MarketSim
Simultaneous Play Version
Student Manual

By Ebenge Usip and Rochelle Ruffer

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Introduction

Welcome to MarketSim! The goal of this program is to let you participate in a simulated economy to help you better understand how economic systems work.

MarketSim consists of two parts: Jeremy's Market and Adam's Market. In Jeremy's Market each student is responsible for a household that consumes and produces goods. You also will be able to trade with the households run by your classmates. Your goal is to try to pick a production and trading strategy that gives your household the highest possible level of happiness.

In Adam's Market you will be responsible for both a household and a firm. In Adam's Market money is used to make transactions between firms and households. As a household, you need to decide how many hours you are going to work and what goods you will buy. As a firm, you need to decide how much labor time to hire and how much output to produce. In the more complex versions of the simulation, you will also need to decide whether to make additional investments in your firm's capital and whether to switch industries. Your goals are to try to maximize your household's happiness and the value of your firm.

You will participate in MarketSim via the Internet. Your computer must be running the Microsoft Windows 98 operating system (or a later version of Windows) and you must access the site using Internet Explorer 5.x or later. Go to the URL for the Simultaneous Play Version at http://marketsim.ysu.edu and click on "Play A Game". You will need to register at the site just before your instructor starts the game. In this version you must remained logged into the simulation the entire time a game is in progress.

Our hope is that participating in MarketSim will challenge you to try to apply the concepts you are learning in class and make Economics come alive for you. Let the trading begin!

Chapter 1
Jeremy's Market

I. Introduction

The student manual for Jeremy's Market is divided into three parts. The first part is this brief introduction. The second section gives an overview of the simulation, offers some tips on strategy, and gives descriptions of each component of the program. Much of this information is also available through the simulation's help system. The third part of the manual will relate the economic theory you are learning in class to Jeremy's Market. This section includes a theoretical discussion of the concepts of scarcity, choice, and opportunity cost in relation to production, consumption, and trade.

II. Overview, Strategy Tips, and Program Structure

A. Overview

In Jeremy's Market you and your classmates are each responsible for a household, and your goal is to maximize the household's happiness. Each household consumes two goods. Your household's happiness, or utility in the jargon of economics, depends on your household's consumption of the two goods and leisure time. You can ask the program to display the function used to calculate your utility and view the utility functions of your classmates.

The simulation is divided into periods. In each period of the simulation every household has use of 100 hours. You can use the hours as leisure time or spend the time producing goods. After the first period, you can trade the goods that you produce with your classmates. Your challenge is to try to use your time to maximize the amounts you consume and balance your consumption of the goods to make your household as happy as possible.

To help understand how the simulation works, the following lists the rules for Jeremy's Market:

- The simulation is divided into four periods; your instructor controls when the periods end.
- You and your classmates will be divided into "attribute groups." All of the members of an attribute group have the same utility and production functions.
- At the beginning of each period, the number of units consumed is reset to zero and each household is given a new time allotment (usually 100 hours).
- When you produce units of a good or receive units of a good in trade, those units are added to your stock of that good. Units held in stock are units you own, but have not yet consumed. Units of goods in stock at the end of a period are automatically consumed.
- Your utility is a function of the number of units you consume and the amount of leisure time you have in that period.

- To trade goods, you can either accept an offer posted by another student or post your own offer and wait to see if another student accepts the offer.
- You can cancel an offer to trade if it has not yet been accepted by another student.
- Any offers that have not been accepted at the end of the period expire and are removed from the list of available offers.
- If a student makes an offer and then fails to keep enough units in stock to honor the offer, the offer will be removed and it will be recorded that a bad offer was made. Participants making bad offers may be penalized.
- It is possible to trade time. If you receive time in a trade you are essentially hiring another student to work for you, and you must chose what will be produced with the time. You cannot consume another student's time as leisure time.
- You will be assigned points based on the number of periods you participate and your lifetime utility (the sum of your utility from all of the periods).

B. Strategy Tips

- At the start of the game you have no idea what trades other participants are likely to accept. It is a good idea to initially produce relatively small amounts of both goods and offer to trade the good that are better at producing.
- Try to get the same additional utility from the last dollar spent on each good given the implicit prices of the goods or the tradeoff between goods is the same as the relative prices.

C. Program Structure

The user interface of Jeremy's Market consists of four different web pages:

- **Worksheet**. You will use this page to plan your strategy. This page will tell you what your utility will be with different combinations of goods and leisure without having to do the calculations yourself.
- **Actions**. On this page you actually indicate how much you will produce and consume. In Barter mode you can accept offers and post offers.
- **Functions, Graphs.** Your production and utility functions are displayed on this page, as well as the functions for the other groups in your class. The page also displays graphs illustrating information about the simulation such as the rates at which goods were exchanged in the most recent trades.
- **User Record.** This page displays a summary of all the actions you have taken.

To change the page you are viewing, click on a link on the main menu on the left-hand side of the screen. If you click on the "Help" link you will see information about the page you are viewing. On the login page there is a button marked "New User Help", which also gives an overview of the program.

The individual pages are described in detail below:

Worksheet

Optimal Combination without Trade

This section shows the combination of goods and leisure time that maximize your utility if you were not able to trade.

Current consumption and stocks
At the top of this page, you can see the number of hours that can still be used either as leisure time or to produce more output. The table provides information about the number of units of goods the student has in stock, the number of units consumed this period, and the amount of time spent this period producing the two goods.

Additional Production
This section allows you to experiment with how your utility will change if you spend additional hours producing one or more of the goods. The calculations take into account how much time you have already spent producing the goods and how much you have already consumed. The dropdown menu allows you to set the number of additional hours you want to spend producing the good (the number of hours is limited to the number of hours that were not committed to producing output or traded away). After you make the selection the marginal product of an additional hour, the number of hours remaining, and the utility after consuming the output are all calculated.

Potential Trades
Pressing the button labeled View Offers allows you to see the exchange rates for the last five trades and all current offers. For example, if 15 units of milk were traded for 10 units of bread, then the exchange rate of milk for bread would be equal to 1.5 (on average, the trader gave up 1.5 units of milk for every unit of bread received).

In the section below the title, you can see how making trades will effect your utility. Use the dropdown menus to indicate what you would like to trade away and what you would like to receive in trade. Fill in the amounts in the text boxes and click the button labeled "Add Trade." The effect of the trade will be added to the "Consumption After Trade" table, and you can see how your utility would change with the trade. Clicking the "Clear Trades" button removes the trades.

Utility Maximization
Type in values for the exchange rates, and then press the button labeled "Calculate MU per Dollar." The program will calculate the implicit prices of the goods based on the exchange rates you specified. It will also calculate the marginal utility per last dollar spent (MU/P). To maximize utility, you should be receiving the same additional utility per dollar spent on each good.

Store Target Values
Once you have chosen a strategy, pressing the "Store Target Values" button will create a record of your intended production and trades. When you switch to the "Actions" page to actually produce and trade goods, you can call up the stored values to remind you of the actions you want to take.

Show Graphs
Pressing this button will display a graph of the production possibilities frontier and the indifference curve passing through the combination of goods and leisure that you have

selected. It will also display a consumption opportunity curve, which shows the different consumption options available to you given any trades you have made. If you have not made any trades the consumption opportunity curve and the production possibilities curve will be the same.

Actions

Production and Consumption

The top section of this table provides information about how many units of bread and milk you have in stock, the number of units you have consumed this period, and the amount of time you have spent this period producing the two goods.

To produce units of a good, click on a text box in the row labeled "Additional Hours for Production." Type in the number of hours you want to spend producing the good and press the button labeled "Produce".

To consume units of a good, click on a text box in the row labeled "Additional Consumption." Type the number of additional units you want to consume and click on the button labeled "Consume." If you would like more flexibility with what you can trade, you can elect not to consume anything in the period and the program will automatically consume all your stock at the end of the period.

Accept Offers

In this section you can accept offers made by other students. From the dropdown list, select the item you want to receive in a trade. The current offers for that item will be displayed in the list box below. To accept an offer, click on the offer you wish to accept, and then click on the button labeled "Accept Offer."

If you receive time in a trade, you are hiring another player to help you produce a good. You have to click on one of the radio buttons below the offers list to indicate which good will be produced with the time you are receiving.

Post Offers

In this section, you can post offers to trade. In the left-hand set of radio buttons, click on a button to indicate what you are offering to trade. Type the number of units you want to trade away immediately below.

In the right-hand side of the box, select a button to indicate what you want to receive in trade, and type the number of units you are asking for in the text box. Note that if you receive time, you must indicate which good will be produced with the time you receive. The amount of output produced will be determined by your production function and the amount of time you have already spent producing the good this period.

Press the button marked "Submit Offer" to add your offer to the list of available offers. You now need to wait and see if someone accepts your offer. At this point you may want to exit the simulation and check back a few hours later.

At the end of a period, all offers that were not accepted are canceled. You should not post offers to trade if they will not be able to honor them. The program records bad offers and the instructor may choose to penalize students who repeatedly make bad offers.

Cancel Offers

If you post an offer and no one accepts it after a reasonable amount of time, you may want to cancel the offer and post a new one. For example, suppose you offered to trade 10 units of bread for 20 units of milk. No one accepted your offer, and in the most recent trades one unit of bread was typically traded for one unit of milk. You might choose to cancel the offer, and then post a new offer to trade 10 units of bread for 10 units of milk.

In the "Cancel Offer" section, the list box displays all of the offers you have posted which have not been accepted. To cancel an offer, just click on the offer to be canceled and click on the button labeled "Cancel Offer."

Functions & Graphs

User Functions

The top of the page displays your utility and production functions, and the functions of students in other groups. Note that you do not need to actually use the functions to calculate anything because the program will do the calculations for you. The functions are displayed just for your information.

Graphs

This section provides you with important information about what other players in the simulation are doing. Select the graph you want to view from the dropdown menu. The menu options are described below:

Production by period: Displays the total amount produced of each good by period.

Consumption by period: Displays the total amount consumed of each good by period.

Current stocks: Displays the total amount of each good currently held in stock.

Total utility (user's attribute group): Displays the utility values for everyone in your attribute group. The utility displayed is the sum of your current utility and lifetime utility. Your performance is evaluated based on how well you do relative to the other students in your group.

