THE ECONOMICS NET-TEXTBOOK

Learning Resource Guide

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Overview

The Economics Net-TextBook Resource Guide is a paperback companion to the Net-Text [http://nova.umuc.edu/~black/pageg.html] netsite. The Resource Guide and the netsite should be used together. The netsite is an open-source interactive learning environment where it is possible to “learn-by-doing” using *active learning simulations* of graphical models. The Resource Guide provides additional material and explains the models and concepts in more detail.

A range of topics in economics is available for study, including aspects of micro and macro theory, money and banking and, international economics. The topics complexity ranges from elementary principles to advanced undergraduate concepts. The *active learning simulation* approach encourages better understand economic concepts by interactive examination of the graphical determinants of the conceptual models and, it encourages quantitative analysis of the graphical models.

The approach is graphical and quantitative. Visualization of the economic concepts provides the means to compare and contrast changes in the graphical economic models to better understand the concepts. Exact statistical results appear with precise graphical illustrations and text. Visualization is an important dimension of the learning process and the Net-Text encourages mastery of concepts.

Acknowledgements

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Chapter 1. Introduction to Active Learning

How to Use the Interactive Graphical Models of Economic Concepts

This chapter explains the use of graphical economic models and why interactive study of the models will improve understanding of the subject matter. Reading textbook narrative and depictions of graphical economic models often creates more questions after reading than before. *Active-learning simulation* of graphical models improves understanding of the economic, enhancing the ability to learn using the virtual reality of the models framework.

With the Net-Text, it is possible to create and change the graphic models with a click to see what makes the graphical illustrations of concepts appear as they are shown in a paper textbook. The use of the interactive graphics point-and-click parameter selection allows comparisons and contrasts of alternative scenarios comprised of different values of pivotal economic variables that affect the results of the economic models. Each graphical parameter in the *active learning simulation* reflects an important feature of the economic theory and the capacity to see the impacts of changing these parameters (often textbook assumptions) betters understanding of the limits of effectiveness of the theory.

The process of using the graphical models for active learning simulations involves a series of point-and-click selections to extend the graphical models beyond the static forms usually seen in the traditional text. A step-by-step explanation of the procedures for using the simulations appears next. This generic template of each chapter explains how each topic will appear in the Net-Text.

ECONOMIC METHODOLOGY

Economic theory explains how free markets resolve problems of scarcity in a variety of settings. These economic concepts are illustrated with graphical models to simplify the theory and to visualize how the concepts may be used to explain what is observed in the “real world”. Graphical models of economic theory utilize and emphasize the importance of quantitative analysis. Most, if not all, of the models in the NetText are conceptual models with empirical counterparts that may be developed with real world data using econometric techniques to derived exact estimators for the parameters used in the simulations.

Active learning simulation is learning-by-doing, rather than just passive reading of pages in a textbook. During lectures or in the text, professors might illustrate a concept with a graph or two when explaining concepts. Reading a paper

textbook that might also use one or two static graphical depictions of the theory is equally confining. The Net-Texts' graphical models explain and illustrate the theory and concepts but it does so with a significantly different approach to learning. It links the concepts to the parameters that 'drive' the graphical models. Changing the parameters that affect the models means exploring the limits to the effectiveness of the models and concepts.

This methodology is designed to encourage the use of the rational method and, to use concepts and data together. It emphasizes the importance of both theory and the use of statistical data to provide evidence to analyze concepts. As a result it is a good preparation for the use of quantitative methods when analyzing economic, financial and business problems.

THE ACTIVE LEARNING SIMULATION MODULE TEMPLATE FOR EACH TOPIC IN THE NET-TEXTBOOK

Each topic in the Net-Text presents a graphical model of an economic concept that is the subject of the module. At present, there are fourteen chapters or modules covering a diverse array of topics ranging from simple concepts like the production possibilities frontier, to complicated multi-equation models requiring simultaneous solutions, like the ISLM model. The material is organized into four categories: I. Introductory concepts; II. Microeconomic concepts; III. Macroeconomic concepts and; IV. International economics concepts. A list of programming code for all topics appears at the bottom of the home page of the Net-Text and the material in the code list is ordered chronologically, starting with the first module produced on the net (the ISLM model in 1996) to the latest (the money market in 2002).

Each module that appears in the Net-Text is found in a separate chapter in the Resource Guide and the material is presented in the same general format.
The module is introduced on the ***frontpage*** and the ***active learning simulations*** appear in a subsequent page (or pages). Both the *frontpage* and the *active learning simulations* have subsidiary elements described below.

THE MODULE FRONTPAGE

The module *frontpage* has three elements. First, learning objectives appear as a hypertext link at the top of the introductory page for the topic and, these objectives enumerate specific goals of understanding to achieve upon completion of the module. The purpose and background of the material is also discussed to provide perspective on the importance of studying the topic. Second, the *frontpage* provides introductory conceptual narrative about the subject area of the topic and describes important aspects of the economic theory and related subject material. Third, a set of parameters are presented that may be selected

to explore the topic in greater detail using the active learning process. These parameters offer a diverse range of options to see how the economic concepts are affected by the assumptions that are used in the model. *Active learning simulations* of the concepts may be created with a point and click.

Purpose and Learning Objectives

Each module is introduced with a discussion of the background and philosophical role of the conceptual topic. This introduction explains what is important about the topic and why it should be studied. It discusses the basics of the lesson in the module and provides perspective on the role it plays in economic methodology and policy formulation.

Learning objectives appear in each chapter and are identified to help focus attention on specific learning goals. Quantitative analysis of the models is encouraged but detailed knowledge of most of the equations is not necessary, although it is recommended for majors in economics or for majors having strong analytical requirements. The degree of understanding of the quantitative methods depends on the level of the reader: principles students can focus on the direction of change in market equilibrium, while more advanced students should become acquainted with more complete aspects of the analytical results. The models themselves are documented and the details of the mathematics and programming code appear in the open-source code listing on the Net-Texts' homepage.

Conceptual Narrative

The *frontpage* of each module offers an introductory discussion of the topic. The economic theory is explained and placed in context of material that appears elsewhere in the Net-Text or, that may be found on other netsites. Often, hypertext links are used to allow readers to go into greater depth in their reading of the introductory material.

This introductory conceptual narrative explains how the topic is addressed in the module. It explains important aspects of the economic theory that are illustrated by the graphical simulation model. It introduces parameters that may be selected within the context of the model and explains the role the parameters play in the simulation. Explanations of the impacts of the parameters are provided by the text engine of the simulation along with descriptions of the model solution. The introductory narrative usually does not go into great depth about the analytical solutions, although in some chapters (like the macro model in Chapter 7), it does explain the national income accounting identities being used and some of the behavioral equations using some algebra.

The Parameter Selections

The *frontpage* for each topic displays a set of model parameters that may be selected and changed. Each parameter is an empirical proxy representing a conceptual variable that is expected to influence the outcome of the simulation.

In other words, the range of parameter values offer different views of the conceptual depiction of the theory as shown in the graphics.

The parameters allow the reader of the Net-Text to ask and answer questions and, better understand how model assumptions affect the results. Parameter values are usually hypothetical and are not based upon results of specific econometric studies but, are reliable. Changing parameter values is highly recommended as a way to understand how sensitive the outcomes of the model are relative to the parameter.

The best approach is to conceptually determine how the model will react to the parameter selection (by using a pencil and paper or a spreadsheet). Then, after determining the outcome based on this analysis, run the model in the Net-Text to verify and check their results. Often there are a large number of parameters and the combinatorial problem of the solution renders a very large solution universe. For many of the topics, hundreds of thousands (and some topics have millions) of outcomes may be created, so focus attention of one or two parameters at a time.

ACTIVE LEARNING SIMULATIONS OF THE ECONOMIC CONCEPTS

Once a set of parameters has been selected on the *frontpage* of each topic and the "graph it" button (usually a rectangular gray button with similar words on it) is clicked, the *active learning simulation* is solved and the results of the graphical model are displayed on a new page (or pages). The *active learning simulation* has three important subsidiary elements: a restatement of the parameter set selected for the scenario(s); the graphics engine and; the text engine.

The objective of the Net-Text is to encourage visualization of the economic concepts using a graphical solution of the mathematical model containing the economic specifications. An equation or system of equations is usually (but not always) specified to represent the conceptual process described in the topic[1]. For example, a consumption function is specified to show how consumption expenditures depends upon income, given the marginal propensity to consume (MPC) and the level of autonomous consumption.

A specific mathematical form of the equation (or system of equations) is used in the simulation itself to allow for a discrete mathematical solution and to formulate the graphical illustrations. A linear function, for example, has a slope and intercept term and these parameters have economic counterparts (the parameters are empirical proxies for theoretical variables). In the consumption function, the slope is the MPC and, the intercept is autonomous consumption. The parameter values that may be selected are predetermined. The solutions are

[1] Every graphical model in the Net-Text uses a mathematical model that may be seen by inspecting the open-source programming code listed on the bottom of the homepage.

bounded by the range of the parameter values and the use of a particular mathematical specification for a family of equations. This is done to ensure the presentation space of the results contains a solution that may be used to depict the concept in the graphical illustration, given the range of values of the solution.

Scenario Parameters Selected

The *active learning simulation* for each topic includes a listing of the parameters selected. Often two sets of parameters may be used to represent a baseline scenario and an alternative scenario, for comparisons and contrasts of alternative scenarios. The parameters are usually color coded to allow immediate inspection of the results using the graphical depictions.

The Graphics Engine

Graphical results of the *active learning simulation* are presented for each topic to demonstrate the conceptual issues and to illustrate how the parameter values affect the results of the graphical model. Since the parameter set can be altered, it is helpful to view the graphical results keeping in mind how the general results explained by the topic are obtained. It is important to understand there is a range of parameter values that may be used to illustrate the results.

The presentation space of the graph is defined numerically as the upper and lower limits of each axis in the graph. Since the mathematical solution of some equation systems depends upon the parameters selected, the visual depiction of the solution (the beginning and ending numerical values shown on the horizontal and vertical axis) often depends on the parameter set. So, in many topic simulations, the range of values on the horizontal and vertical axis, as well as the scale on the values show will differ depending on the parameters.

