# COMPUTER-AIDED TUTORIAL FOR PRODUCTION ECONOMICS

by

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## Introduction

Economics is frequently considered by students to be an abstract and mysterious subject. This is particularly true for entry or principles level courses. Most of the students enrolled in these courses are there reluctantly to fill a requirement or, at best, to check out a possible major. Many have had little or no previous training in the field, have poor mathematical skills, and may have trouble deciphering simple tables or graphs.

Many of the terms employed in the field have connotations different from those in general usage. Moreover, most of the concepts may and usually are presented in mathematical and qraphical representations. All too frequently textbooks and lectures fail to communicate the meaning of the concepts, and the correspondence of the mathematical and graphical presentations. Many, probably most, entry level economics students are reduced to memorization survival strategies, seldom or occasionally comprehending the full meaning and import of the materials presented.

There are many reasons for these failures. They include inadequate or inconsistent explanations in texts, poor lecture skills often aggravated by large class sizes, and low student motivation levels. Wherever the blame is placed, however, it is clear that the barriers to entry into the circle of

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comprehending students are too high and/or the incentives are too low for many students. In an effort to lower these barriers, we are developing a computer-aided tutorial in economics. These tutorials are intended to augment, rather than replace, standard textbook and lecture presentations.

Production economics was chosen for our initial lessons because students seem to have particular problems in this area. We believe that there are three principal reasons for this. First, most students have had little or no direct involvement with business. Second, explanations of production economics almost invariably involve at least three dimensions.[2] Students with little or no graphics skills quickly become lost when asked to make sense of a three dimensional figure and to relate it to a two-dimensional graph and the associated mathematics. Further complicating the graphics, and to a lesser extent the mathematics, is the fact that many different scales are often depicted on the same axis. For example, it is traditional to display total product, average product, and marginal product on the same graph. Often this is done with little or no warning to the student that the scales are actually different.[3] While a computer-aided tutorial cannot mitigate a student's lack of familiarity with the business world, the powerful graphics capabilities of microcomputers can serve to

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[2]Production functions with one variable input can be portrayed in two dimensions. As soon as a second input is introduced, a three-dimensional depiction is required.

[3]Total, average, and marginal products are all in terms of units of production. However each is different. Total product is the number of units of product (y) and average product is the number of units of product divided by the number of units of input (x). Therefore, the actual scales are y and y/x, respectively. This point seems transparent to those familiar with these terms, but can be a source of endless confusion to those who are not.

alleviate the problems related to understanding graphics and their correspondence to mathematical and textual explanations.

Before proceeding to a description of the approach we have taken in developing our tutorial, in the next section we will discuss the advantages and disadvantages of computer-aided instruction in higher education. This discussion will serve as background for the presentation of our work. In particular, it will demonstrate that our lessons are designed to take advantage of the strengths of this medium as a teaching tool.

## The Role of Computer Aided Instruction in Higher Education

With the widespread acquisition of microcomputers for instructional purposes, the question has arisen of how best to utilize this medium in teaching. Clearly with their ease of usage and generally quick turnaround times, microcomputers are well suited for students to practice applications on a variety of statistical and mathematical procedures which have large computational requirements. It is much less clear, however, as to the microcomputer's role in instruction; i.e., in the communication of information regarding the how's and why's of a system or body of thought.

Empirical evidence on the issue is inconclusive. Several studies in elementary and secondary schools have demonstrated considerable gains in instructional effectiveness using computer-aided instruction (CAI).[4] At the college level, however, most of the evidence suggests that CAI has a modestly positive impact on student achievement levels and little or no impact on student interest levels. CAI, however, substantially lowers the

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[4]For examples of studies at the elementary and secondary levels see Vinsonhaler and Bass; Edwards et al.; Jamison, Suppes, and Wells; and Hartley.

amount of time necessary for student-instructor interaction.[5] Against this advantage, however, must be weighed the resources necessary to create or procure the software and to provide student viewing facilities.

There have been a number of explanations put forth for the apparently modest effectiveness of CAI for higher education. These may be broken down into two categories. The first is that CAI is a neutral carrier of the message. In other words, the same message can be transmitted via any of the media, i.e., Cai, lecture, or text. The second explanation, which is really the first with a different emphasis, is that the generally lackluster record for CAI has been due to attempts to teach materials not well-suited to the medium and failure to capitalize on the medium's relative strengths.[6]

It is impossible to present an incontestable list of characteristics or instructional tasks for which CAI is better or worse suited than lectures or textual materials. Given the proper lesson design, it seems likely that any medium can perform any task. However, most would likely agree with the following:

1. CAI should not be used as an electronic textbook. That is, microcomputers are not as well suited as textual materials to present extensive amounts of largely unillustrated materials.

2. CAI is superior to textual materials when student interaction is desirable. It also may be superior to lecturing if classes are large or the schedule does not allow sufficient time for questions and answers or students feel too intimidated to participate fully.

3. CAI is superior to textual materials and, in many cases, to

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[5] A survey of 59 studies of university level CAI applications is presented in Kulik, et al.

[6] Excellent discussions of these points of view can be found in Kulik et al., and Clark.

lectures regarding the presentation of graphical materials with movement.

4. CAI, unlike lectures, can be repeated endlessly on demand.

A final strength for CAI, which could be listed, is that it is novel and may thus serve to hold the student's attention. As Clark (pp. 449-50) points out, however, novelty is a fleeting virtue. Indeed, today's university students are likely to have some familiarity with computers, if not with CAI. Therefore, CAI should be used as deemed appropriate given the medium's strengths, and not simply for its entertainment value.