Past utility distribution: The graph displays a two-tone bar graph for each user group. The bars represent the sum of the utilities from previous periods. The height of the bar represents the maximum utility value for that group; the height

of the dividing line between the two colors represents the median value (the middle value for people in that group).

Exchange rate (milk for bread): Displays the exchange rate for the last 20 accepted offers for milk and bread. The exchange rate is the amount of one good that had to be given up to get one unit of another good. For example, assume someone traded 20 units of milk for 10 units of bread. The exchange rate of milk for bread in that trade would be 2, because two units of milk were traded away for each unit of bread received. The numerical value of the exchange rate tells you how many units of the first good had to be given up to get one unit of the second good mentioned.

User Record

Inventory Record

This table records any consumption, production, and trading of the goods. It displays the amount of leisure time and goods at the start of period and at the end of the period (or the units currently in stock in the case of the current period). The table records the date and time in which you produced, consumed, or traded a good. Deletions in inventory are recorded in red and additions to inventory are recorded in green. For example, if you traded 3 units of bread for 5 units of milk, the table would show a value of –3 in red for bread and a value of 5 in green for milk. Additionally, if you receive time to produce a good in a trade, the amount of output produced is recorded in the table.

Consumption Record

This table records the date and time in which you consumed any milk or bread. It also notes the ending total of milk, bread, and time (leisure). Since all your stock is consumed each period, your ending stock of bread and milk will be zero.

Current Utility

During a current period, you can see your utility based on what you have currently consumed. After the period is over, this information will tell you your utility at the end of that period based on your consumption in that period.

Utility if all stock consumed

This information is only displayed during a current period. It shows you what your utility would be if you consumed the milk and bread you have in stock.

Logins

This table displays the number of times you logged in during the period. Since play is simultaneous and you are not able to close out of the program, your logins will be 1. Remember not to close out of the program or you will be unable to log back in for the remainder of the game.

III. Learning Theory

The purpose of the exercises is to illustrate the principles you are learning in class using Jeremy's Market. The exercises are organized into four topic areas: Production, Consumption, Opportunity Cost, and Production and Consumption in a barter economy. Each topic begins with a brief discussion of the relevant concepts and their theoretical basis, and is followed by a set of activities that demonstrate how to use the concepts while participating in the simulation. The goal is to show you how to apply economic theory to solve real world problems.

1. Production

Overview

Economists define production as using inputs, such as labor and raw materials, to produce output, like food and clothing, using the available technology. This section examines some basic concepts about production, including: production functions, marginal product, and the law of diminishing marginal returns.

1.1 Production Functions

In Jeremy's Market you spend time to produce goods. One important issue is how many units of a good you could make with some amount of time. For example, if you were producing bread, how many loaves could you make if you spent 10 hours producing bread?

The answer to that question will depend on what kind of equipment you have to work with and your knowledge in baking. Economists represent the relationship between the amount of time spent and the output produced with a mathematical formula called a production function. The function is designed to include all the factors that determine the level of output. Economists frequently assume that some inputs cannot be changed. The amount produced will then depend on how many units of the variable inputs are used. For example, if labor is the only variable input, the level of output (Q) will vary directly with the number of hours spent producing the good. The general form of the production function can then be written as:

$$Q = f(\text{Hours}) \qquad (1)$$

The specific form of the function will depend on the level of technology and the amount of available equipment. A very simple production function might look something like this:

$$\text{Bread} = 10(\text{Hours}^{.5}) \qquad (2)$$

Since the number of hours for making bread can be varied, we can pick different amounts of time and see how many loaves will be produced. For example, if we spent 9 hours making bread, 30 loaves would be produced. That is:

$$\text{Bread} = 10(9^{0.5}) = 10(3) = 30 \qquad (3)$$

In the production function above the exponent on hours of labor was 0.5, which is the same as taking the square root. How could we calculate the amount produced if the exponent was a number other than 0.5? Most calculators can easily solve this type of problem for you. On your calculator, look for a button labeled "y^x". For example, to find the value of $9^{0.5}$ you would type "9", press "y^x", type ".5", and press "=". The answer "3" will be displayed. To show that $16^{.25}$ is equal to 2, perform similar operations: "16", "y^x", ".25", and "=".

1.2 Marginal Product

We frequently want to know how much output will be produced when one more unit of an input is used. Economists refer to the additional output produced as "Marginal Product" (MP). So the question you need to consider in deciding how to spend your labor time is how much additional output will be produced when you spend one more hour producing the good. This is called the marginal product of labor (MP). It is computed as the change in total output (Q) divided by the change in the number of hours spent producing the good.

The production function of equation 2 above [Bread = 10(Hours $^{0.5}$)] was used to generate the total output of bread in the table below. The MP values in column 3 were then computed. For example, the change in labor from 2 to 3 is 1 (i.e., 3-2); the change in output from 14.1 to 17.3 is 3.2 (i.e., 17.3-14.1). Thus, when three hours of labor is used the MP = 3.2 (i.e., 3.2÷1).

Table 1

Hours of Labor	Loaves of Bread (Q)	Marginal Product (MPL)
1	10	–
2	14.1	4.1
3	17.3	3.2

1.3 The Law of Diminishing Marginal Returns

This Law of Diminishing Marginal Returns applies to production when some inputs remain fixed while others vary. As more units of a variable input are combined with fixed inputs, the marginal product of the variable input will ultimately decline. The reason is that the ratio of the number of units of the variable input to the number of units of the fixed input is changing. For example, think of hiring additional employees to work in a factory. Since there is a limited amount of equipment for the employees to work with, at some point the increase in output from hiring an additional employee will be lower than the increase in output from the previous employee.

Table 1 provided an example of the law of diminishing returns. When the second hour of time was used to produce bread 4.1 additional loaves were produced, but only 3.2 loaves were produced when the third hour of labor was added.

2. Consumption

Overview

Every consumer has a goal: To maximize their total utility from all the goods and services that she or he can afford to buy. Total utility represents the level of happiness that is derived by consuming some combination of goods and services. The relationship between the level of happiness and the amount of each good or service consumed is called the utility function. The contribution to the total happiness or utility by consuming one more unit of the good or service is called marginal utility.

Since consumers' preferences differ, the combination of goods they will select will differ. Consumers will also choose different combinations of goods because their incomes differ. However, all consumers must pay the same prices.

2.1 Utility Functions

In the production section we focused on the relationship between one input (labor hours) and one output (bread or milk). The relationship between total utility (U) and the quantity consumed of the different goods can also be represented with a mathematical function. For example, the general form of a utility function where a consumer gains utility from consuming bread, milk, and leisure time can be stated as:

$$U = f(\text{Bread}, \text{Milk}, \text{Time}) \qquad (1)$$

All else remaining constant, the greater the number of units consumed of each good, the higher the level of total utility.

In the simulation, your utility is determined by the utility function assigned to your attribute group. A typical utility function would look like this:

$$U = 10\,[(\text{Bread}^{0.5})\,(\text{Milk}^{0.5})\,(\text{Time}^{0.2})] \qquad (2)$$

If you click the **Functions& Graphs** link, your household's utility function will be displayed under **Your User Function** sections.

As an illustration, suppose that you have 100 hours to spend towards producing bread and milk, or enjoying as leisure time. Let's assume you chose to allocate the 100 hours in as follows: 1 hour for bread production, 19 hours for milk production, and 80 hours for leisure. If the corresponding total output for each good is 10 units of bread, 18.02 units of milk and 80 units of leisure time, then as a consumer, your total utility from consuming this amount of each good can be computed as:

$$\begin{aligned} U &= 10^{0.5} \times 18.02^{0.5} \times 80^{0.2} \qquad (3) \\ &= 3.162 \times 4.245 \times 2.402 \\ &= 32.25 \end{aligned}$$

This is the level of utility (or the amount of satisfaction measured in utils) that you have derived by consuming the combination of 10 units of bread, 18.02 units of bread, and 80 units of leisure time. During the simulation, look under the **Production and Utility** table;

MarketSim will report the total utility value for each combination of bread, milk, and leisure chosen.

2.2 Marginal Utility

Marginal utility (MU) is the change in total utility that occurs when one more unit of a good is consumed while leaving the consumption of all other goods the same. For example, Table 2 below shows possible bundles of bread (B), milk (W) and leisure time (T) and their total utility. The utility values are derived from the function:

$$U = 10\,[(B^{0.2})\,(W^{0.2})\,(T^{0.4})] \qquad (4)$$

The amount of bread consumed increased from 10 loaves to 11 loaves 11.9 to 12.3 and the corresponding MU is 0.4 (12.3 - 11.9). This means that the additional utility from consuming the last loaf of bread (marginal utility of the last loaf) was 0.4 utils. MU thus allows us to measure how much your well-being has increased by consuming one more loaf of one good versus another. For example, if the MU of bread is 1, and the MU of milk is 2, consuming one more unit of milk will yield more utility than consuming another loaf of bread.

Table 2

Bread	Milk	Leisure Time	Utility	Marginal Utility (MU)
10	15	40	11.9	--
11	15	40	12.3	0.4
12	15	40	12.4	0.1

2.3 The Law of Diminishing Marginal Utility

The law of diminishing marginal utility says that as more units of a good are consumed marginal utility will fall, all else remaining constant. For example, assume you are very thirsty and you drink a glass of water. You are now much more comfortable, so drinking the glass of water caused a substantial increase in your utility. If you drink a second glass of water your utility will still go up (let's assume you were a little thirsty), but the increase in your utility from the second glass will not be nearly as large as the increase from the first glass. Refer to the example in table 2 once again and examine the marginal utility (MU) values in the last column. The decrease in MU as more units of bread are consumed illustrates the law.

3. Opportunity Cost

The opportunity cost of something is the value of the next best alternative that was foregone. Opportunity costs exist because resources are scarce, we can't produce infinite amounts of all goods. In Jeremy's Market the scarce resource is time; your household has a limited number of hours that can be used to produce bread, produce milk, and consume as leisure time. To produce more of one thing resources must be shifted away

from producing something else. This implies that in Jeremy's Market opportunity cost of producing more units of bread could be measured in terms of the units of milk that must be sacrificed to produce the additional bread.