Graphical visualization of economic concepts in each topic is enhanced and amplified with narrative to explain and to emphasize the important aspects of the results shown in the graphical illustration of the model. Depictions of equilibrium concepts are often used and attention is focused on specific points of the graph. The solution values are exact, and although rounded to three significant digits, students can inspect the graphs to verify the numerical results.

The Text Engine

Results from each topic are explained using a text engine that produces narrative with embedded numerical results to describe and annotate the graphical depiction. The text engine generates words depending on the parameter set and the resulting solutions. Some of the topics have text engines that are more sophisticated than those found in other topics.

The text engine results contain embedded solution values that are usually color-coded and always refer to specific points on the graph and/or are calculated from the parameter set. For example, the baseline scenario values may appear in blue while the alternative scenario used red. The points labeled on the graph that

correspond to the baseline and the numerical values and parameters that are explained in the text are color coded in one color and those for the alternative appear with a different color.

Often the text engine results describe points on two or more functions and the graphical depiction may use two or more graphs. Where more than one function or graph is used, the text engine will provide reference information to link the explanation to the graphical results with either color coding, reference point labels or both. In most cases the presentation space in the graphical illustration is clearly linked to the text. However, since the solution universe is so large for a given topic, every solution has not actually been tested and it may be possible to get graphics and text where the presentation space does not match the narrative.

Chapter 2. The Production Possibilities Frontier (PPF)

Scarcity, Opportunity Cost and the PPF

Purpose
This module illustrates and explains some important results from the production possibilities frontier (PPF) diagram, it defines the concept of scarcity and provides a quantification of the concept of opportunity cost. The role of economics is to improve understanding of the everyday choices made given scarcity. For example, anyone with a budget understands the limits of scarcity and the fundamentals of allocation problems. This chapter will discuss the capability to produce goods given resource constraints.

There are several important graphical measures that are used in the model. The PPF graphical model visually depicts the concept of scarcity and defines opportunity cost as the slope of the PPF. This definition of the slope depends on the choice of variables for the axes (the variables appearing on the horizontal and vertical axis). It defines the algebraic definition of slope as the opportunity cost ("OC") price of the good shown on the horizontal axis of the graph. The concept of opportunity cost is important in economics and this module quantifies its' meaning and definition.

PPF Learning Objectives
The learning objectives for the PPF module focus on understanding the measurement of opportunity cost and the graphical depiction and concept of scarcity. The PPF model is a simplification of production in an economy using two goods and a set of restrictive assumptions. Points on the PPF are attainable and efficient, points beyond the PPF are unattainable and points below the PPF are attainable but inefficient.

Scarcity is illustrated by the fact that only one point on the PPF may be attained and only if the economy is efficient. The other points on the PPF are efficient but, the choice of alternative points involves trade-offs. Movement between two points on the PPF illustrates the trade-off or opportunity cost of production choices. Quantification of the concept of scarcity is measured by the slope of the curve at a point and measures the "opportunity cost" ("OC") price of the good shown on the horizontal axis. The "OC" price of a product increases as more is produced and this result provides a simple derivation of the law of supply which states that the supply price increases as more is produced by a firm.

The Production Possibilities Frontier (PPF)

THE PPF *FRONTPAGE*

The PPF frontpage provides some background narrative about the concepts of scarcity and opportunity cost and, introduces the PPF model. The PPF diagram depicted on the *frontpage* is a clickable image. Clicking on one of the labeled points will generated a diagram with more explanation about the graphical definition and measurement of opportunity cost. In addition, at the bottom of the *frontpage* the assumptions of the PPF may be changed by selecting new parameters.

Discussion of the PPF

The production possibilities frontier (PPF) is a simple model of economic choice. It assumes that only two goods are produced with a finite resource endowment. Production technology is given and there is no money, only barter. If full employment is attained the economy will operate on the PPF, otherwise it will fall below it if unemployment or underemployment of resources occurs. Points on the PPF show the maximum potential of the economy to produce differing combination of the two goods and points beyond the PPF are unattainable.

Points are labeled on the PPF to allow comparison of differing level of production of one or the other good in the economy. Since there are only two goods, production of one good can be increased only by diverting resources out of production of the other good (assuming the economy stays on the PPF). In the case of food and cloth, starting at a point on the PPF, if food production increases, the resources must be taken from cloth production and hence production of cloth will decline.

The concept of scarcity is explained by this trade-off. The increase in the production of one product may be measured by what is foregone in terms of production of the other product. This definition expresses the concept of opportunity cost: the value of the next best alternative. In other words, what must be given up, in order to have something else. It assumes the economy is operating at full capacity as shown by the PPF.

<u>Changing the Assumptions of the PPF</u>

The assumptions of the PPF are presented in the conceptual discussion. Each of the assumptions is represented by a parameter with a numeric value that may be increased or decreased in relative terms to show how the PPF is affected. A change in one the assumptions will affect the shape of the PPF and may shift it inward or outward.

<u>The Clickable PPF Image and the Parameter Selection</u>

The PPF diagram has five points labeled A through E. Positioning the mouse on any of these points and clicking will produce a new image that graphically illustrates and describes the concept of opportunity cost in more detail. It

measures the concept of scarcity and quantifies opportunity cost by measuring the slope of the PPF at that point.

The parameter selection on the PPF *frontpage* allows the student to change any of the assumptions of the PPF. The parameters may be increased or decreased in percentages that range from a 25% reduction to a 25% increase. The parameter assumptions are:

- population living in the economy;
- food production technology and;
- clothing production technology.

THE *ACTIVE LEARNING SIMULATIONS* OF PPF MODEL

The *active learning simulations* of the PPF model provide visualizations of the problem of scarcity and show the meaning of the opportunity cost ("OC") price of the good depicted on the horizontal axis (cloth). That is, the "OC" price of cloth is the number of units of food that must be sacrificed to gain one more unit of cloth. Selecting a point of the clickable image shows the slope of the PPF at the point selected and a graph of the slope function measuring the concept of relative (or "OC") price.

The Parameter Set

If the clickable image is selected from the PPF *frontpage*, no additional parameters are used. The results appear and the diagram is self-explanatory. If the parameter selections are changed on the *frontpage* the new parameter selection is identified in the title of the graph and in the explanatory text.

The Graphical Engine

Selection of a point on the *frontpage* clickable image (points A-E) will result in a new diagram with the PPF on the top and the slope of the PPF measured on the lower graph in the diagram. Changing one of the parameters and clicking the rectangular "graph it" button on the *frontpage* creates a new image of the PPF showing the baseline PPF and the alternative PPF reflecting the change in the parameter assumptions.

The Text Engine

The text engine for the PPFs' *active learning simulation* module briefly describes the results from the graphics engine. Selecting the clickable image from the *frontpage* provides narrative describing the slope of the PPF at the point selected and explains how the measurement of the slope is an empirical proxy for relative scarcity at that point. It defines the variable "opportunity cost" price (of cloth) as the slope of the PPF at a point as is the "OC" price of the good on the horizontal axis at that point. The "OC" price is the trading ratio of one unit of the good on the

horizontal axis for the other good (how many units of food must be given up to obtain one more unit of cloth).

Changing one of the PPF parameters on the *frontpage* provides narrative that discusses the graphical image and the changes in the PPF. Two PPFs appear and are described using the change in the parameter selected. The narrative restates the change in the parameter assumptions and describes the shift in the PPF.

The Production Possibilities Frontier (PPF)

Assignment Questions

1. Choose two points on the PPF and explain the trade-offs that arise using the concept of opportunity cost.
2. Based on one of the points shown in the PPF, what is the measure of the “OC” price, in numerical terms? How is this interpreted on the graph and explain it in terms of the economics.
3. While on the PPF, as production of one good increases, what happens to the “OC” price and why?
4. When the PPF shifts, the “OC” price at some level of output will change as well. Explain.

Chapter 3. Supply and Demand

An Overview of the Price Mechanism

Purpose
The supply and demand overview provides a “broad-brush” picture of the price mechanism. The principles of market economics are introduced using an interactive model to provide an overview of how free markets function to allocate resources and to show the market conditions that affect the results. This big-picture of the market mechanism provides perspective for study of the economic concepts of supply and demand and it also introduces and explains the concept of market equilibrium.

Two approaches are used to study the market. One provides a simulation of the conceptual shift variables for supply and demand functions. The second is an algebraic formulation of the supply and demand equations. This approach uses linear expressions to allow inspections of the slope and intercept terms as empirical proxies for theoretical shift variables.

Supply and Demand Learning Objectives
The learning objectives for the supply and demand module are designed to improve understanding the effects of market changes and the role of price and quantity. It is important to understand how equilibrium is determined and how market changes may be examined using comparative statics to see the effects on equilibrium price and equilibrium quantity.

The impact of changes in shift variables provides an overview of how each shift variable will move supply or demand leftward or rightward. Market equilibrium is impacted by one or more changes in shift variables. With the conceptual knowledge of shift variables it is possible to predict the direction of change in equilibrium price and the direction of change for equilibrium quantity, due to a change in one or more shift variables or a simultaneous change in shift variables for supply and demand. Also, if a shift variable for supply and a shift variable for demand are changed simultaneously, the results might be indeterminate for either equilibrium price or equilibrium quantity.

The linear form of the supply and demand functions provides a quantitative expression of the functions used in the market model. The impacts of changes in shift variables may be modeled using the intercept term to explain the effects. The slope term is included to show how changes in this parameter may affect the results.

Supply and Demand Overview

THE SUPPLY AND DEMAND *FRONTPAGE*

The supply and demand frontpage provides background narrative about the conceptual framework of price theory and offers selection of the parameters representing either the effects of the theoretical shift variables or, for slope and intercept terms in the algebraic form, for a baseline and an alternative scenario. The model examines the produce market, assuming that the market equilibrium is attained.

