBS.
Hope to see you back again real soon!!
```

```
Have a nice day...
```

At this point, you should enter the escape sequence for your version of telnet; on my VAX system, it is "^]" (i.e., Ctrl-]), but on your machine it may be different. You will need to know this escape sequence to properly terminate your connection to the ESLBBS. The following prompt will then be returned to you:

```
TELNET> exit          (you type EXIT)
Local connection closed
$
```

At this point, you will have returned to your original VAX prompt.

If you need help using any part of the ESLBBS, please contact:

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McClelland Hall, Rm.#116
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University of Arizona
Tucson, Arizona 85721
Phone: (602) 621-6218 Fax: (602) 621-5642

InterNet: lamaster@arizona.edu
lamaster@convx1.ccit.arizona.edu
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lamaster-uasite@nova.novanet.org

If you have questions about the TEACHING SIG or "Classroom Expernomics," please contact:

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