Typically, the opportunity cost of a good will increase as more units of that good are produced. Economists refer to this phenomenon as the Law of Increasing Opportunity Cost. Table 3 provides an example of increasing opportunity cost. When the first ten units of bread are produced, the opportunity cost is 5 units of milk, because milk production falls from 100 to 95. For the next ten units of bread, the opportunity cost is 10 units of milk, since production falls from 95 to 85. As more bread is produced the amount of milk sacrificed keeps rising.

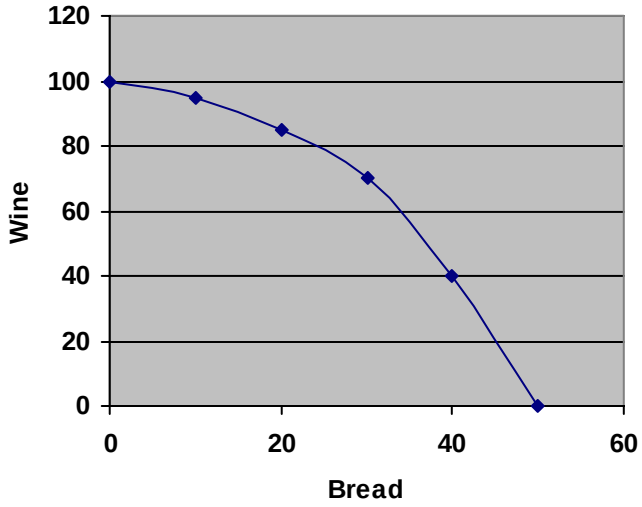
Table 3

Possible Combination	Milk	Bread
A	**100**	**0**
B	**95**	**10**
C	**85**	**20**
D	**70**	**30**
E	**40**	**40**
F	**0**	**50**

Economists frequently use a graph called a production possibilities frontier to represent the concepts of opportunity cost and increasing opportunity cost.

For example, if we graphed the values in the table above we would have a production possibilities frontier as shown in Figure 1.

Figure 1, PPF



The concept of opportunity cost is illustrated by the PPF because as you move to points with greater consumption of bread, you have to reduce the amount of milk consumed. We can also think of the slope of the PPF as representing the size of the opportunity cost. For example, assume we move from consuming 10 units of bread and 95 units of milk to 20 units of bread and 85 units of milk. The slope of the PPF between those two points would be -1 [(95-85)/(10-20) = (10)/(-10) = -1], which indicates that for each additional unit of bread you consume you must give up a unit of milk.

On the other hand, if we move from consuming 20 units of bread and 85 units of milk to 30 units of bread and 70 units of milk, the slope of the PPF between those points is -1.5 [(85-70/(20-30) = (15)/(-10) = -1.5]. The increase in the opportunity cost is represented by the slope of the PPF growing steeper as more bread is consumed. This gives the PPF its bowed out (or concave) shape.

4. Production and Consumption in a Barter (or an Exchange) Economy
Overview
In reality, no economy can be characterized as self-sufficient. Economists use the Robinson Crusoe model (the model of no trade) as a standard for measuring the potential gains from trade. Gains from trade occur because different individuals (or nations) have different opportunity costs in producing a good. Individuals and nations that specialize in those productive activities for which they have a smaller opportunity cost are said to have comparative advantage and can reap significant benefits by trading.

4.1 Specialization and Trade
Mutually beneficial exchange between two households is possible if one household can produce a good at a lower opportunity cost than another household. For example, assume there are two households, and each household has four hours that could be used to produce either bread or milk. Table 4 below shows the different amounts that would be

produced by the households.

Table 4

		Household A		Household B	
Hours Producing Bread	Hours Producing Milk	Units of Bread	Units of Milk	Units of Bread	Units of Milk
0	4	0	28	0	100
1	3	40	24	10	90
2	2	70	18	18	70
3	1	90	10	24	40
4	0	100	0	28	0

Suppose initially both households spent two hours producing bread and two hours producing milk. In this case the total amount of bread produced would be 88 (70 units by household A and 18 by household B), and the total amount of milk produced would also be 88.

If Household A spends another hour in bread production, it can make 20 more units of bread at the cost of an 8 unit reduction in the output of milk; so on average the household would only sacrifice 0.4 units of milk for each unit of bread. On the other hand, if household B were to spend another hour producing bread, it would only gain 6 additional units of bread, and would sacrifice 30 units of milk, a loss of 5 units of milk for each unit of bread.

Since the opportunity cost of producing bread is lower for household A, that household has a comparative advantage in bread production. We can use the same argument to show that B has a comparative advantage in milk production.

Now suppose both households specialize in producing the good where their opportunity cost is lower. The total output of both bread and milk would rise to 200 units. If the households trade, it is then possible for both households to consume more of both goods than they did when trade was not possible.

To maximize your utility in the simulation you first need to identify the good that you have a comparative advantage in. The **Functions, Graphs** page displays the functions for all of the attribute groups. In a typical game you will have a comparative advantage in the good you can produce the most of in one hour. You then want to specialize in the production of that good, and trade for the good in which you do not have a comparative advantage. When trading, you should also seek to trade at an exchange rate that maximizes the amount received in trade.

MarketSim lists the exchange rates for the most recently-accepted trades. The exchange rate, the rate at which one good is traded for another, is useful in deciding whether you should try to get more of a good by producing it yourself or trading for it. For example, suppose you want to consume more bread, and your production function for bread is:

$B=10Hours^{0.2}$. If you spend five hours producing bread you will make 13.8 units of bread. Also assume your production function for milk is: $W=10Hours^{0.8}$, with 5 hours of time you would produce 36.2 units of milk.

Your next step is to try and trade milk for bread. Table 5 below shows three different offers and the associated exchange rates. In case of the first offer, you would actually have less bread by trading than if you simply produced bread.

The next two offers show that you are clearly much better off by producing and trading milk since you will end up 36 and 72 loaves of bread, respectively. Note however that the exchange rate of milk for bread will depend on the offers that other participants in the simulation are willing to accept.

Table 5

Offer	Milk (W)	Bread	Exchange Rate: Milk for Bread
1	36	9	4
2	36	36	1
3	36	72	0.5

4.2 The Barter Economy and the Utility-Maximizing Rule (MUx/Px = MUy/Py)
The utility-maximizing rule states that consumers maximize their utility by picking combinations of goods such that the marginal utility per dollar is the same for all goods. The rule is frequently written as:

$$MUx/Px = MUy/Py$$

If MUx/Px is greater than MUy/Py, this means that you are getting more utility from the last dollar spent on X than the last dollar spent on Y, and you should purchase more X. As you buy more X the marginal utility of X will fall, as you buy less Y the marginal utility of Y will rise, and you will move towards meeting the utility-maximizing rule.

In Jeremy's Market all exchanges take place through barter, and money is not used in that economy. Since no money is used, there are no explicit prices. However, we can come up with implicit prices based on the exchange rates of the trades and use the utility-maximizing rule.

In Jeremy's the price of an hour of time is set at $1. We can then calculate the prices for other goods relative to the price of labor. For example, assume that the exchange rate of bread for time was two units of bread for one hour of time. This implies that the value of a unit of bread is half the value of an hour of time, so the price of one unit of bread should be $0.5, or 50 cents.

In the section of the Worksheet page called **Utility Maximazation**, you will need to type in values for the exchange rates. Using those values, the software will calculate the implicit prices of bread and milk and the values for MU/P of bread, milk, and leisure.

Chapter 2
Adam's Market

I. Introduction

Welcome to Adam's market, we hope it will give you a better understanding of how markets work. The Adam's Market section of this manual is divided into three parts. The first is this brief introduction. The second part gives an overview of the simulation, offers some tips on strategy, and gives descriptions of each component of the program. Much of this information is also available through the simulation's help system. The third part of the manual will relate the economic theory you are learning in class to Adam's Market. This section includes a theoretical discussion of the circular flow model, utility maximization, labor supply, profit maximization in the short run, profit maximization in the long run, depreciation, entry and exit of firms, and the bond market.

II. Overview, Strategy Tips, and Program Structure

A. Overview

In Adam's Market you and your classmates are each responsible for both a household and a firm. Money is used to make transactions between firms and households. As a household, you need to decide how many hours you are going to work and what goods you will buy. As a firm, you need to decide how much labor time to hire and how much output to produce. In the more complex versions of the simulation, you will also need to decide whether to make additional investments in your firm's capital and whether to switch industries. Your goals are to try to maximize your household's happiness and the value of your firm.

The simulation is divided into periods. In each period of the simulation every household has use of 100 hours. You must sell those hours to earn income. Firms, in turn, buy the labor from households and then produce goods with the labor. In later periods, the firm can also choose to buy capital.

To help understand how the simulation works, the following lists the rules for Adam's Market:

Both Households and Firms

- The simulation is divided into a certain number of periods depending on the type of game your instructor has chosen (short-run or long-run); your instructor controls when each period ends.
- Any offers that have not been accepted at the end of a period expire and are removed from the list of available offers.

- Your grade will be determined by your participation and performance in the simulation. Performance is determined by the total utility of your household as well as the net worth of your firm. Most likely your performance grade will be more heavily weighted on the performance of your household. Thus, it is in your best interest to transfer money (dividends) from your firm to your household so that your household is able to reach a higher utility by spending more income.

Households

- Households receive utility from leisure and consuming two goods. The goal of the household is to maximize utility.
- Goods are consumed as soon as they are purchased. Households cannot resell goods after they have purchased them. Time not spent working for a firm is automatically consumed as leisure.
- Households start the simulation with $500 in cash.
- Households will be given $100 of additional income each period.
- At the beginning of each period, each household is allocated 100 hours that can be consumed as leisure or spent working for firms.
- Households can earn income by giving up some of their leisure time to work for firms.
- Your household "owns" your firm. If your firm earns profits, you can transfer some of the profits from the firm to your household.
- At the beginning of each period the number of units consumed is reset to zero. Each participant is given a new allotment of leisure time. Only cash can be carried over from one period to the next.
- The utility for each period is calculated at the end of the period. Total utility is equal to the sum of the utilities from the completed periods.