Discussion of Theoretical Shift Variables of Supply and Demand

The law of demand states that price and quantity demanded are inversely related, whilst the law of supply explains how price and quantity supplied are directly related. Both laws are subject to the effects of shift variables that can move the supply or demand function leftward or rightward. A simplifying assumption is made that these shift variables lead to rightward or leftward shifts in the functions but, changes in shift variables will not change the slope of the supply or demand functions. The effect of shift variables on the market equilibrium may be examined by selecting the shift variables directly and specifying the direction and relative magnitude of change or, by changing the intercept and/or the slope to further explore the empirical aspects of shift variable changes as explained in the next section (*Discussion of The Linear Form of Supply and Demand Functions).*

.Supply Shift Variables

Supply shift variables explain how the supply function may move leftward or rightward in response to changes in conceptual variables that influence supply. The law of supply explains that price and quantity supplied are directly related. Firms will supply more of the product, if the market price is higher, but the effects of changes in shift variables must be recognized since these other influences are expected to affect the firms' production decision given the price.

factor prices

The prices firms pay for the factors of production are an important determinant of the supply price at any given level of output. For example, to produce 1000 units of some product, suppose a firm currently pays its' labor 11.24 ($/hr). Also assume the supply price the firm must receive to maximize profits (or minimize costs at that output level) is $25.00 per unit. If the cost of labor rises to 14 ($/hr), the firms' supply function will shift leftward, meaning at 1000 units the supply price will rise, to say $26.00 per unit to cover the increased cost of labor.[1]

technology

Another important supply shift variable is technology utilization. An improvement in the use of resources the firm uses, or an increase in its efficiency due to some

[1] The exact increase in the firms' supply price depends upon the factor intensity and productivity.

technological advance may be expected to shift the supply function rightward. In the example above, if the firm initially expected a supply price of $25 at an output level of 1000 units and some technological advance was adopted successfully, the supply function would shift rightward. This would suggest the supply price of the firm at 1000 units would decline, say to $24.50, meaning it now costs less per unit to produce 1000 units due to the new technology.

profit expectations
If a firm expects that the market conditions are such that a products' profitability will be greater in the future, it is likely to produce more of it. This effect will shift the supply function to the right. Thus for any given supply price, a firm will be willing to increase the quantity supplied because it expects the product will be more profitable.

other product prices
This supply shift variable reflects a producers' ability to other products with the same resources. A farmer, for example, can produce wheat, corn or barley on some acreage and usually grows some mix of all three. If the price of barley is up, the farmer may reduce the production of wheat and substitute increased production of barley to take advantage of the elevated price of barley. This effect would shift the barley supply function to the right at a given market price.

the number of firms in the market
The supply function will shift rightward or leftward in response to an increase or decrease, respectively, in the number of producers (firms) in the market. The market supply curve is the horizontal summation of the individuals' quantity supplied at any price. When more firms enter a market, the market supply curve shifts to the right and, when firms exit the industry, the market supply function shifts to the left.

Demand Shift Variables
Demand shift variables explain how the demand function may move leftward or rightward in response to changes in variables that affect demand. The law of demand explains the inverse relationship between price and quantity demanded. Demand shift variables move the entire function, altering the relationship between price and quantity demanded, but in a systematic way.

tastes and preferences
Consumers are thought to have an inclination to consume a product, in addition to their decision about price. That is, for any given price, consumer tastes or preferences reflect the willingness of a consumer to purchase the product. An increase in preference would shift the demand function to the right, meaning that at any given price, a consumer will be willing and able to buy more of it. Modern advertising is thought to be a means of doing this and firms seeking to influence consumer choice incur substantial expenditures.

income
A consumers' income level is a significant determinant of demand. If incomes rise, a consumer is expected to buy more of the good[2]. Thus at any given price, there would be an increase in quantity demanded associated with an increase in income. This appears as a rightward shift in the demand function as income rises.

prices of other goods
The prices of other goods available to the consumer represent another demand shift variable and these goods can be classified as substitutes or complements. In the case of a substitute (e.g. tea for coffee), if the price of the substitute declines, some consumers will increase their consumption of the substitute and purchase less of the good in question (less coffee when the price of tea declines – iced tea instead at the afternoon coffee break) at any give price. Thus the demand curve would appear to shift to the left when the price of the substitute declines. In the case of a complement good (tea and crumpets), a decrease in the price of the complement will lead to an increase in the quantity demanded at any given price (more crumpets will be purchased if the price of tea falls). Thus, the demand for a complement will shift to the right when the price of the complement declines.

the number of consumers
The demand function will shift rightward or leftward in response to an increase or decrease, respectively, in the number of consumers. The market demand curve is the horizontal summation of the individuals' quantity demanded at any price. When more consumers enter a market, the market demand curve shifts to the right.

The Market Equilibrium Condition
The intersection of the supply and demand function depicts the one price where quantity supplied equals quantity demanded. This equilibrium condition provides a convenient benchmark to evaluate market changes in response to changes in the shift variables. That is, using a comparative static approach, the two equilibrium conditions associated with different scenarios are examined to demonstrate how the market equilibrium price and equilibrium quantity respond to changes in market conditions.

In the *active learning simulation* of supply and demand two scenarios may be used to show how market equilibrium changes due to differences in the shift variables. It is possible to compare and contrast the impacts of the change in a supply or demand shift variable. Simultaneous impacts on the market equilibrium of both a supply and demand shift variable change may also be examined. Shift variables are proxies for the market conditions that affect the market.

[2] This assumes the good is a "normal" good and has a positive income elasticity.

Supply and Demand Overview

Discussion of The Linear Form of Supply and Demand Functions

The linear form of the supply and demand model is provided to explain the quantitative form of the model. A linear specification is used because it is a simple mathematical expression and can be readily used to explain both the law of demand and supply, as well as the shift variables. For both the supply and demand function, the effects of the shift variables may be specified as being embedded in changes in the intercept term. The slope term is assumed to remain constant.

Consider a specification for the supply function where:

P = a' + b * Q **[1]**

Where **a' = a0 + a1 * W + a2 * Tech + a3 * Pog + a4 * N** **[2]**
W = factor prices (wage rate)
Tech = technology
Pog = other prices (other product prices)
N = population in the market

The intercept term a' is sum of the terms on the right hand side of the expression **[2].** The parameters **a0, a1, … a4** are empirically derived from an econometric estimation of the demand function, along with the slope term **b** in **[1]**. Each of the terms on the right-hand side of **[2]** is evaluated at the mean value of the variable in question (e.g. mean or average income is used) to derive the value of a' for simplicity of expression in this exercise.

The demand function may be specified as:

P = c' + e * Q **[3]**

Where **c' = c0 + c1 * Y + c2 * SCP + c3 * POP** **[4]**
Y = consumer income
SCP = other prices (substitutes and/or complements)
POP = population in the market

<u>The Intercept Term</u>
Using the linear form of the supply function in equations **[1]** and **[2]** and, the demand function in equations **[3]** and **[4**], the effects of changes in the shift variables may be specified using changes in the intercept terms (**a',** and **c'**). Assuming the initial position is calculated using the mean values of the shift variable (as shown in **[2]** and **[4]**), a change in one of the shift variables would impact the intercept term as shown in expression **[2]** for the supply function and expression **[4]** for the demand function. For example suppose population increased and the mean value of the population (**POP**) in a market area (the subject of the demand study) went from 1.1 million to 1.2 million. The impact of

this change in population as a demand shift variable may be calculated by using the impact on **c'** as specified by equation **[4]** by substituting the new value of the population variable (**POP*=**1.2) and multiplying by **c3** (the rest of the terms on the right-hand side of the expression are unchanged).

Supply
A change in one of the supply shift variables would impact the intercept term **a'** in expression **[1]**. As shown in expression **[2]**, **a'** depends upon the mean values of each of the shift variables, multiplied by the relevant coefficient (**a1, a2**, etc). The impacts in the simulations are suggestive and no specific values of the coefficients are used. Instead, the intercept term is directly changed by a constant proportion.

Demand
A change in one of the demand shift variables would impact the intercept term **a'** in expression **[3]**. As shown in expression **[4**], **c'** depends upon the mean values of each of the shift variables, multiplied by the relevant coefficient (**c1, c2**, etc). The impacts in the simulations are suggestive and no specific values of the coefficients are used. Instead, the intercept term is directly changed by a constant proportion.

The Slope Term
The slope term for supply (**b**) in expression **[1]** and the slope term (**e**) for demand in expression **[3]** are not expected to change due to changes in shift variables. However, this is an empirical question and the simulations make this assumption for simplicity. Changes in the slope are important and do affect the elasticity of the demand and supply functions.

Supply
Changes in the slope of the supply function (**b**) may be introduced to see how changes this parameter may affect the results. The slope term may be increased or decreased relative to the baseline scenario to compare and contrast the actual impacts. The baseline and alternative scenarios will be depicted in the *active-learning simulation.*

Demand
Changes in the slope of the demand function (**e**) may be introduced to see how changes this parameter may affect the results. The slope term may be increased or decreased in the alternative scenario, relative to the baseline scenario, to examine the resulting changes in market equilibrium. The baseline and alternative scenario in the *active-learning simulation* may be compared to show the effects of changes in the slope and intercept.

Supply and Demand Parameters
The supply and demand model offers a selection of parameters to examine the effects of changes in the theoretical shift variables, as well as the effects of

changes in the intercept and slope terms for linear supply and demand functions. The *active learning simulations* use comparative statics and the two equilibrium positions of the baseline and alternative scenarios are examined to view the results. Parameters sets may be selected to specify the baseline scenario and an alternative scenario.

Changes in Shift Variables

The parameter set for examining changes in shift variables allows the user to increase or decrease one of the shift variables for supply and one shift variable for demand. The simultaneous effects of one shift variable change on both supply and demand may be examined by comparing the equilibrium price and quantity for the two scenarios. The impacts of a change in either a supply and demand shift variable may be also be seen one at a time.

Supply Shift Variables

The following choices are available to increase or decrease supply shift variables by a given percentage (from 5-25%).

- *factor prices*
- *technology*
- *other product prices*
- *profit expectations*
- *the number of firms in the market.*

Demand Shift Variables

The following choices are available to increase or decrease demand shift variables by a given percentage (from 5-25%).

- *tastes and preferences*
- *income*
- *prices of substitutes*
- *prices of complements*
- *the number of consumers in the market*

Slope and Intercept Parameters for Linear Supply and Demand Functions

The linear form of the demand and supply system provides a range of choices for the intercept and slope term for supply and demand.

the intercept term

The user may select a range of values of the intercept term for each function

- *supply:* the choices range from 1 to 7 with a default value of 4
- *demand:* the choices range from 7 to 20 with a default value of 10

the slope term

Selection of the slope term may be made for both supply and demand.