The production economics tutorials are being designed in line with the above philosophy. Presentation of the material typically involves going back and forth between mathematical and graphical presentations. Frequently the graphics must be made to move, again, a task difficult to portray convincingly in books or accurately at the blackboard. Pointers and colors are employed to draw attention to areas of a paragraph, figure, or table at the appropriate times. This is something that an instructor can do in a classroom, but that is impossible in textual materials.[7] Students are forced to interact in the lesson. Frequently they are called upon to complete a table, figure, or sentence. If their answer is incorrect, they are either immediately told the correct answer and why or given clues and routed back to try again. Correct answers are acknowledged, usually accompanied by a brief explanation of why the answer was correct. At no point can a student become "stuck" in an endless cycle of wrong answers.

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[7]Highlighting to emphasize a point is, of course, possible in textual materials. What is meant here is that with textual materials it may be difficult to direct the reader's eye at a particular point in the presentation, e.g., a critical point on a graph.

Whenever the number of possible answers are large or infinite, the student is permitted a specified number of tries before the correct answer and an explanation is supplied.

## Overview of the Production Economics Tutorial

### Organization

The tutorials are being designed to augment other materials and lectures for the entry level agricultural economics course taught in the Food and Resource Economics Department of the University of Florida. However, the tutorials would be suitable for most entry level economics and agricultural economics courses. The production economics section is divided into lessons or modules designed to take 30 minutes or less to complete. This balkanization of the material is intended to combat student fatigue and to allow for greater flexibility for cases in which only subsections of the materials are required. The modules for the production economics section include:

1. Introduction

   Introduces the tutorial

   Use of special function keys.

   Directory of subsequent modules.

2. Basic Review

   Reviews basic economic terminology and the construction and interpretation of graphs and tables.

3. Factor-product Model I

   Terminology and formulas used in production analysis, along with the assumptions that underlie two-dimensional (single variable input) production functions.

   Graphic and tabular analysis of the production function.

   Stages of production

4. Factor-product Model II

   Determination of the economic profit maximization point of operation

5. Factor-factor Model

   Isoquant analysis

   Economic decisions under limited budgets

The production economics package is designed to be used sequentially, proceeding from module 1 to module 5. However, some students may require only a subset of the modules. In module 1 a brief outline of the topics and concepts covered in each of the succeeding modules are presented. This is intended as a guide to assist the user in identifying which modules he/she wishes to cover. Throughout all of the lessons, as users register incorrect responses, they are advised of the location (i.e., the module or screen number) of materials they may wish to review. Therefore, an overeager student who begins on module 4 may be directed to return to earlier lessons.

At the time of this writing, modules 2 and 3 are essentially complete, module 1 is being programmed, and the remaining modules are in various stages of screen design.

Notable Program Features

Every effort has been made to make the lessons user friendly and interesting. On each screen there appears the directions to page ahead or backwards in the lesson. The background colors of the screens differ depending upon the type of screen. This both alleviates boredom and provides a mental cue. Another cue is the use of an animated tractor to "drag" definitions and basic assumptions onto the screen. Another device employed to maintain user interest and to improve communication is the

depiction of a growing corn stalk as more of the input (water) is applied. Sound is not used as it can easily become annoying or embarrassing, particularly in a teaching lab situation. Also while the language avoids the use of uncommon or "sophisticated" terms, care was taken to not convey a condescending tone.

Frequent interaction is one of the major features of the lessons. The student is asked to respond in a number of ways. These include multiple choice answers, reading points off a curve or interpolating points from a table (a range of responses are permitted), and calculating responses using a calculator routine in the program. This interaction serves to reinforce the student regarding his/her comprehension and alleviates boredom or passivity.

The use of graphics is perhaps the hallmark of the lessons. Both two and three-dimensional figures are presented. Figures may have movement and/or changing highlights in accordance with the brief textual explanations. For example, in one sequence a three-dimensional (i.e., two variable input) production surface is displayed. A level for one input is selected. Then portions of the production surface are removed until only one total physical product curve remains. The graph is then rotated until the typical two-dimensional production function is displayed. In another sequence a three-dimensional production surface is viewed from the side. It is then rotated until the viewer is "looking down" on it and able to see isoquants.

Testing of the Program

At this time no formal testing of the lessons has been made. A few students enrolled in the entry level agricultural economics course have been shown portions of the lessons and asked to comment. Virtually without exception, their reactions have been favorable, including an occasional "Oh, so that's what you meant in class!" Formal testing is scheduled to begin in the Fall Semester, 1986.

## Minimum Hardware Requirements

The minimum hardware requirements are as follows:

1. IBM PC or compatible
2. One double-sided, double density 320K 5-1/4" floppy disk drive
3. Color graphics

A printer is not necessary unless the user wishes to print out screens.

## Summary

In this paper a computer tutorial for entry level production economics has been discussed. Also discussed has been the overall role of computer aided instruction in higher education. The principal conclusion of that discussion is that computers are not the ideal medium for all instructional situations. Indeed, their use should probably be limited to situations in which their relative strengths can be employed to advantage. These strengths include the use of graphics, particularly when movement or changing highlights are required; student interaction; and repeatability. It was shown that the production economics lessons were designed to accentuate these features.

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