Firms

Producing Output and Maximizing Profit

- Firms start the simulation with $500 and 16 units of capital. Firms will receive $100 in additional amounts of cash at the start of each period.
- Firms can earn profits by producing output and selling it to households. The firm must buy labor from households in order to produce output.
- The amount of output produced is a function of current capital stock and the quantity of labor hired. Once labor is purchased, it is automatically used to produce output. The firm's labor time is reset to zero at the start of each period.
- Any unsold output in the firm's inventory is carried over into the next period, minus a 10 % depreciation rate of the inventory. Depreciation in the inventory is due to the output spoiling or becoming obsolete.
- The profits that are reported are accounting profits, not economic profits.
- Firms are able to distribute their profits to their household, in the form of dividends.
- In addition, firm's net worth is calculated. This is calculated as cash + value of inventory + value of capital stock + present discounted value of bonds. Since

everyone starts with the same amount of capital, the value of capital is equal to zero until your firm has an opportunity to purchase capital.

Purchasing Capital

- Your instructor has the option of allowing firms to purchase additional capital.
- When it is possible to buy more capital, the simulation assumes there is a capital producer who buys labor from the households, produces capital, and then offers the capital for sale to the firms.
- When a firm buys capital, the capital will not have an effect on the firm's output until the next period. Thus, you cannot buy capital in the last period.
- The firm's capital, minus the 10 % depreciation of capital, is carried over into the next period. Depreciation is the amount of capital lost each year through the wear and tear of using the capital.

Switching Industries

- Your instructor has the option of allowing firms to switch industries. To decide whether to switch industries, you should check the graph on the Functions and Graphs page showing the profits by industry.
- If you choose to switch industries, your firm will produce the new product in the next period. When the change to the new industry occurs, all remaining inventory from your original industry will be lost. Also, your capital stock will decrease by a penalty of 15% of your current capital stock.

The Bond Market

- Your instructor has the option of choosing a scenario with a bond market.
- Bonds are method of borrowing and lending money. If a firm sells a bond to a household, the firm is borrowing money from the household, and promising to pay some amount back at a future date. Firms may choose to borrow so they can make larger investments in capital.
- In the simulation only firms can issue new bonds (borrow money). Both firms and households can buy new bonds (lending money to the firm). Bonds can be resold. For example, a household could purchase a newly-issued bond from a firm, and then resell the bond to either a firm or a household.
- Make sure your firm keeps enough cash to pay for all the bonds it has issued when the bonds mature. If the firm that sold the bond does not have enough cash to pay the face value of the bond, the program will confiscate enough inventory and capital from the firm to pay the face value and a penalty. The penalty is 20 percent of the face value of the bond.

B. Strategy Tips

Both Households and Producers

- When you are viewing a particular page, you can click on the Help link on the side menu bar and you will receive help for the page that you are currently viewing.
- To refresh a page to see if your offers have been accepted, right click on a page and choose "refresh". The program will not notify you of any accepted offers until you either click onto a different page or refresh the current page you are viewing.

Households

- At the beginning of the simulation, we don't know what wage rates firms will accept. Begin by offering a small number of units of labor for sale. That way, if the wage rate increases dramatically, you will not lose out by selling all your labor early at a low wage.
- Your total utility will be highest if you tend to spread your consumption more evenly over all of the periods.
- Remember to use the rule for utility maximization to help you decide what purchases to make.

Firms

- Remember your goal as a firm is to maximize profits by setting marginal revenue (MR) equal to marginal cost (MC).
- If you are able to hire labor, and produce output, such that the additional revenue you receive from selling that additional output will be greater than the additional cost of hiring the labor, then you should buy the labor and sell the output.
- Your production function will obey the law of diminishing marginal returns, so the output gained from hiring an hour of labor will always be less than the output gained from hiring the previous hour.
- Remember that the price of output might change over the course of a period, so do not count on being able to charge a specific price for huge units of output.
- Given that consumer income is limited, it is unlikely you will be able to sell all of your firm's output in one offer to a single consumer. Consider making multiple offers of smaller amounts.
- When making decisions about purchasing capital, experiment with different quantities of capital before deciding how much capital to buy.
- Recall that once every firm buys more capital, they will be able to produce more output with the same level of labor. What do you think might happen to the prices of goods as this occurs?
- Since your grade is more heavily weighted on household performance, it is helpful to raise your household's utility by transferring some dividends from your firm to your household.

C. Program Structure

The simulation must be viewed using Internet Explorer. The tables will not work in other web browsers. When you log onto Adam's market, you will see a side bar on the left hand side of the screen. This sidebar includes the links for the following pages: Consumer Worksheet, Consumer Action, Consumer Bonds (if your professor has turned on the bond option), Firm Worksheet, Firm Action, Firm Bonds (if your professor has turned on the bond option), Functions and Graphs, User Record, and Help. In addition, you can see the value for your current utility (utility for the current period), total utility (current utility added to utility from previous periods), total profit (the sum of the profits earned in all periods defined as total revenue – total cost), and firm net worth (cash + value of inventory + value of capital stock + present discounted value of bonds). The calculation of firm net worth will change if the prices of the goods change. To estimate the value of the inventory a weighted average of the price of the good is calculated. If it is not possible to purchase capital, the value of capital stock is assumed to be zero. Once firms can purchase capital, the value of your stock of capital is determined by the capital production function and a weighted average of the price of labor used to produce capital.

The pages of the interfaces are described below:

- **Consumer Worksheet.** You will use this worksheet to plan your strategy as a consumer. This page will help you to decide how many hours to work and how much of the two goods to purchase. None of the actions on this sheet will be recorded. Remember that all of the calculations are based on the expected prices and wages.
- **Consumer Actions.** This page is where you implement your strategy planned on the worksheet pages. You may post offers to sell labor, accept offers from the firms to purchase goods, and cancel offers that have not been accepted.
- **Consumer Bonds.** This page will only appear if your instructor selected the scenario with the bond market option. Your consumer may purchase bonds (lend money), sell a bond you currently hold, and cancel offers that have not been accepted.
- **Firm Worksheet.** You will use this worksheet to plan your strategy as a firm. This page will help you decide how much labor to hire, whether you should purchase more capital, and how much output your firm will produce in order to maximize profits. None of the actions on this sheet will be recorded. Remember that all of the calculations are influenced by the prices you specify.
- **Firm Actions.** This is the page where you activate your strategy planned on the worksheet pages. You may purchase labor from the households, use the labor to produce output, and make and cancel offers to sell the output. You may also choose to distribute profits back to your household in the form of dividends. In later periods, you may also choose to buy capital or switch industries.
- **Firm Bonds.** This page will only appear if your instructor selected the scenario with the bond market option. Your firm may purchase bonds (lend money), post offers to sell a bond (borrow money), sell a bond your firm currently holds, and cancel offers that have not been accepted. At the bottom of the page, there is a

table that summarizes your firm's outstanding bonds. Any actions taken on this page are recorded.

- **Functions and Graphs.** The top half of the page displays your household's utility function, the utility functions of the other households, your firm's production function, and the product functions of firms in other industries. In the bottom half of the page is a graphing area and a dropdown menu. From the dropdown menu you can pick from a variety of graphs summarizing different results from the simulation. The information displayed includes information on prices, production, consumption, profits, and utility.
- **User Record.** This page displays a summary of all the actions you have taken, both as a consumer and a producer.

To change the page you are viewing, click on a link on the main menu on the left-hand side of the screen. If you click on the "Help" link you will see information about the page you are viewing.

The individual pages are described in detail below:

Consumer Worksheet

Current values

The table in this section displays information about the money you have at your disposal and your consumption in the current period. The row labeled "Cash" displays the amount of money you currently have available to spend. You can carry over cash from one period to another. The next two lines display how much you have consumed this period. Units of the goods are automatically consumed when you purchase them. The last line in the table lists the number of hours available for work or leisure.

Set Prices

To calculate your consumption options you must specify the wage rate you expect to earn and the prices at which you will buy your goods. The table displays the prices and wages paid for the last five purchases. You typically want to choose a price between the highest and lowest prices listed.

Consumption Options

In the menu on the left-hand side, set the division between leisure and work. Combined with the wage rate set in the table above, the program will calculate the expected income. In the right-hand menu, select the amounts to spend on each good. As you change the amount you work and the amount you spend on the two goods, your level of utility will change in the table below. The table in this section will display the expected amount of income earned and the number of units purchased of each good. You can also see your level of utility as well as the marginal utility per dollar. You want to try different combinations of goods and leisure until you get roughly the same marginal utility per dollar from both goods and from leisure time. You always want to consume more of the item that has the highest marginal utility per dollar (you want to get the most value per dollar spent). When you find your utility maximizing point, you can click on the "Store Target Values" button to save your results.

Store Target Values
Once you have chosen a strategy, pressing the "Store Target Values" button will create a record of your intended work and consumption. When you switch to the "Actions" page to actually sell labor and purchase goods, you can call up the stored values to remind you of the actions you want to take.

Budget Line, Indifference Curve Graph
At the bottom of the Consumer Worksheet page, there is a button labeled "Budget Line, Indifference Curve Graph." When displayed, you can see the graphical representation of the information in the table. The graph shows a point on the budget line that represents the combination of goods being consumed. Some books use a curve to represent a particular level of utility and the tradeoff from trading one good for another (this curve is called an indifference curve). The goal is to maximize utility (to be on the highest curve possible), given the budget line. When the budget line is tangent to the curve, the consumer is maximizing utility. The curve will be tangent to the budget line when the MU/P is equal for the two goods. Although you have not learned about indifference curves, you can tell if you are maximizing your household's utility by looking for the tangencies in the graph.

Consumer Actions

View Target Values
If you stored your target values in the worksheet page, you can press the "View Target Values" button in order to view your results from the worksheet page. You will see a popup window labeled Consumer Target Values. The program will display all of the values you selected on the worksheet. You can use this information to help remind you how many hours to work and how many units of each good to buy when you post offers of labor to sell and buy goods.

Current Values
The table in this section displays information about the money you have at your disposal and your consumption in the current period. The row labeled cash displays the amount of money you currently have available to spend. You can carry over cash from one period to another. The next two lines display how much you have consumed this period. Units of the goods are automatically consumed when you purchase them. The last line in the table lists the number of hours available for work or leisure.

Post Offer to Sell Labor
To post an offer to work for a firm, type in the number of hours you are willing to work and the wage you are asking in the appropriate text boxes. Push the button marked "Post Offer" to make the offer available. Remember that you need to retain a portion of your time for leisure time to maximize your utility. Offers that are not accepted before the end of the period are automatically cancelled.