- *supply:* the choices range from .09 to .2 with a default value of .15

- *demand:* the choices range from -.05 to -.28 with a default value of .15

Selecting the Simulation View

- *the supply function:* If the supply function is selected, only the supply function is depicted for the baseline and alternative scenario.
- *the demand function:* If the supply function is selected, only the supply function is depicted for the baseline and alternative scenario.
- *the market equilibrium of supply and demand:* Selection of the supply and demand system will allow inspection of the equilibrium price and quantity for both the baseline and alternative scenarios.

THE *ACTIVE LEARNING SIMULATIONS* OF THE SUPPLY AND DEMAND MODEL

The *active learning simulations* of the supply and demand model show the affects of shift variables on market equilibrium and, a linear version of the supply and demand framework illustrates the use of changes in the intercept and slope as empirical proxies for theoretical shift variables. The supply and demand model using changes in shift variables provides a complete range of conceptual shift variables from both sides of the market. The linear form of the supply and demand model allows inspection of the empirical means to affect rightward and/or leftward shifts in demand and supply functions with exact numerical results from the solutions.

The Parameter Set

The parameters selected for the simulation appear at the top of the *active-learning simulation* page. The parameters listed are those referring to the selection from the *frontpage*. The graphical results display the baseline scenario and the effects of a change in the parameters representing the shift variables or the set of linear parameters selected.[3]

The Graphical Engine

Each graphical depiction of the baseline and alternative scenario for the supply, demand or, supply and demand system appears in the upper left-hand side of the *active-learning simulation* page, after clicking the “graph it” rectangular button on the supply and demand *frontpage.*

The graph shows price on the vertical axis and quantity on the horizontal axis. The two equilibrium points are depicted for the supply and demand system. If the supply or the demand function is displayed the original position (point A) and another point (B) are shown.

[3] The exact form of the shift variable effects may be examined by an inspection of the software code modules appearing in the open source listing on the homepage of the Economics Net-TextBook.

Supply and Demand Overview

The Text Engine

The text engine for the supply and demand *active learning simulation* module provides a brief discussion of two points depicted in the graphics engine. The original point on the baseline function is entitled point A, and the corresponding price and quantity are identified. If the supply and demand system is displayed, point A corresponds to the original equilibrium and point B, the new equilibrium. If the supply function or the demand function is selected, point A is described along with point B (the equivalent of the new equilibrium from the supply and demand system). Some narrative discusses the shift in the function using the original price and comparing the change in quantity supplied or quantity demanded.

Supply and Demand Overview

Assignment Questions

1. Using the supply shift variables what happens to equilibrium price and quantity if there is an increase in factor prices?
2. Suppose along with an increase in factor prices, the level of population increases at the same time. What happens to equilibrium price and quantity? (hint: population is a demand shift variable)
3. Do the results from question 2 depend on the magnitude of the shifts in factor prices and population?
4. Using the linear form of the demand and supply system, what is the reduced form expression for the solution of equilibrium quantity?

Chapter 4. Elasticity and Revenue

The Effect of Demand Elasticity on the Relationship Between Price Changes and Revenue Changes

Purpose
This module explains the impacts of demand elasticity on revenue movements given a change in price. The topic is important because the value of demand elasticity determines the responsiveness of revenue to price changes. In most of the Net-Text, linear demand functions are used and elasticity changes along a linear demand function. Revenue is calculated as price multiplied by quantity and as price changes revenue will change.

It uses a graphical model of linear demand functions and also shows the revenue functions. To amplify how price changes affect revenue, given the elasticity of demand, it explains the relationship between price and revenue and elasticity using two different demand functions and their corresponding revenue functions to illustrate and compare the results. Both the slope and intercept of either demand function may be selected to simulate the model.

Learning Objectives
The learning objectives for this module include some quantitative relationships derived from the demand and revenue functions. First, the revenue effects of price changes depend upon the elasticity of demand. Linear demand functions exhibit the property that elasticity varies along the function and at any given level of quantity demanded and, the intercept and slope parameters also affect elasticity. Prices changes are directly related to revenue when demand is inelastic but, inversely related when demand is elastic.

THE ELASTICITY AND REVENUE *FRONTPAGE*

The elasticity and revenue *frontpage* provides background narrative about the relationship between revenue functions and demand functions. The model uses two linear demand functions each with a slope and intercept term that may be selected with a click.

Discussion of the Model of Elasticity and Revenue
Linear demand functions have two parameters that affect the function: the slope (**b**) and the intercept (**a**). The demand function is specified as a bid function (**P=a-b*Q**), with price on the left-hand side of the equals sign to improve the visual use

of the parameter set. Each of these two parameters will affect the resultant revenue function (**R=P*Q**).

Elasticity varies along a linear demand curve and revenue responds to price changes, given the elasticity of demand. This module examines the relationship and shows how it occurs. The elasticity formula specified also affects the results and the Laspeyres (end-point baseline from the original position) expression is used although, the mid-point formula is applied to explain results at the detailed level when needed.

The relationship between price changes and revenue depends upon elasticity and may be summarized as follows. When elasticity is greater than one (elastic demand), price changes and revenue changes are inversely related. If elasticity is less than one (demand is inelastic), price changes and revenue changes are directly related.

The Elasticity and Revenue Parameter Selection
It is possible to change the intercept and slope terms for both demand functions and then compare and contrast the results. A wide range of parameter values is offered to allow comparison of different shaped demand functions. One demand function is entitled the baseline and the other the alternative scenario.

Two demand functions are used to amplify how the elasticity of demand determines the relationship between price changes and revenue. The graphical model depicts both functions and analyses areas that are common to both. Each function provides analytical evidence supporting the claims about elasticity, price and revenue.

Begin with the default values and examine the simulation results. Once the default results are clear, other cases may be examined to inspect the limitations of the model and how demand and revenue functions depend upon the parameters used. In each case the analysis focuses on the elasticity of demand on the relevant segments of the demand functions.

THE *ACTIVE LEARNING SIMULATIONS* OF THE ELASTICITY AND REVENUE MODEL

The *active learning simulation* of the elasticity and revenue model uses two demand functions to illustrate and explain the results. Specific segments of the demand and revenue functions for the two scenarios are compared using quantities common to both the baseline and alternative scenarios. These comparisons provide analytical details and are used to discuss the relationship between price, revenue and elasticity. Revenue is calculated as price multiplied by quantity and as price changes along a demand function, quantity will also change and the affects on revenue are determined by elasticity.

Elasticity and Revenue

The Parameter Set
The parameters selected from the *frontpage* appear at the top of the *active learning simulation* of the elasticity and revenue model. The baseline parameters appear in blue and the alternative scenario is in green. The slope and intercept terms selected for both linear demand functions are restated.

The Graphical Engine
Two illustrations of the elasticity and revenue model are used and each one has two graphs sharing the same horizontal (quantity) axis that show the demand and revenue functions. These two illustrations are virtually the same except, the first shows the entire functions while the second zooms in on a much smaller portion of the graph to document the analysis in detail. Each illustration is color coded to reference the baseline and alternative scenario.

In the top graph of the first illustration, the two demand functions appear and two points are labeled on each function for a given level of quantity demanded. The point on the baseline demand function appears as point 'B' and that on the alternative as point 'A'. The corresponding revenue functions are shown in the lower graph of the illustration with points 'A' and 'B' labeled to reference the resulting revenue for that level of quantity demanded. Both the demand function and revenue function graphs share the same horizontal quantity axis. A shaded area in the first illustration shows the area expanded and examined in the lower (detailed) illustration.

Sets of points are used to analyze the key segments of the demand and revenue functions. In the second (detailed) illustration, the top graph shows the demand functions and two points on each demand function. Movement between these points along the demand functions, representing a price change and allows for analysis of the revenue changes and evaluation of the elasticity along the segment.

In the top graph of the second (detailed) illustration, movement along the baseline demand function is shown as that movement between point 'B' to point 'C'. Starting from the same quantity demanded common to both functions, the corresponding percentage change in price along the alternative demand function is shown as the movement between point 'A' and point 'E'. Point 'C' is shown in dark blue and point 'E' in red. The bottom graph in the second (detailed illustration shows the associated revenue functions and the same four points are labeled to show the corresponding points on the revenue functions and the associated quantities may be read from the axes.

The Text Engine
The text engine for the *active learning simulation* of the elasticity and revenue model has two sections. The first section corresponds to the first illustration of the demand and revenue functions showing the entire functions and it explains

the results for each demand and revenue function for the same level of quantity demanded. The second section zooms in on the shaded area from the first illustration and shows the illustration with detail.

The embedded values in the text are color coded for reference to the illustration graphics. The points and the actual numerical values are explained using the economic concepts. The relationship between price and revenue is explained in the first section and the second section examines the affect of price change on revenue given elasticity.

The elasticity formula used in the second section relates to the segment of the demand function between the two enumerated points. The Laspeyers (end-point baseline using original position) formula is used in the narrative although the midpoint formula is discussed in a note at the end of the second section when it affects the results. The use of a percentage price change common to both (10%) allows ready comparison of results.

Elasticity and Revenue

Assignment Questions

1. Select two values of the slope term but, keep the intercept constant. Compare and contrast the results of the two scenarios.
2. As one slope term increases and the other scenarios slope term decreases, what generalizations can be made about the outcomes?
3. Form two scenarios keeping the slope term constant but, vary the intercept term.
4. If the value of the intercept differs substantially, what is the most obvious difference between the scenarios.
5. Why do both the intercept and the slope affect the results?

Chapter 5. Consumer Behavior

Income Restrained Utility Maximization

Purpose

This module introduces an economic theory of consumer behavior and provides illustration of key concepts with a graphical model. Three analytical constructs are used: the indifference curve, the budget constraint and the optimization process of the consumer. The model is helpful because it offers interactive graphical depictions of the optimization conditions that are algebraically derived from the theory. Utility indifference curves and budget constraints are each individually explained and analyzed along with the conditions for income restrained utility maximization.

Understanding the mechanics of consumer behavior is important because it is the underlying conceptual determinant of demand. The level of utility or satisfaction consumers attain from consumption is a conceptual measure that is essential to understand the individuals' motivations in making consumption decisions. Indifference is an important concept that is used extensively in economic analysis and is one of the analytical constructs of this chapter. The role of the budget constraint is essential since it is a "real-world" fact and is familiar to everyone. The impacts of prices and income, as parameters, provide added precision to the model.

Learning Objectives

Sets of learning objectives are specified for the income restrained utility maximization model. The objectives are enumerated for each of the three analytical components of the model:

<u>Indifference Curves</u>

The concept of indifference is a key aspect of the model. Changes in the composition of a mix of the two goods will derive the same level of satisfaction if the two points are on the same indifference curve. Changes in the level of total utility appear as shifts between indifference curves. The slope of the indifference curve changes as the quantities change, due to the shape of the function.

<u>Income Restraint</u>

The income restraint represents a "consumption possibilities curve" for a consumer. It shows how much of the two goods the consumer can buy of the two goods, given they spend all of their income and the prices and level of income are constant. Increasing the quantity of one good can only be achieved by reducing the consumption of the other.

The slope of the restraint is determined by the price ratio of the two products in the model Changes in either product price with affect the slope and the axis intercept of the good experiencing the price change. It is important to understand how changes in prices of either the good on the horizontal axis or changes in the price of the good shown on the vertical axis, as well as changes in income, affect the slope and intercept of the restraint.

Income Restrained Utility Maximization.
The graphical results of the optimization condition imply that the highest indifference curve is just tangent to the income restraint. This single point shows that combination of the two products that satisfies the behavioral objective of the consumer. It is also a point that appears on the demand function, corresponding to the product price and the quantity demanded (the quantity that maximizes utility given income and prices).

THE CONSUMER BEHAVIOR *FRONTPAGE*

The Consumer Behavior *frontpage* provides background narrative about the fundamental economic concepts behind the demand function. The behavioral premise used to explain consumer behavior is specified as income constrained utility maximization and this objective function may be used to explain demand. The module develops the analytical elements behind the concept of income constrained utility maximization on the part of the consumer.

There are three sections of this module: (i) indifference curves, (ii) income restraint and, (iii) income restrained utility maximization. Each section develops one of these analytical components of the theory of income constrained utility maximization and explores the set of economic parameters designed to illustrate and amplify the concepts.

Discussion of the Consumer Behavior

The conceptual discussion of consumer behavior relies on an economic model of consumer choice that explains the law of demand. An objective function is specified, as a behavioral premise, that a consumer will select products in the market (given prices), to maximize satisfaction, given his or her budget. This objective function may be graphically analyzed to explain how the consumer choice is made and the resulting selection of product quantities, given income and product prices.

The model of consumer behavior restricts consumer choice to two goods for simplicity. Both products have prices that are given assuming the markets are competitive and the consumer is a price-taker in each. Income (or budget) is also fixed for the relevant time period of the analysis. The graphical analysis depicts the quantity of one of the two goods on the horizontal axis and, the quantity of the other good on the vertical axis.

Consumer Behavior

There are three components of the discussion of consumer behavior. The first is the indifference curve, which reflects the level of satisfaction or utility a consumer derives from consumption. The second is the income restraint or budget which shows consumers' potential product choices are determined by the level of income or budget and, the product prices. The third is the optimization rule for income restrained utility maximization that graphically illustrates the results.

Indifference Curves

An indifference curve reflects all combinations of two goods that provide the same level of satisfaction for the consumer. As one moves along the indifference curve, the product mix changes, but the level of satisfaction is constant. The concept of indifference means simply that the level of utility is constant for certain combinations of the products.

Moving outward from the origin involves attaining higher levels of satisfaction, as indifference curves with greater utility are realized. Indifference curves do not intersect and completely cover the mix of all combinations of the products. They bow inward towards the origin and the slope of the indifference curve at a point is the ratio of the marginal utilities.

Income Restraint

The income restraint reflects the possible budget choices of the consumer given the prices of the products and the level of income. Both product prices and income are held constant along an income restraint. It is a linear function and slopes downward to the right.

The consumers' budget restraint may be expressed algebraically as:

$$\mathbf{Y = P_f * Q_f + P_c * Q_c} \qquad \mathbf{[1]}$$

Where:

Y = the fixed income or budget of the consumer
$\mathbf{P_f}$ = price of good "f" --- food
$\mathbf{Q_f}$ = quantity of good "f" --- food
$\mathbf{P_c}$ = price of good "c" --- clothing
$\mathbf{Q_c}$ = quantity of good "c" --- clothing.

Suppose that $\mathbf{Q_f}$ appears on the horizontal axis and $\mathbf{Q_c}$ on the vertical axis. The accounting identity above may be rewritten to show the income restraint is a linear function. That is:

$$\mathbf{Q_c = a - b * Q_f} \qquad \mathbf{[2]}$$

Where:

a = Y / P_c --- the intercept term on the vertical axis and,
b = P_f / P_c --- the slope term.

A change in the level of income will shift the restrain inward or outward for an increase or decrease in income, respectively. A change in one or both product prices will change the slope. For example, an increase in the price of the good on the horizontal axis will rotate the restraint inward towards the origin but, keep the same intercept term. Changing income or product prices provides a method to study demand and the law of demand is "proven" in Chapter 6 using this technique given income restrained utility maximization.

Income Restrained Utility Maximization

Utility maximization given the income restraint is depicted graphically as the point of tangency between the highest indifference curve and the income restraint. The algebraic condition derived from the optimization calculus states that the slope of the budget restraint **(-P_f / P_c)** is equal to the slope of the indifference curve **(-MU_f / MU_c).** This condition may be restated where:

$$MU_c / P_c = MU_f / P_f \qquad [3]$$

Or, the marginal utility per dollar of expenditure is constant across all goods.

The utility maximizing quantity of the two goods, given the optimization rule, results in a single combination of quantities of the two goods at the point of tangency between the highest indifference curve and restraint. These quantities are unique and the ordered pair on the graph is that point representing the likely choice of the consumer given prices and income. The model reflects the optimization results of the model of consumer behavior to explain product choice: maximizing utility (the highest indifference curve), given income (the income restraint).

Changes in the prices and income level leads to a different point of utility maximization. That is, when prices and/or income change, the consumers' product choice changes to reflect their preferences. A different utility maximizing point will be attained for any combination of product prices and income.

The Parameter Selection for Income Restrained Utility Maximization

The parameter selection for the income restrained utility maximization model is designed to allow experimentation with the parameters of the graphical model to better understand how the concepts are specified. The parameter set allows the inspection of the three components of the model: (i) indifference curves; (ii) the income restraint and; (iii) the income restrained utility maximization result. Each component offers a set of parameters that affect the graphical model and that reflects changes in important economic concepts.

In each case, the graphical model depicts the results of the indifference curves and/or the income restraint on a graph with the quantity of one good (food) appearing on the horizontal axis and, the quantity of the other good (clothing) on the vertical axis. The combination of the two functions (indifference curves and the budget constraint) provides the analysis for the income retrained utility maximization, using the same two axes. Changing the parameters provides a convenient way to depict the effects of these key variables on the graphical results of the conceptual model.

Indifference Curves

The indifference curve analysis examines the effects of changing the level of total utility. Selection may be made of the levels of total utility for two different scenarios: a baseline case and an alternative. Changing the level of satisfaction between the two cases allows an inspection of the consequences on the relative position of the two indifference curves.[1]

Income Restraint

The income restraint analysis allows the selection of three parameters from the accounting identity **[1]**. The prices of the two goods and the level of income may be changed for either the baseline case or the alternative scenario. Both product prices and income can be increased or decreased simultaneously.

Selecting changes in the product prices is helpful to understand how the restraint is affected. Prices changes affect the slope and will affect the intercept of the restraint appearing on the axis of the product experiencing the price change. Income changes are reflected as an inward or outward shift in the restraint without changing its' slope.

Income Restrained Utility Maximization.

The income restrained utility maximization condition is described mathematically in expression **[3]**, and graphically is shown as the point of tangency between the indifference curve with the highest utility and the income restraint. The parameter choices are those related to both the income restraint for the baseline and alternative scenario.

The results show the two income restrained utility maximizing points for the two scenarios where the indifference curve with the highest utility for each scenario is tangent to the income restraint for the scenario. The parameter set is identical to that of the income restraint model and the resulting utility maximizing point is depicted with the single indifference curve associated the maximized level of total utility.

[1] The total utility function that is used to derive the indifference curve is not discussed. Consequently the parameters that affect marginal utility are excluded from selection and change, to simplify the discussion.

Consumer Behavior

Analysis of two different outcomes for the behavioral model improves student understanding of how the product choice varies with income and price changes. Combinations of price and income changes can be examined together or in isolation. In each case the income restrained utility maximizing combination of product choice is depicted for the scenarios allowing contrast and comparison of the two outcomes.

THE *ACTIVE LEARNING SIMULATIONS* OF CONSUMER BEHAVIOR MODEL

The active learning simulations for the model of consumer behavior provide graphical depictions of the results of the parameter selections. The graphical simulations and parameters appear but, a text engine has not been retrofitted to the simulation model as of the date of this volumes publication. A text engine for this model is expected by the next edition.

The Parameter Set

The parameters selected appear on the *active learning simulation* page in the upper right-hand corner. The parameter values selected for both the baseline and alternative scenarios are shown.

Indifference Curves

The level of total utility for the baseline scenario (shown as $\mathbf{U_0}$) is shown along with the level of total utility for the alternative scenario (shown as $\mathbf{U_1}$). The values are expressed in theoretical units of "utils" and this measure is a cardinal index of total utility of the individual.

Income Restraint

The product prices of the two goods (food and clothing) and the income levels for the baseline and alternative scenarios are shown from the parameter selections on the *frontpage*. The price of food for the baseline scenario ($\mathbf{P_{f0}}$) appears, along with the price of clothing for the baseline ($\mathbf{P_{c0}}$) and the baseline income level selected ($\mathbf{Y_0}$). The values for these parameters for the alternative scenario are listed next ($\mathbf{P_{f1}}$, $\mathbf{P_{c1}}$, and $\mathbf{Y_1}$)

Income Restrained Utility Maximization.

The product prices of the two goods (food and clothing) and the income levels for the baseline and alternative scenarios are shown. The price of food for the baseline scenario ($\mathbf{P_{f0}}$) appears, along with the price of clothing for the baseline ($\mathbf{P_{c0}}$) and the baseline income level selected ($\mathbf{Y_0}$). The values for these parameters for the alternative scenario are listed next ($\mathbf{P_{f1}}$, $\mathbf{P_{c1}}$, and $\mathbf{Y_1}$)

The Graphical Engine

The graphical engine shows the results of the consumer behavior model using the two scenarios selected based on the parameter set gotten from the

frontpage. The two scenarios are color coded in the graphical models. The baseline scenario appears in black and the alternative scenario appears in red.