Cancel Offer to Sell Labor
The table in this section lists all of the offers to sell time you have posted but have not yet been accepted. To cancel an offer, highlight the offer you wish to cancel and click on the "Cancel Offer" button.

Purchase Goods
Click on the radio buttons to select the good which you want to buy. The table below lists the offers posted by firms producing the goods. To accept an offer, highlight the desired offer by clicking on it and press the button labeled "Make Purchase." Note that when you purchase units of a good they are immediately added to your consumption. It is also not possible to resell goods after you have purchased them.

Consumer Bonds
Current Values
The table in this section displays information about the money you have at your disposal and your consumption in the current period. The row labeled "cash" displays the amount of money you currently have available to spend. The last line in the table lists the number of hours available for work or leisure.

Purchase Bonds (Lend Money)
The table in this section lists all of the bonds that are being offered for sale. To purchase a bond, click on the bond you wish to buy and click on the button labeled "Accept Offer". The following characteristics of the bond are listed in the table:

- Price Asked -- This is the amount you must pay for the bond. It is the amount you are lending to the seller of the bond.
- Face Value -- This is the amount that will be paid to whoever holds the bond when it matures.
- Period Matures -- At the end of the period the face value of the bond is deducted from the cash of the firm that originally issued the bond and is added to the cash of the firm or household that owns the bond.
- Projected Yield -- A measure of the return received by the purchaser of the bond expressed in percentage terms. The size of the yield depends on the difference between the purchase price and the face value, and the amount of time before the bond matures.

For example, suppose a household bought a bond from a firm for $200 at the very end of period 3. If the bond matured at the end of period 4 and had a face value of $220, the bond would have a yield of 10%. The relevant calculation would be: (220 - 200)/200 = 20/200 = 0.1 = 10%. The yield changes to reflect the fraction of the period left.

Sell a Bond You Currently Hold
You have the option of reselling bonds which you have purchased from a firm. The table in this section lists all of the bonds you own. To sell a bond, highlight the bond you wish to sell, type in the price at which you want to sell the bond, and click on the "Post Offer" button. Before you press the "Post Offer" button, you may want to press the "Calculate

Yield" button. When this button is pressed the program will display the yield to the new owner of the bond, given your asking price.

Cancel an Offer
You can cancel an offer to sell a bond if the offer has not yet been accepted. Click on the offer you wish to cancel and press the "Cancel Offer" button.

Firm Worksheet
Current Values
This tables displays information about your firm. The first line lists the type of product you produce. The second line lists the amount of cash the firm has available to buy labor; money which is not spent by the end of the period is carried over into the next period. The third line lists the number of units of capital available to produce goods in the current period. The amount of capital (minus depreciation) is carried over into succeeding periods. The line labeled "New Capital Next Period" lists the number of units of capital that will be added to the firm's stock of capital in the next period. When a firm buys additional units of capital it has to wait until the following period before it can use the capital to produce output. The next line lists the amount of labor hired so far this period. The last line "Units of Output in Inventory," lists the number of units of output the firm has produced this period but has not yet sold. Inventory is carried over into the following period minus the 10 percent depreciation rate.

Purchase and Offer Information
To help you estimate the price at which you can sell your output and the wage at which you can purchase labor, this table shows the values for the last four accepted offers and the current four lowest offers.

Set Capital, Wage Rate, and Price
Before the program can estimate the costs and revenues earned from different amounts of output you must specify the price at which you will sell the output, the wage rate you will need to pay your workers, and the amount of capital used. Using the information on the prices from the last set of accepted offers, type in the expected prices in the text boxes and press the button marked "Calculate Revenues, Costs, and Profits."

Output, Costs, and Revenues Given Different Amounts of Labor
This section helps you find the profit-maximizing levels of employment and output given some amount of capital. In the jargon of economics, it helps you find the short run profit-maximizing level of output. In the short run firms have a fixed amount of capital to work with but can vary the amount of labor they employ. In the simulation, the length of the short run depends on whether you can purchase capital or not. If you cannot purchase capital, you are always dealing with a "short-run" situation. If you can purchase capital the short run lasts until the end of the current period, because you cannot change the amount of capital in the current period, but you can purchase additional capital for use in the next period. Remember that in the short run firms add to their profits whenever revenues exceed variable costs.

The first table shows cost and revenues for different levels of output. In this table the most important values are marginal cost (MC) and marginal revenue (MR). Firms maximize profits in the short run by hiring up to the point where the additional cost from producing another unit of output (MC) equals the revenue from producing another unit of output (MR). Also keep in mind the shut-down rule, which states that a firm should not produce anything if MR is less than average variable cost (AVC) for all levels of output.

The second table helps you find the profit-maximizing level of output in terms of employment. In this case you want to compare the wage rate and marginal revenue product (MRP). Marginal revenue product measures how much revenues rise when an additional unit of labor is hired; the wage measures how much costs rise when an additional unit of labor is hired. To maximize profits firms should hire labor up to the point where MRP equals the wage. Note that the profit-maximizing levels of output and employment using MR and MC will match the levels found using the wage and MRP.

Once you have found the profit maximizing combination, you can press the button marked "Store Target Values". The information from the output, costs, and revenue table will be stored so you can recall it later.

Production and Cost Graphs

The graphs are based on the information in the previous tables. You can select to display five different types of graphs from the drop-down menu.

Revenues and Costs From Additional Capital

This section of the worksheet helps you decide if you can increase your profits by purchasing capital. Additional capital will increase output and revenue for the rest of the simulation, so you need to compare the cost of the capital against the total value of the additional revenue in all the remaining periods.

To estimate the value of additional capital, pick the amount of capital you think you would like to purchase from the drop-down menu labeled "Capital Purchased". Type the price you expect to sell your output for in the text box labeled "Output Price", and type the amount of labor you think you will hire each period in the text box labeled "Labor per Period". Next, select the rate at which you are going to discount future revenues from the drop-down menu labeled "Discount Rate." When you press the button labeled "Calculate Net Present Value of Capital" the results are displayed in the table at the bottom of the page.

The first column in the table displays your capital stock for each period assuming you do not buy any capital. Economists refer to the rate at which capital wears out as the depreciation rate. If the depreciation rate has been set to zero, the amount of capital will be the same for all the periods. If the depreciation rate is 5 percent, the stock of capital will decrease by 5 percent each period. The second column shows the amount of capital you would have if you did purchase the additional capital.

The third column shows how much more output would be produced if you purchased the additional capital, given the amount of labor you said you would hire. The fourth column shows the additional revenue you would receive, given the additional output and the output price you specified.

The last column discounts the additional revenues. Economists typically assume that money received in the future is not as valuable as money received in the present. If you pick a discount rate of 5 percent, it means that you believe that 95 cents in the current period has the same value as a dollar received in the next period.

In deciding whether to purchase capital, you should compare the difference between the present value of the additional future earnings from buying the capital and the cost of purchasing the capital. Economists would call the difference the net present value of the additional capital. If the net present value of the capital is positive, purchasing the capital will increase your profits if your estimate of the output price is correct.

If you decide you can add to your profits by purchasing more capital, you should go back to the short-run cost and revenue section of the page, and see if the additional capital will change your profit-maximizing level of employment.

Firm Actions

View Target Values

If you stored your target values in the worksheet page, you can press the “View Target Values” button in order to view your results from the worksheet page. You will see a popup window labeled Firm Target Values. You can see the wage, price of output, capital stock, optimal employment, and optimal output. You can use this information to help you determine how much labor to hire and what price to post your output for sale.

Current Values

This section displays information about your firm. The first line lists the type of product you produce. The second line lists the amount of cash the firm has available to buy labor; cash which is not spent by the end of the period is carried over into the next period.

The third line lists the number of units of capital available to produce goods in the current period. Capital (minus depreciation) is carried over into succeeding periods. The line labeled "New Capital Next Period" lists the number of units of capital that will be added to the firm's stock of capital in the next period. When a firm buys additional units of capital it has to wait until the following period before it can use the capital to produce output. The fifth line lists the amount of labor hired so far in this period.

The last line, "Units of Output in Inventory," lists the number of units of output the firm has produced this period but has not yet sold. Inventory (minus depreciation) is carried over into the following period.

Purchase Labor
The table in this section displays the households' offers to sell labor time. To accept an offer, select the offer and press the button marked "Accept Offer." The labor purchased is then automatically used to produce output (it is not possible to "store" labor hours).

Post Offers to Sell Output
In this section you can post offers to sell output. Type in the number of units you want to sell and the price you are asking. When you have filled in all of the information press the button marked "Post Offer." Any offer which is not accepted before the end of the period is automatically cancelled.

Cancel an Offer
The table lists all of the offers that you have made this period that have not yet been accepted. To cancel an offer, click on the offer you want to cancel and press the button marked "Cancel Offer."

Distribute Dividends
You can transfer cash from your firm to your household. Type in the amount of money you wish to transfer from the firm to your household and press the button marked "Distribute Dividends."

Purchase Capital
The simulation assumes there is a producer of capital who hires labor from the households, makes capital, and then sells the capital to firms. Thus, there may be a small amount of time in the beginning of the simulation when there is no capital available for sale if there are no offers of labor for the capital producer to buy. Whenever a firm buys capital, the capital producer takes the money from the sale and tries to buy labor to produce new capital.

This section of the page displays the current price of capital and a drop-down menu showing the number of units of capital available for purchase. Select the amount of capital you wish to buy from the drop-down menu and click on the button marked "Purchase Capital". The number of units you buy will be added to your capital stock at the start of the next period. If a participant purchases all of the capital, there may be a brief period in which no capital is available.

The price of capital is based on the cost of labor hired and the production function for capital. For example, if it takes two units of labor to produce a unit of capital and the wage rate is $10, capital will cost $20 per unit.

Change Industry
If firms in another industry are earning significantly higher profits than the firms in your industry, you may want to consider switching industries.

To change industries, select the industry you wish to enter from the drop-down menu and press the button marked Change Industry. Starting in the next period, you will be producing the product you selected.

There are two consequences to changing industries. First, your inventory will be set to zero when you start producing the new product because you cannot carry over inventory from your old industry. In other words, if you are producing bread and in period 3 you indicate you want to switch to producing milk, none of your bread inventory can be carried over into period 4. In this case you would want to have sold all of your bread inventory by the end of period 3.

The second consequence to changing industries is there will be a reduction in your stock of capital by 15%. The reduction in capital is justified since changing industries would most likely cause a need for different equipment and retraining of workers.

Firm Bonds
Current Values
This tables displays information about your firm. The first line lists the type of product you produce. The second line lists the amount of cash the firm has available to buy labor; money which is not spent by the end of the period is carried over into the next period. The third line lists the number of units of capital available to produce goods in the current period. The line labeled "New Capital Next Period" lists the number of units of capital that will be added to the firm's stock of capital in the next period. The next line lists the amount of labor hired so far this period. The last line "Units of Output in Inventory," lists the number of units of output the firm has produced this period but has not yet sold.

Purchase Bonds (Lend Money)
The table in this section lists all of the bonds that are being offered for sale. To purchase a bond, click on the bond you wish to buy and click on the button labeled “Accept Offer.”

The following characteristics of the bond are listed in the table:

- Price Asked -- This is the amount you must pay for the bond. It is the amount you are lending to the seller of the bond.
- Face Value -- This is the amount that will be paid to whoever holds the bond when it matures.
- Period Matures -- At the end of the period the face value of the bond is deducted from the cash of the firm that originally issued the bond and is added to the cash of the firm or household that owns the bond.
- Projected Yield -- A measure of the return received by the purchaser of the bond expressed in percentage terms. The size of the yield depends on the difference

between the purchase price and the face value, and the amount of time before the bond matures.

For example, suppose a household bought a bond from a firm for $200 at the very end of period 3. If the bond matured at the end of period 4 and had a face value of $220, the bond would have a yield of 10%. The relevant calculation would be: (220 - 200)/200 = 20/200 = 0.1 = 10%

Post Offer to Sell a Bond (Borrow Money)

You may decide to borrow money so you can invest in additional capital. If you borrow to purchase capital you want to be sure that the return on your investment is greater than the amount you have to pay to borrow the money. One approach to finding if you want to borrow money to invest is to first find the yield on the bond you are going to offer. Next go to the capital section of the firm worksheet page. Use the estimated yield of the bond as the discount rate in calculating the net present value of the additional capital. If the present value of the investment is positive, and all your other assumptions are correct, it will be profitable to issue the bond.

To post an offer to sell a bond, select the period in which the bond will mature, the price you are asking for the bond, and the amount you promise to pay when the bond matures (the face value). You should then press the "Calculate Yield" button to find out what the expected yield on the bond will be. Finally, click on "Post Offer".

Sell a Bond You Currently Hold

You have the option of reselling bonds which you have purchased. The table in this section lists all of the bonds you own. To sell a bond, highlight the bond you wish to sell, type in the price at which you want to sell the bond, and click on the "Post Offer" button. Before you press the "Post Offer" button, you may want to press the "Calculate Yield" button. When this button is pressed the program will display the yield to the new owner of the bond, given your asking price.

Cancel an Offer

You can cancel an offer to sell a bond if the offer has not yet been accepted. Click on the offer you wish to cancel and press the "Cancel Offer" button.

Bonds Outstanding

This table lists the bonds you have issued, when they mature, and the face value (the amount you will need to pay when they mature). You want to be sure to have enough cash to pay the holder of the bond when the bond matures.

Functions, Graphs

Functions

This section displays your household's utility function and your firm's production function for output. It also displays the utility functions of the other household groups and the production functions of other industries. Note that you do not need to directly

use these functions when participating in the simulation. You can use the worksheets, which are based on the functions, to plan your strategy.

Graphs of Simulation Data

You can display a variety of information about the simulation on a graph. The information that can be displayed includes:

Production by period: Bar Chart displaying the total number of units produced by all of the firms in each industry for each period.

Units sold by period: Bar Chart displaying the total number of units sold by all firms in each industry for each period.

Output prices paid: The prices charged for the last twenty sales of each product.

Current inventories: Bar Chart displaying current inventories for each industry.

Wages paid and Capital prices paid: Wage rates paid for the last twenty sales of labor and Prices paid for the last twenty sales of capital.

Total Utility by Group: Bar chart displaying the total utility by user group. The user group is sorted by both household utility group and the product you produce. The bar chart labels the maximum total utility value and median* total utility value for each user group.

Current utility (user's group): Bar chart showing the rank of your current utility compared to all other households in your user group. The user group is sorted by both household utility group and the product you produce. This graph shows how your current utility ranks compared to other similar households who also happen to produce the same good as you do.

Total utility (user's group): Bar chart showing the rank of your total utility (current utility added to past utility from previous periods) compared to all other households in your user group. The user group is sorted by both household utility group and the product you produce. This graph shows how your total utility ranks compared to other similar households, who also happen to produce the same good as you do.

Profit by industry, Previous period: Bar chart displaying the profit (previous period) by industry. The maximum profit value and median profit value for each industry group are labeled in the chart.

Firm Net Worth (user's industry group): Bar chart displaying the rank of your firm's net worth (defined as cash + value of inventory + value of capital stock + present discounted value of bonds) compared to all other firms in your industry group.

Firm Net Worth by industry: Bar chart displaying the net worth (defined as cash + value of inventory + value of capital stock + present discounted value of bonds) by industry. The maximum net worth value and median net worth value for each industry group are labeled in the chart.

*: The median is the middle value in a set of numbers. For example, in the set of numbers: 10, 9, 8, 3, 3, the median value is 8.

III. Learning Theory

The purpose of this section is to relate the principles you are learning in class to Adam's Market. The nine topics discussed are: Circular Flow, Utility Maximization with Money, Labor Supply, Profit-maximizing Level of Output in the Short Run, Profit-Maximizing Level of Employment in the Short-Run, Profit-maximizing Level of Capital, Depreciation, Entry and Exit, and Bonds. For each topic, we provide a brief discussion of the relevant concepts and their theoretical basis.

1. Circular Flow

Virtually every economics textbook has a diagram that shows the circular relationship between goods, resources, and payments between households and firms. Sometimes this diagram does not occur until the macroeconomics section of the textbook. Locate the circular diagram in your textbook.

Adam's Market is a perfect example of the circular flow diagram. As a consumer, we sell our labor (a resource) to firms. Firms then use the labor (and capital) to produce output (a good). Firms then sell these goods to households. This process completes the circular flow of goods and resources. Similarly, there is also a flow of money. Households spend their incomes on goods, which gives the firms revenue. Firms use the revenue to buy resources (or factors) and thus make payments to the households. Payments by firms to the labor market give consumer income. Households then use the income to purchase goods, and so on.

2. Utility Maximization with Money

In your text, you have encountered the problem of consumer equilibrium or utility maximization. There are different ways to approach this problem but for the purposes of Adam's Market, we maximize utility in terms of marginal utility per dollar (using the MUx/Px = MUy/Py rule).

In class, you have learned about the utility of a consumer. **Utility** is defined as the total satisfaction an individual receives from consuming a particular amount of goods (sometimes called a bundle of goods). **Marginal Utility (MU)** is the additional satisfaction (or additional utility) a consumer gets from consuming an additional unit of the good. Usually households experience diminishing marginal utility, where each successive unit of the good gives smaller and smaller incremental increases to utility. The law of diminishing marginal utility then says that with each additional unit of a good consumed, the marginal utility of that good decreases. For example, consider the table below:

Quantity of good X	Utility	**Marginal Utility of good X**
0	0	**---**
1	28	**28**
2	50	**22**
3	70	**20**

If the first two columns were given, we could calculate the third column as the change in utility divided by the change in the quantity of good X. Notice that Marginal Utility falls immediately. Some students think the law of diminishing marginal utility says utility will fall. Notice that utility is increasing, but at smaller and smaller increments. The law of diminishing marginal utility is apparent in your every day life. Do you think you obtain as much satisfaction from eating your fourth or fifth piece of bread as you did from eating your first?

A consumer's goal is to maximize utility. In order to maximize utility in the simulation, a consumer must spend all of his or her income. A consumer's **budget line** shows all the possible combinations of two goods the consumer can afford to buy, with given prices and income. For example, if a consumer spends all of his or her income on two goods, X and Y, and the price of good X is $5, the price of good Y is $2, and the consumer has $50 to spend, then the table below reflects some of the points on the consumer's budget line.

Quantity of good X	Quantity of good Y
10	0
8	5
6	10
4	15
2	20
0	25

Graphing these points, with quantity of good X on the X axis and quantity of good Y on the Y axis, will yield a downward sloping graph with a slope of -2.5. The slope of the budget line reflects the ratio of the prices.

In order to discuss utility maximization (called consumer equilibrium in some texts), we must introduce the concept of **marginal utilities per dollar** (**MU/P)** which is defined as the marginal utility divided by the price of the good. A consumer maximizes his or her utility by setting the marginal utilities per dollar of goods equal while spending all of his or her income. If we have three goods, X, Y, and Z, then the consumer would maximize utility when all the income has been spent and the $MU_x/P_x = MU_y/P_y = MU_z/P_z$, where P is the price of good X, Y, or Z. In the simulation, the consumer chooses between three goods: leisure, bread, and milk.

3. Labor Supply

The market for labor is such that households or households are suppliers of labor and firms are the demanders of labor. In Adam's market, your household supplies labor to firms. An individual consumer's supply curve for labor is made up of all the utility maximizing points between income and leisure. Typically the consumer's supply curve for labor is upward sloping. Each point represents the amount of hours a consumer is willing to work at each wage rate. As the wage rate increases, we are willing to work more hours. Sometimes, an individual's supply curve for labor can begin to bend

backward at very high wages. At some point, as wages increase, we might actually choose to work less.