Indifference Curves

The indifference curve graph shows the indifference curves corresponding to the two different scenarios as specified by selecting different levels of utility on the *frontpage*. The baseline appears in black and the alternative in red. Higher indifference curves correspond to greater satisfaction and indifference curves closer to the origin correspond to levels of utility that are relatively lower.

Income Restraint

The income restraint graph offers a number of different outcomes based on the parameter selections. Since both product prices and incomes can be changed for either the baseline or alternative scenario, the number of distinct income restraint graphical depictions is large.[2] The baseline restraint appears in black and the alternative is red.

Income Restrained Utility Maximization.

The graphical depiction of income restrained utility maximization shows the indifference curve corresponding to the highest level of utility that is tangent to the income restraint for each scenario. The baseline indifference curve and income restraint appear in black and the alternatives are red. At each point of utility maximization the quantities of the two goods are depicted with dotted lines extending from the income restrained utility maximizing point to the horizontal and vertical axis to identify the quantities precisely.

[2] At the time of publication of this edition, the number of possible combinations is 15625.

Consumer Behavior

Assignment Questions

1. Change the price of food, holding income and the price of cloth constant. What is the affect on the slope and intercepts of the income restraint.
2. Re-arrange the income restraint algebraically to show the quantity of food on the left-hand side of the equals sign. What are the values of the intercept and slope?
3. When income increases, what happens to the slope and intercepts of the income restraint.
4. Explain the concept of indifference.
5. As satisfaction increases, this is reflected by higher indifference curves. Using the same quantity of cloth, examine the corresponding level of food associated with the two indifference curves. Explain.
6. When the price of one good changes, the model shows the utility maximizing quantity of the other good remains the same. Is this a reasonable claim?

Chapter 6. Law of Demand

Deriving the Consumers Demand Function Based on a Behavioral Assumption of Income Restrained Utility Maximization

Purpose

This module uses a model of consumer behavior to derive a downward sloping demand function. It provides a graphical demonstration of the law of demand by showing that downward sloping demand functions are derived from economic theory of consumer behavior. Utility indifference curves and budget constraints introduced in Chapter 5 are used to graphically illustrate income restrained utility maximization and product price change is demonstrated and analyzed to show the law of demand.

This lesson is an important part of the theory of consumer behavior and in the broader theory of the market mechanism. Price theory explains how producers and consumers interact to determine market outcomes. The derivation of demand based on consumer behavior provides half of the specifications of the conceptual determinants in economic theory of free markets.

Learning Objectives

The learning objectives for this module relate to understanding the model of consumer behavior. The quantity of a product demanded by a consumer, given the price appears as a point on the demand function but, is shown to arise due to a process of maximizing the utility of consuming the good(s), given the budget. A graphical model of income restrained utility maximization is used to show the quantity demanded of a product depends on the price of the product, given the prices of other goods and, income. The quantity demanded that corresponds to the income constrained utility maximizing point may be determined for any numerical value of the product price.

The effect of price change on the income restraint is especially important, since this forms the mechanical basis of the law of demand. Income constrained utility maximization obtains a unique level of quantity demanded for each price specified for the product and, each of these pairs of price and quantity demanded correspond to a point on the demand curve. The inverse relationship between price and quantity demanded is demonstrated with three prices using the model of consumer behavior based upon income constrained utility maximization. Changes in income also affect the model and the change in the quantity consumed depends upon the income elasticity of demand for the product(s).

Law of Demand

THE LAW OF DEMAND *FRONTPAGE*

The Law of Demand *frontpage* provides brief background narrative about the concepts of income restrained utility maximization and a product price change is used to derive the law of demand. A hypertext link for income constrained utility maximization refers the reader to Chapter 5 for background and review.

Discussion of the Law of Demand

This module is an extension of that presented in Chapter 5 on consumer behavior and income constrained utility maximization. The model presents consumer behavior using a two good model with fixed income and product prices. The reader may click on a hypertext link to return to the *active learning simulation* for income constrained utility maximization. The derivation of the law of demand builds directly upon this conceptual model and shows how price changes lead to changes in quantity demanded that are inversely related.

The law of demand states that price and quantity demanded are inversely related. Using the results of the income constrained utility maximization model, it can be shown that product price changes and the resulting utility maximizing quantities, conform to the law of demand. That is, beginning with one point of income constrained utility maximization, a price reduction will reduce the slope of the income constraint and rotate it around the other product intercept (the price of the other product does not change). The resulting new point of income constrained utility maximization will lead to a change (increase) in the quantity of the good experiencing a price change (reduction). This demonstrates the law of demand.

A hypertext link in the law of demand *frontpage* brings the reader to the law of demand derivation page containing some additional narrative and the parameter set. The law of demand derivation page is designed to allow the reader to pick three prices for one of the products (food) in the model of income constrained utility maximization. The three prices selected represent three points on the demand function for which corresponding utility maximizing quantities will be shown using the algorithm of consumer behavior from Chapter 5 (income constrained utility maximization).

The Law of Demand Parameter Selection

Three product prices for food may be selected. From Chapter 5, the result of a price change is graphically depicted as a rotation in the income restraint (assuming the price of the other good and income remain constant). As the product price changes, the *active learning simulation* shows the resulting utility maximizing quantities corresponding to each product price.

Select three different prices to illustrate the effects of price changes on quantity demanded. For each price selected, the utility maximizing quantity of the good

(food) will be shown using the model of income constrained utility maximization. The resulting quantity demanded for each price will conform to the law of demand.

THE *ACTIVE LEARNING SIMULATIONS* OF THE LAW OF DEMAND

The *active learning simulations* of the law of demand are designed to show how price changes and changes in quantity demanded are inversely related. The model of consumer behavior in Chapter 5 showed how the maximization of utility subject to an income restraint yielded the quantities a consumer will demand, given product prices and income. The law of demand uses this model and shows that a change in product price induces a change in the quantity demanded (associated with the income constrained utility maximizing combination of quantities) that would vary inversely with the price change.

The Parameter Set

The parameter set selected for the *active learning simulation* appears in the upper right hand side of the page. The three prices of food are shown as $\mathbf{P_{f0}}$, $\mathbf{P_{f1}}$ and, $\mathbf{P_{f2}}$**.** The values selected from the parameter choice on the law of demand *frontpage* are restated.

The Graphical Engine

The graphical depiction of the law of demand demonstration appears on the left-hand side of the *active learning simulation* page. The graphical illustration has two graphs that appear and share the same horizontal axis (quantity of food). The graph on the top of the illustration is the indifference curve analysis explained in Chapter 5 and includes the income restraint and shows the utility maximizing point for each price selected from the *frontpage.* The graph on the lower part of the illustration is the demand function arising from the analysis.

The lower graph of the demand function shows product price ($\mathbf{P_f}$, or price of food), and each of the three food prices selected from the *frontpage* are shown. Corresponding to each of these prices (shown on the vertical axis of the demand function) is the income restrained utility maximizing quantity (shown on the horizontal axis), found from the indifference curve analysis in the top graph of the diagram. Since the top and bottom graphs share the same horizontal axis, the comparison of the quantities can be made directly by drawing a vertical line directly between the two horizontal axes of the top and bottom graphs in the diagram.

The utility maximizing points from the constrained indifference curve analysis in the top diagram and the associated pairs of quantity and price in the demand function depiction in the lower diagram are color-coded. The baseline price ($\mathbf{P_{f0}}$) appears in black, the alternative price ($\mathbf{P_{f1}}$) appears in red and, the other price ($\mathbf{P_{f2}}$) appears in blue. Prices are parameters that affect the slope of the income

restraint in the top diagram but, appear as a variable on the vertical axis in the bottom diagram showing the demand functions.

Law of Demand

Assignment Questions

1. Choose three prices that are nearly the same and compare the results to those when the three prices are divergent. Does the law of demand depend upon the values selected?
2. If income changes, does the law of demand still hold?
3. Why does the slope of the income restraint change as the price of food changes?

Chapter 7. Simple Macro Model

A Simple Keynesian MacroEconomic Model

Purpose
This module explains some important graphical results from a simple Keynesian model of the macroeconomy. It introduces and illustrates the concept of macroeconomic equilibrium using two different expressions for GDP, one measured in terms of income and, the other measured in terms of expenditure. It uses a diagram that includes a 45-degree line to denote the attainment of equilibrium or equivalence between the two measures of GDP. National income accounting identities are used to explain the role of subsidiary macroeconomic and fiscal policy variables.

This model provides an introductory view of the macroeconomy. It is a summarization of the product markets and shows how income and expenditure are related. Income is an empirical proxy for the level of production in the goods market and expenditure is a proxy for sales in the goods market. The relationship between sales and production explains inventory adjustment and there-by provides the conceptual basis of the disequilibrium adjustment mechanism.

Learning Objectives
The concept of equilibrium in the macro economy may be visualized to involve a relationship between income and expenditure that reflects the national income accounting identities and is graphically depicted as the point where the aggregate expenditure function crosses the 45-degree line in the model. The disequilibrium adjustment process ensures that if the economy is out of equilibrium, it will have a tendency to return to it via the inventory adjustment behavior of businesses.

Fiscal policy instruments have a significant effect on the macroeconomy and there is an array of policy instruments available. Impacts of changes in policy will affect autonomous expenditure (**AEXP)**, the intercept term in the aggregate expenditure (**AE**) equation. The effects of changes in autonomous expenditure are determined by the income expansion equation and the multiplier[1]. Finally, alternative fiscal policy scenarios may be compared and contrasted to evaluate their effectiveness or to reflect differing political preferences in attaining macro policy goals.

[1] See the model below for explanation of these terms.

Simple Macro Model

THE MACRO MODEL *FRONTPAGE*

The macro model *frontpage* provides background narrative about the concepts of macroeconomic equilibrium. A hypertext link is used to explain the goods market. National income accounting identities are used to sum up the components of aggregate expenditure for the analysis of equilibrium in the model and one components of aggregate expenditure (consumption) is specified to depend upon income. A set of fiscal policy parameters may be selected for a baseline scenario and an alternative scenario may also be selected.