This result might seem odd, but is not. When the wage rate changes, the total effect of that wage change is broken down into two different parts. The **substitution effect** allows the consumer to consider the effect of the wage rate change on his or her behavior without considering the actual change in income that might result in that wage change. Thus, the consumer only considers the relative change in the price of work versus the price of leisure. The substitution effect causes households to substitute into the relatively cheaper "good". Thus, if the wage rate increases, it becomes more expensive to leisure and the substitution effect part of your response would lead you to consume less leisure and work more. The **income effect** refers to the consumer's response to the possible change in income as a result of the wage change. As long as leisure is a **normal good** (we consume more leisure as income increases), then as the wage rate increases and income increases for each hour worked, then the income effect would cause the household to consume more leisure and work less. As you can see, there is a conflict here. When the wage rate increases, the substitution effect causes the household to consume less leisure, but the income effect causes the household to consume more leisure. The total effect is a sum of both the substitution effect and the income effect. Thus, for an increase in wages, the total effect could result in one of three outcomes: the consumer chooses to leisure more (work less) if the income effect is bigger than the substitution effect, the consumer chooses to leisure less (work more) if the substitution effect is bigger than the income effect, or to consume the same amount of leisure as before the wage change (work the same) if the income effect and substitution effect are the same size. So you can see that a backwards bending supply curve for labor just means that for the low level of wages, the substitution effect is bigger than the income effect and then for the backward bending part of the supply curve, the income effect is bigger than the substitution effect.

4. Profit-maximizing level of output, short run

Economists distinguish between the short run and long run in the following way: in the short run there is at least one fixed input. In the long run, all inputs are variable. Thus, in the short run, we have both fixed inputs and variable inputs. The costs associated with each specific type of input are appropriately called **Variable Costs (VC) and Fixed Costs (FC)**. We refer to **total costs (TC)** as the sum of VC + FC. We typically assume that firms produce the level of output in order to maximize profit. Profits are defined as **Total Revenue (TR) – Total Costs (TC)**. Total Revenue is defined as the total amount of receipts the firm would receive from selling a certain amount of output. TR is calculated as price times quantity.

The additional revenue the firm receives from producing an additional unit of output is called **Marginal Revenue (MR)** and is defined as the change in total revenue divided by the change in output (Q). The additional cost of producing an additional unit of output is called **Marginal Cost (MC)** and is defined as the change in total cost divided by the

change in output (Q). The table below shows how to calculate MC and MR. The columns marked in bold have been calculated.

Output	Price	TR	MR	VC	FC	TC	MC	Profit
0	10	**0**	**----**	0	100	100	**----**	**-100**
25	10	**250**	**250/25 = 10**	200	100	300	**200/25 = 8**	**-50**
60	10	**600**	**350/35 = 10**	400	100	500	**200/35 = 5.71**	**100**
90	10	**900**	**300/30 = 10**	600	100	700	**200/30 = 6.67**	**200**
110	10	**1100**	**200/20 = 10**	800	100	900	**200/20 = 10**	**200**
120	10	**1200**	**100/10 = 10**	1000	100	1100	**200/10 = 20**	**100**

The Total Revenue (TR) is calculated as Price times Output. In this example, it is assumed the price stays the same no matter how many units are sold. This is similar to the table in Adam's market, where you will specify the price of output. Marginal Revenue (MR) is calculated as the change in total revenue divided by the change in output. Note that FC is the same for all levels of output. This would represent the cost of all the firm's fixed inputs. Notice that VC varies with output. If the firm is not producing any output, then VC is equal to 0. Marginal Cost (MC) is calculated as the change in total cost divided by the change in output. Notice that since FC is constant, the change in TC is the same as the change in VC, so MC could equally be computed using the formula change in VC divided by the change in output.

In order to maximize profit, the firm thinks on the margin. For each additional unit of output, it compares the MR to the MC. If the MR is bigger than the MC, then the firm will produce that level of output and profits will increase. If the MR < MC, the firm will not choose to produce that level of output since profits would fall at that point. Thus, profits are maximized where MR = MC. In the table above, profits would be maximized at an output level of 110, where profits equal 200. Any point beyond that, profits would fall. Notice that at the output level of 110, MR = MC and profits to the firm are at their highest (200). If the firm continues to produce more output beyond that point, MR < MC, and profits fall to 100.

5. Profit-maximizing level of employment, short run

The problem of profit maximization can be examined in terms of the output produced to maximize profits, or similarly, in terms of the labor hired (that will then produce the profit maximizing level of output). The decision, in the end, will yield the same result. A firm's demand for labor is called the Marginal Revenue Product (MRP) of labor. This is defined as the additional revenue that the firm earns from hiring an additional unit of labor. There are two steps in order for the firm to earn additional revenue from hiring additional labor. First, the firm hired the labor and the labor makes additional product. Then, the firm sells the additional product to earn the additional revenue. Thus, MRP is calculated as MP_L times MR, where MP_L is the marginal product of labor (the additional output from hiring an additional unit of labor) and MR is the marginal revenue (the additional revenue earned from selling an additional unit of output). The table below shows how MRP of labor is calculated.

Quantity of Labor (L)	Output	**Marginal Product**	Marginal Revenue	**MRP**
0	0	**---**	10	**--**
1	20	**20**	10	**200**
2	50	**30**	10	**300**
3	70	**20**	10	**200**

The columns in bold were calculated. The columns (L, Output, and MR) were given. MP_L is calculated as the change in output divided by the change in labor. Since the MR is constant here, we can assume that the output market is perfectly competitive and MR is equal to the price of output. MRP is calculated as MP_L times the MR.

In the case of the simulation, the wage rate is given and firms act as wage takers. Thus, the wage represents the additional cost resulting from hiring an additional worker.

The firm will maximize profits when the MRP is equal to the wage rate. If the MRP is greater than the wage rate, then the firm could earn more profits by continuing to hire labor. If the MRP is less than the wage rate, then the firm's profits will fall by hiring that additional worker. Only when the MRP = wage rate will the firm be maximizing its profit.

6. Profit-maximizing level of capital, long-run

As you recall, the short run is defined as the situation when at least one input is fixed. In the case of Adam's market, capital is the fixed input. However, at some point in the simulation your firm will have the opportunity to purchase capital for use in future periods.

The depreciation rate of capital is set to 10 percent. For example, let's say we are playing a game with 6 periods and in period 3, your firm gets the option to purchase capital. Your firm will be able to use that additional capital to produce output in periods 4 through 6. Thus, if your firm purchases 10 units of capital to use in period 4, the table shows how many units of the new capital will be available to the firm in each period.

Period	Capital Purchased in Period 3 (the new capital is added to the existing capital stock)
4	10
5	9
6	8.1
7	7.3
8	6.7
9	6

Once your firm has purchased capital, it will have some portion of that capital to use for the remainder of the simulation. Recall your firm also received 16 units of capital at the beginning of the game. With a 10% depreciation, your firm will also have 11.66 units of

capital still remaining from the initial 16 units. Thus, the total capital stock available to your firm in period 4 will be 21.66 units.

The decision of whether to produce capital is one in which the additional costs of buying additional capital must be compared to the additional revenue the firm could earn from buying capital. If the additional costs are greater than the additional revenue the firm would earn by purchasing additional capital, then the firm should not buy the capital. However, if the additional revenue the firm gets from purchasing an additional unit of capital is greater than the additional cost of buying the capital, then the firm should buy the capital.

In the simulation, the table "Revenues and Costs from Additional Capital" will help your firm decide whether to purchase capital and how much capital to purchase. In order to understand the table, you must understand the concept of **Present Value**. Present value is defined as the value, in today's dollars, of what you will receive at a specific date in the future.

In terms of the example above, each period that you have additional capital, your firm will be able to produce more output with the same amount of labor hired and earn additional revenue. The sum of the additional revenue over every period would tell us the total additional revenue from purchasing capital. However, since your firm will not receive those revenues until the future, it needs to be **discounted** in terms of what it is worth today. Most likely, your professor might set the discount rate to zero, so that the sum of the additional revenues will simply equal the present value of the additional revenues. In the firm worksheet, you are able to choose the discount rate you want to use or your professor may recommend using a specific rate. Whatever choice for the discount rate, the table will tell you the Present Value (PV) of the change in revenue. Just remember this is basically what the additional revenue from buying capital is worth to you in today's dollars (the period in which you are trying to decide whether or not to buy capital).

Once the PV of additional revenue is calculated, it is subtracted from the cost of the additional capital. This difference is called the **net present value**. If the net present value from a particular amount of capital is positive, then you should buy that capital. If the net present value from a particular amount of capital is negative, then it costs you more to buy the capital than you will earn in the future. You should not buy the capital. You should try to find the level of capital where the net present value is at its highest. This is the profit maximizing level of capital you should buy.

7. Entry and Exit of Firms

Your professor may choose to give firms the option to change industries at some point in the simulation. The mechanical process to do so is simple. At the bottom of the firm actions page, you simply choose the new industry in which you want to change and then press the button labeled "Change Industry".

The decision about changing industries is not simple. There is no one table that will help you make the definite answer. You must use your knowledge of economics and the information you have to come to the best informed decision that you can.

The following is one suggestion of the factors you might want to consider before changing industries. First, you might want to view the current inventories graph on the Functions and Graphs Page to see how much inventory of each good is available.

Of course, inventory is only one small picture of what is happening in an industry. You most definitely would want to look at the profits within an industry. You can do this by clicking on the link to the Functions & Graphs page. View the graph "Profit by Industry, Previous period" and compare the profits of your industry to the profits of the other industries in the simulation. This information will help you to determine if you want to choose industries.

Before jumping in and automatically entering an industry that is doing well, you must consider your firm's individual performance in the industry. Click on the link to the Functions & Graphs page. View the graph "Firm Net Worth (user's industry)." From here you can see how many producers are doing better than your firm and how many producers are doing worse than your firm.

Before making the final decision, your firm must consider the impact that entry might have on the existing situation. What would be the most likely impact of entry on price of output, total output produced, and profits to firms? Obviously if some firms switch industries, there will be entry into the more attractive industry and exit out of the less attractive industry. What would be the most likely impact of exit on price of output, total output produced, and profits to firms?

Ultimately, you do not now what other firms are going to do. You must make a decision after having assessed the situation. Remember you will lose all of your remaining inventory as well as 15% of your capital when changing industries.

8. Depreciation

To produce goods firms use capital (plants and equipment). Unfortunately, plants and equipment do not last forever. Equipment may be damaged while producing output or become obsolete. Economists refer to the loss in value of a firm's capital as depreciation. Economists include depreciation as one of the implicit costs of producing output.

In MarketSim your capital stock will depreciate at some constant percentage chosen by your instructor at the end of each period. In addition, the value of your inventory will decrease at the end of each period as well. This reflects the routine charge for the percentage of goods in the inventory that may spoil if they are not consumed in the current period.

To see the effects of depreciation, call up the firm's worksheet and look at the 'Revenues and Costs from Additional Capital' section (you will only be able to do this if it is

possible to purchase capital). As shown in figure 1 below, the screen will display the number of units of capital your firm will have no additional purchases of capital. In this case the depreciation rate is 10 percent and the initial capital stock is 14.4 units. With no new investment the capital stock will fall to 12.96 in the next period (12.96 = 14.4 – (0.1)(14.4)).

Figure 1

Revenues and Costs from Additional Capital

Current Capital Stock: 14.40 Depreciation Rate: 0.10

Capital Purchased: 2 Labor per Period: 30

Output Price: 5 Discount Rate: 0.00

Calculate Net Present Value of Capital

Period	Units of Capital, No New Capital	Units of Capital With New Capital	Change in Output	Change in Revenue	PV Change in Revenue
3	12.96	14.96	14.67	73.34	73.34
4	11.66	13.46	13.92	69.58	69.58
5	10.50	12.12	13.20	66.01	66.01
6	9.45	10.91	12.52	62.62	62.62
Present Value of Additional Revenues:					271.56
Cost of Additional Capital:					30.00
Net Present Value:					241.56

Example: Assume that you have 100 units of capital at the start of period 1. If depreciation rate is 10%, how much capital would you have at the start of (1) period 2, and (2) period 3?

Solutions:

1. At the end of period 1, 10 units of capital will be lost (10% of 100 units). This means that the amount of capital at the beginning of period 2 = 100 – 10 = **90 units**.

2. At the end of period 2, 9 units of capital will be lost (10% of 90 units). This means that the amount of capital at the beginning of period 3 = 90 – 9 = **81 units**

9. Bond Market

Firms issue bonds in the primary market as a means to raise money, usually for capital financing. A bond is essentially a promise to pay a fixed amount of money at some future date. For example, if a firm needs $100,000 to buy new equipment, it might offer to sell a bond with a face value (FV) of $121,000 that matures in two periods for a price of $100,000. The date when the payment is made is called the maturity date. For example, a bond that matures in 20 years is called a 20-year bond.

Households buy bonds as a way of earning interest on their saving. By preserving part of their current income in this manner they defer today's consumption. However, holding

bonds allows them to increase future consumption by reselling bonds from their portfolio and/or as the bonds mature. Firms also buy bonds issued by other firms as a way of earning interest on savings. Once issued, all of the outstanding bonds in the hands of the households and firms can be resold in the secondary market.

A bond that does not make any payment above the face value is a pure discount bond; it is always issued at a price less than its face value at the time of sale. The difference between the bond's selling price (SP) and the face value is the interest. For example, if a bond with a face value of $100,000 is sold at a discount price of $80,000, the interest to the buyer is $20,000. If the bond matures in one year, it would have an effective return rate of .25 (or 25%) that is equivalent to the bond yield [i.e., yield = (FV – SP) ÷ SP or = Interest ÷ SP]. In MarketSim, firms can only issue pure discount bonds.

In actual bond markets, most bonds also include a series of payments called coupon payments in addition to repayment of the principal. For example, the issuer of a 30-year bond with a face value of $100,000 might also promise to pay $5,000 for each of the 30 years plus the $100,000 at maturity. In this case, the series of coupon payments in each year must be incorporated in determining the bond price (or its present value) at the time of sale.

The principle of present value provides the theoretical basis for calculating the selling price of a bond in the current period. The present value is the value of a future payment or stream of payments in today's dollars. Thus, the selling price (SP) of a bond that promises to pay a certain face value (FV) with or without additional series of coupon payment (C) in each period during the maturity period is the present value (PV) of all the anticipated/promised future stream of payments.

For a pure discount bond, the general formula for calculating the present value (PV) of the stated FV of a bond can be summarized as:

$$PV = FV \div (1+ i)^t$$

As stated, 'i' is the quoted interest rate or yield, and 't' is the maturity period (t = 1, 2, …, 30 years). Since the PV is to be received at the end the 't' period, it is the highest price that one would pay in the current period to buy the bond.

For a coupon bond, the general formula for calculating the PV of both the bond's FV and the coupon payment (C) in each period can be summarized as:

$$PV = C \div (1+ i)^1 + C \div (1+ i)^2 + \ldots C \div (1+ i)^t + FV \div (1+ i)^t$$

Again, 'i' is the quoted interest rate or yield, and 't' is the maturity period (t = 1, 2, …, 30 years). Since the PV is to be received at a date certain in the future (i.e., period 't'), it is the highest price that one would pay in the current period to buy the bond.

When using MarketSim you and other participants are assigned specific periods for

playing the game. The beginning (end) of a simulation period to the beginning (end) of the next period is equivalent to a year in terms of calculating the bond yield. Consequently, in any given period, the yield that you must offer in order to sell a bond that matures within the simulation period increases as the remaining time in that period decreases. For example, if you issue or sell a bond whose FV is $100 for a SP of $91 at the beginning of a simulation period the interest to the buyer is $9, which is equivalent to a yield of about 10% (9.89%) assuming that the bond matures at the beginning of the next period. On the other hand, if you issue the bond at the same price of $91 in the middle of the current simulation period and it matures at the end of the period the yield will be approximately 21%.

In every simulation period, you should note the following caveats as you play the game:

1. As you approach the close of a period feel free to cancel any outstanding offer that remains since the yield that you may have to pay in order to sell the bond will be too high.

2. In your role as a producer, you or your firm should issue new bonds in the primary markets when you need to buy more capital. Doing so is a commitment to pay the FV of the bond but by using the borrowed funds to buy capital you can produce more goods and consequently make more profits -- part of which you also use to pay for the interest cost on the bonds. Also, by reselling existing bonds in your portfolio, you can generate cash quickly for use in a variety ways such as hiring more labor or making dividend payments to households.

3. In your role as a consumer, buying bonds now is a way of preserving a part your current income (or cash) and will allow you to increase your future consumption as the bonds mature. However, deferring too much consumption in the current period may actually lower your life-time utility. Therefore, try to spread your consumption more or less evenly over the entire simulation.

The following examples illustrate how to calculate Present Value (PV) to determine the selling/purchasing price of a bond. Example 1 highlights the relationship between the bond price and the face value of the bond. Example 2 demonstrates how MarketSim calculates the PV.

Example 1: **PV and the Relationship between Bond Price and its Face Value:**

1. Consider a pure discount bond that has a face value of $100,000. Suppose the interest rate is 5%. What will this bond sell for in this period if:

a. the maturity date is one year?

Solutions: $PV = FV \div (1+ i)^t = \$100{,}000 \div (1+ .05)^1 =$ **$95,238.09524**

This is the most price that a potential buyer would willing to pay for this bond.

b. the maturity date is three years?

Solutions: PV = FV ÷ $(1+ i)^3$ = \$100,000 ÷ $(1+ .05)^3$ = **\$86,383.75985**

This is the most price that a potential buyer would be willing to pay for this bond.

2. Consider a coupon bond with a face value of \$100,000 and a coupon payment of \$5000 at the end of each year. Suppose the interest rate is 5%. What will this bond sell for in this period if:

a. the maturity date is one year?

Solutions: PV = C ÷ $(1+ i)^1$ + FV ÷ $(1+ i)^1$
= \$5,000 ÷ $(1+ .05)^1$ + \$100,000 ÷ $(1+ .05)^1$
= \$4,761.904762 + \$95,238.09524
= **\$100,000**

This is the most price that a potential buyer would be willing to pay for this bond.

b. the maturity date is three years?

Solutions: PV = C ÷ $(1+ i)^1$ + C ÷ $(1+ i)^2$ + C ÷ $(1+ i)^3$ + FV ÷ $(1+ i)^3$

= \$5,000 ÷ $(1+ .05)^1$ + \$5,000 ÷ $(1+ .05)^2$ + \$5,000 ÷ $(1+.05)^3$ + \$100,000 ÷ $(1+ .05)^3$
= \$5,000 ÷ (1+ .05) + 5,000 ÷ (1.1025) + 5,000 ÷ (1.157625) + 100,000 ÷ (1.157625)
= \$4,761.904762 + \$4,535.147392 + \$4,319.187993 + \$86383.75985
= **\$100,000**

This is the most price that a potential buyer would be willing to pay for this bond. Why is this price the same as in part 'a'?

Example 2: **PVP and the Relationship between Bond Price and its Face Value as Implemented in MarketSim.**

As mentioned earlier, chances are that you will not trade in bonds immediately at the start of a simulation period. This means that a bond may actually mature within one simulation period instead of the next period that would coincide exactly with one full maturity period (or a year) from a theoretical view point. The consequences of trading within a specific simulation period are higher (1) bond yield, and (2) selling price. The following numerical examples illustrate both cases.

Suppose you want to sell a bond that has a FV = \$100, and a yield (i) = 10%.

1. What is the selling price if you were to sell the bond at the beginning of the current simulation period and the bond matures exactly in one full period - - that is, it matures at the exact time at the beginning of the next simulation period?

Solution: SP or PV = \$100 ÷ $(1+ .10)^1$ = \$90.90 or **\$91**

2. What is the SP you would set if you wanted to sell the bond halfway into the current simulation period and the bond matures at the end of the same simulation period?

Solution: SP or PV = \$100 ÷ $(1+ .10)^{½}$ = \$95.4919 = **\$95.50**

Notice that the SP is higher than it otherwise would have been had the bond matured in one full period.

3. What is the bond yield (**i**) if the SP = \$91, the bond is sold halfway into the current simulation period and it matures at the end of the same period?

Solution: Because both the FV and the SP are known, the PV rule can be used to solve for 'i' as follows:

$\$91 = 100 \div (1+ .i)^{½}$

or $[\$91(1+ .i)^{½}]^2 = 100^2$

or $91^2 (1+ .i) = 10{,}000$ or $8281 (1+ i) = 10{,}000$

Isolating 'i' yields **i = 21%** (.20758) which is higher than the yield (10%) had the bond matured in one full period or year. This is why the yield that the MarketSim reports may not be exactly the same as the one you are likely to obtain by using the PV formula to determine the selling price of bond with a fixed maturity date, 't'.