Discussion of the Macro Model

The functional relationship between aggregate expenditure (**AE**) and income (**Y**) forms the basis of the macro model of the goods market. National income may be measured using either expenditures or income and the graphical model depicts this duality. That is, the basic graphical format shows income (Y) on the horizontal axis and aggregate expenditure on the vertical axis.

A national income accounting identity is used to explain how components of aggregate expenditure are summed to measure GDP, based on the expenditure approach. Economic theory specifies a functional relationship between consumption (one of the most important and largest expenditure components) and the level of income. Consumption is thought to be a linear function of income while investment (another component of expenditure) is autonomous.

A discussion of the goods market appears in a hypertext link on the macro model *frontpage.* This discussion of the algebra of the macro model is important since is explains both the national income accounting identities being used and the functional specifications that link income and expenditure for certain components of expenditure (like consumption[2] and investment).

Important Algebraic Specifications of the Graphical Model

The algebraic expressions and national income accounting identities provide the mathematical results that allow graphical inspection of the relationship between income and expenditure, using the concept of equilibrium. The equilibrium condition is that income equals expenditure and this provides a convenient benchmark to study how the model responds to changes in the macro economy. The parameters that are used in the model are linked to important fiscal policy instruments or are specified directly for inspection of their effects on the results.

The macro model is defined using linear functions. This specification is simple and provides two mathematical parameters for specifying the effects of policy and/or other macro economic changes: the intercept and the slope. The expressions from the algebraic specifications provide the functions for the graphical depictions: aggregate expenditure appears on the left-hand side of the

[2] The consumption function is described in detail and an active learning module for study of the consumption function appears in Chapter 13 of the Net-Text.

equal sign in the expression and the components of aggregate expenditure appear on the right-hand side of the equal-sign (some of which are functions of income).

The result is a linear expression for aggregate expenditure that includes two parameters: an intercept term, entitled autonomous expenditure (**AEXP**), and the slope term, the marginal propensity to consumer (**MPC**); and the level of income (**Y**) multiplied by the slope term. This expression is:

AE = AEXP + MPC*Y

The autonomous expenditure (**AEXP**) term is composed of a number of subsidiary elements as explained in the goods market hypertext narrative. These components include the fiscal policy parameters and the other macro economic parameters used in the model that may be selected and changed on the *frontpage*. Thus, changing the **MPC** affects the slope the **AE** function, while changing any other parameter affects the intercept.

The Macro Model Parameter Selection

Parameter selections for the macro model include the **MPC**, some macroeconomic behavioral parameters (like autonomous consumption and investment) and a set of fiscal policy instruments (such as capitation taxes and government spending). A baseline scenario may be specified using the parameter set given by default or changes may be made in it. Selecting changes in the levels of the aforementioned parameters can also identify an alternative scenario.

Autonomous Consumption (**C_a**)

The autonomous consumption parameter (**C_a**) is the intercept of the consumption function on the vertical axis, when the independent (right-hand side) variable is disposable income. That is, it represents that level of consumption that would be attained if disposable income were zero. This parameter would never be observed since it is virtually impossible that the total level of income in the economy would ever be zero. However, it is an empirical question and econometric estimation techniques would provide estimates of the likelihood that this parameter is zero (or some other value) along with the level of statistical significance.

The Marginal Propensity to Consume (**MPC**)

The marginal propensity to consume is the slope of the consumption function with either disposable income or income[3] as the independent (right-hand side) variable. The slope or steepness of the consumption function will be directly reflected in the slope or steepness of the aggregate expenditure (**AE**) function.

[3] If income is the independent variable in the consumption function, taxes must be capitation taxes and not income taxes.

The marginal propensity to consume measures that percentage of additional income that is consumed (**MPC = ΔC / ΔY**).

Government Expenditures (**G**)
Government expenditures (**G**) are included as a parameter in the macro model to allow for fiscal policy changes. Government expenditures may be increased or decreased in response to fiscal policy objectives or political preferences. Changes in government expenditures affect autonomous expenditures (**AEXP**) and this parameter is treated as the intercept term of the linear aggregate expenditure (**AE**) function, where income is on the horizontal axis and aggregate expenditure appears on the vertical axis (equilibrium income is where the **AE** function crosses the 45 degree line).

Capitation Taxes (**T**)
Capitation taxes (**T**) are included to provide another fiscal policy variable. Capitation taxes do not depend on income and are fixed as a parameter for a given scenario. Changes in capitation taxes affect the level of autonomous expenditure where the change in autonomous expenditure is equal to minus the change in taxes multiplied by the **MPC (ΔAEXP= – MPC * ΔT**).

Investment (**I**)
Investment is treated as an exogenous variable in the macro model. Investment is thought to depend on the interest rate gotten from the money market (see Chapter 10 in the Net-Text) but, it does not depend on the level of income. Hence investment is treated as being autonomous (**$I=I_a$**).

THE *ACTIVE LEARNING SIMULATIONS* OF SIMPLE MACRO MODEL

The *active learning simulation* of the simple macro model allows inspection of the aggregate expenditure (**AE**) function for the baseline and alternative scenario and the resulting equilibrium level of income (**Y**). The simulations are depicted using the parameter selection representing the fiscal policy instruments and assumptions about the macroeconomy. The graphical simulation allows visual inspection of the results.

The Parameter Set
The assumptions about the macroeconomy and the fiscal policy parameters are shown in a table in the upper right hand corner of the *active learning simulation* page. The baseline parameters are color-coded to appear in black whilst the alternative scenario appears in red. The left-most column of the table shows the macroeconomic or fiscal policy parameter and the next two columns show the baseline and alternative scenario values. The right-most column in the parameter table shows the change in the parameter between the two scenarios.[4]

[4] The level of capitation taxes is fixed in the alternative scenario.

Simple Macro Model

The Graphical Engine

The graphics engine provides a depiction of the simple Keynesian macro model by showing the relationship between aggregate expenditure (**AE**) and income (**Y**) using a set of national income accounting identities and some behavioral specifications for components of aggregate expenditure (like the consumption function and investment). The **AE** function appears as an upward sloping function where income is shown on the horizontal axis and aggregate expenditure on the vertical axis.

The **AE** function is specified as being linear and the parameters of the simple macro model affect either the intercept or slope of the function. The slope is determined by the marginal propensity to consume (**MPC**) and the rest of the macroeconomic and fiscal policy parameters affect the intercept term of the **AE** function (entitled autonomous expenditure --- **AEXP**). The net affect of changes in parameters on **AEXP** appears in the bottom row of the rightmost column in the parameter table.

The equilibrium condition is where aggregate expenditure equals income (**Y=AE**), shown of the graph where the **AE** function crosses the 45-degree line (the green dashed line). The affects of changing **AEXP** are governed by the income expansion equation:

$$\Delta Ye = MULTI * \Delta AEXP$$

and

$$MULTI = 1 / (1-MPC)$$

The net change in **AEXP (ΔAEXP)** appears in the bottom row of the right-most column in the parameter table.

The Text Engine

The simulation graphics are explained with the text engine. The narrative first explains the equilibrium condition for the baseline and alternative scenarios and the labels on the graph. The empirical simulation results are embedded in the narrative and are color coded to help make associations with the graphical model.

Narrative is also provided to explain how the graphical simulation results are attained. The change in income between the two equilibrium positions is derived using the national income expansion equation and the net change in autonomous expenditure (**AEXP**) based on the parameter selection. The net change in **AEXP (ΔAEXP**) appears in the bottom row of the right-most column in the parameter table. The equation appears using the variables and parameters in general form

and it is then “filled-in” with the empirical values from the scenarios and solved to explain the results.[5]

[5] It is recommended that both scenarios use the same value of the MPC, otherwise the income expansion equation does not hold.

Simple Macro Model

Assignment Questions

1. Change the MPC to create two scenarios. Compare and contrast the results. Why does the level of equilibrium income change?
2. Formulate an alternative scenario that includes an increase in autonomous consumption and a decline change in investment. Explain the change in autonomous expenditure and predict the change in equilibrium income arising from the new scenario.
3. Increase government spending and offset the increase will a decline in investment of the same magnitude. What is the effect?
4. As the MPC increases, what happens to the multiplier? Why does this occur and what does it imply for the macro-model?

Chapter 8. Consumption Function

Consumption Expenditures as a Function of Income

Purpose
This module examines the consumption function that mathematically explains the level of consumption expenditures in macroeconomics. It expands on the conceptual framework of the simple macro model from Chapter 7 and examines the consumption and savings functions. The relationship between consumption and savings at a given level of income is explained and graphically depicted. A linear consumption function is used and two parameters may be selected for the simulations representing autonomous consumption and the marginal propensity to consume.

This topic is important for the study of macroeconomics because consumption expenditures comprise a significant share of total expenditures as measured by GDP. The mass-consumption economy is a modern engine of prosperity unparalleled in history. Understanding the determinants of consumption using the consumption function reflects a behavioral assumption about individual consumers' expenditure patterns. This function provides an essential algebraic component of macroeconomic analysis and forms a crucial link between income and expenditure providing important results for the mathematical solutions in the macro models of equilibrium.

Learning Objectives
The learning objectives for the consumption and saving function model are designed to better understanding of the role of autonomous consumption (**C_a**) and the marginal propensity to consume (**MPC**). The relationship between savings and consumption at a given level of income is also important and stems from the national income identity (**Y=C+S**). In the graphical model, the use of the 45-degree line provides a visual benchmark for determining when savings are zero.

THE CONSUMPTION FUNCTION *FRONTPAGE*

The consumption function *frontpage* provides background narrative about the algebraic relationships and functional specifications used for linear consumption and savings functions. The model illustrates that consumption and savings are related at a given level of income. Linear consumption functions specify the use of two parameters, the slope and the intercept. These parameters are defined as the marginal propensity to consume (**MPC**) and autonomous consumption (**C_a**),

respectively. Each of these parameters may be selected with a click to examine their impacts on the savings and consumption functions.

Discussion of the Model of Consumption Function

The simple macro model of the goods market in Chapter 7 and the macro equilibrium model in Chapter 9 include specifications of the consumption function. A behavioral assumption is made that a functional relationship can be specified between consumption expenditures and the level of income. [1] The consumption function is expresses consumption expenditures as a function of income (**Y**) and the mathematical link between income and expenditures is a key algebraic feature in the aforementioned models.

A linear version of the consumption function is used to provide two parameters to examine the determination of the appearance of the consumption and saving functions in greater detail. The intercept term is defined as autonomous consumption ($\mathbf{C_a}$) and represents the minimal level of consumption attained if income is zero. The slope term is defined as the marginal propensity to consume (**MPC = ΔC / ΔY**) and measures the incremental change in consumption due to a change in income. Taxes are assumed to be zero and hence income and disposable income are equal.

The savings function is derived from the consumption function using the national income identity that income may be saved or consumed (**Y=C+S**). Using the linear specification of the consumption function and substituting for **C** on the right hand-side of the identity, an expanded expression is obtained that contains **Y**, $\mathbf{C_a}$**, MPC** and **S**. Re-arranging terms and putting **S** on the left hand-side of the equals sign yields the savings function. The savings function is shown to be linear with an intercept equal to $\mathbf{-C_a}$ and a slope equal to **1-MPC**.

The Consumption Function Parameter Selection

The parameter selection for the consumption function model allows the student to change the intercept ($\mathbf{C_a}$) and the slope (**MPC**). The autonomous consumption term and the marginal propensity to consume appear as parameters in the simple macro model in Chapter 7 and the macro equilibrium model of Chapter 9 and are important determinants affecting the solution of these models of the macroeconomy. The autonomous consumption term ($\mathbf{C_a}$) appears in the expression for autonomous expenditure (**AEXP=Ca+I+G-MPC*T**) in these macro models and, the marginal propensity to consume (**MPC**) affects the impact of taxes changes on autonomous expenditure, as well as the slope of the aggregate expenditure (**AE**) function.

[1] Empirical evidence about the consumption function is extensive and supports the theoretical claims about a reliable relationship between these two variables. The evidence about the mathematical form is less certain and while a linear form (used here) has often been examined, other specifications have been used and some may be statistically superior to the linear version. The linear version is used for simplicity.

Consumption Function

The autonomous consumption (**C_a**) parameter is the intercept of the consumption function on the vertical axis of the graphical model, where income appears on the horizontal axis and consumption is shown on the vertical axis. The autonomous consumption term also affects the intercept of the savings function. The intercept of the savings function is **$-C_a$**.

The marginal propensity to consume (**MPC**) is the slope of the consumption function. It measures the change in consumption (**ΔC**) associated with some change in income (**ΔY**) or, the percentage of each additional dollar of income that is spent on consumption. The **MPC** also determines the slope of the savings function since the marginal propensity to save, the slope of the savings function (**MPS=ΔS/ΔY**), is equal to **1-MPC**.

THE *ACTIVE LEARNING SIMULATIONS* OF CONSUMPTION FUNCTION MODEL

The *active learning simulation* of the consumption function model examines the relationship between consumption, savings and income. Consumption and savings are related and the model provides the means to better understand the relationship between them. An important visual aid in the graphical simulations is the 45-degree, depicting the points where income (appearing on the horizontal axis) and consumption (shown on the vertical axis) are equal.

A national income accounting identity specifies that income can be consumed or saved, meaning **Y=C+S** (taxes are assumed zero for simplicity). In addition, consumption expenditures are expressed as a linear function of income. Using these specifications as a premise, the savings function is found algebraically as explained on the *frontpage*. Both the slope and intercept of the savings and consumption functions are related. Namely the intercept of the savings function is the negative of autonomous consumption (**$-C_a$**) and, the slope of the savings function (**MPS**) is equal to one minus the slope of the consumption function (**MPS=1-MPC**)

The Parameter Set

The parameter values of autonomous consumption (**C_a**) and the marginal propensity to consume (**MPC**) selected from the *frontpage* appear in the upper right-hand portion of the *active learning simulation.* In addition, the intercept of the savings function and the slope of the savings function also appear. The intercept of the savings function is **$-C_a$** and the slope of the savings function, defined as the marginal propensity to save (**MPS=ΔS/ΔY**), is equal to **1-MPC**.

The Graphical Engine

A graphical illustration of the consumption and savings functions is shown on the left hand-side of the *active learning simulation.* The illustration shows the consumption function in the top graph and the savings function in to bottom

graph. Both graphs share the same horizontal axis: the level of income (**Y**), to allow easy reference between the two graphs.

In the top graph of the illustration, the consumption function appears as an upward sloping blue line. Income (**Y**) is shown on the horizontal axis and consumption (**C**) on the vertical axis. The 45-degree line (where consumption equals income) is a green dashed line. At the point where the consumption function intersects the 45-degree line, savings are zero. This result occurs since **Y=C+S** and, if **Y=C** (the point of intersection of the consumption function and the 45-degree line), then **S** must be zero.

In the bottom graph of the diagram, the savings function is shown. Savings appear on the vertical axis and income on the horizontal axis. The savings function is linear, upward sloping (**MPS=1-MPC>1**) and has a negative intercept (**$-C_a$**). The national income accounting identity always holds and at any level of income **Y=C+S**

The Text Engine

The textual narrative for the *active learning simulation* of the consumption function describes three points on the savings and consumption function, using the income level that is common to both functions. The three points are labeled points 'A', 'B' and, 'C' on the consumption function and, 'AA', 'BB' and 'CC' on the savings function. The relationship between consumption and saving is determined by the identity and depends on the **MPC** and **C_a**.

Point 'A' (and 'AA') is at an income level where **C>Y** (savings are negative), point 'B' (and 'BB') is where **Y>C** (savings are positive) and, point 'D' (and 'DD') is where **C=Y** (savings are zero).

The first point, Point 'A' is at an income level where **C>Y**. At this point, savings are negative since, by inspection the consumption function is above the 45-degree line. At the income level shown at point 'A', drawing a horizontal line from the 45-degree line would show that level of income on the vertical axis (for comparison to consumption). Since the actual level of consumption at point 'A' is above this level of income, consumption exceeds income and, there must be dis-savings (**S<0** or the consumer is borrowing). This appears as point 'AA' on the savings function.

Point 'B' (and 'BB') is at an income level where **C<Y**. At this point, savings are positive since, by inspection the consumption function is below the 45-degree line. At the income level shown at point 'B', drawing a horizontal line from the 45-degree line would show that level of income on the vertical axis (for comparison to consumption). Since the actual level of consumption at point 'B' is below this level of income, consumption is less than income and, savings are positive (**S>0**), shown as point 'BB' on the savings function.

Consumption Function

At point ‘D’, the consumption function crosses the green dashed 45-degree line. This point of intersection is coincident with the point on the consumption function where consumption equals income (**C=Y**). Given the national income accounting identity (**Y=C+S**) always holds, savings are zero (**S=0**).

Consumption Function

Assignment Questions

1. Run the model twice. Start with some value of the MPC and then run it again with a lower value for the MPC. What happens to the consumption and savings functions and why?
2. Using the scenarios from question 1, at the point where savings is zero what is the level of income? Why does it change between the two.
3. Repeat the same exercise with two values of autonomous consumption.
4. What claims can be made about the value of autonomous consumption… could it be zero?

Chapter 9. Macro Equilibrium

Primary and Subsidiary Equilibrium Conditions in the Goods Market

Purpose
This module examines two equilibrium conditions in the goods (or product) market. It expands on the conceptual framework of the simple macro model from Chapter 7 and explains the macroeconomy using the Keynesian model with greater detail. A larger set of parameters is offered than in the simple macro model and more analysis is provided.

The topic is important because it provides a framework to better understand the adjustment process when the economy is out of equilibrium. The subsidiary equilibrium condition specifies equilibrium as the equivalence of expenditure leakages and expenditure injections. Equivalence of sales and production was shown in Chapter 7 to define the primary equilibrium condition that aggregate expenditure (**AE**) equals income (**Y**) and the subsidiary condition expands and amplifies the analytical measurement and meaning of the concept. It forms the foundations for the conceptual framework of the product market in the ISLM model from Chapter 11

Learning Objectives
The graphical interpretation of the subsidiary equilibrium condition that expenditure injections equal expenditure leakages is an important restatement of the primary equilibrium condition. It provides a better explanation of disequilibrium adjustments in the goods market. Graphical depictions of expenditure leakage and expenditure injection functions within the subsidiary condition are shown relative to the level of income and the primary condition. As with the simple macro model in Chapter 7, it is essential to understand the application and use of expression for changes in autonomous expenditure (**ΔAEXP**) and the application and use of the national income expansion equation (**ΔY_e =MULTI* ΔAEXP)**.

THE MACRO EQUILIBRIUM *FRONTPAGE*

The macro equilibrium *frontpage* provides background narrative about the algebraic relationships and functional specifications used in the Keynesian macro model. The model uses two equilibrium conditions and an algebraic derivation is provided to explain how the conditions are related and derived. A ‘global’ equilibrium condition is specified that income equals expenditure and a

subsidiary equilibrium condition is derived that expenditure leakages equal expenditure injections.

A set of macro parameters and fiscal policy instruments may be selected with a click to examine their impacts on the results of the model. All of the parameters from the simple macro model in Chapter 7 are included and two scenarios may be specified to compare and contrast policy prescriptions and to evaluate impacts of changes in the macroeconomy.

Discussion of the Model of Macro Equilibrium

The model of macro equilibrium depicts the simultaneous results using two equilibrium conditions derived from the specifications of the macroeconomy and the national income accounting identities. The algebraic derivation of these results is shown and explained with hypertext links provided to the simple macro model in Chapter 7 and to the model of the consumption function in Chapter 8. Definitions are also given for the meaning of expenditure injections and expenditure leakages and these important variables are developed in the conceptual framework.

The original equilibrium condition explained in the simple macro model shows that the economy moves to a state where income (**Y**) equals expenditure (**AE**) and, has a tendency to remain at this level of income once it has been attained. This 'global' equilibrium condition (**Y=AE**) provides the starting point for deriving the subsidiary equilibrium condition that expenditure injections equal expenditure leakages. Expenditure injections are defined as the sum of investments (**I**) plus government expenditures (**G**) while, expenditure leakages include savings (**S**) plus taxes (**T**). Taxes are assumed to be capitation taxes (for simplicity) and there is a trade balance (imports equal exports or assume there is no foreign sector). Another view of the importance of this condition relative to the goods market and the macroeconomy as a whole may be seen using the circular flow diagram.

Starting with the original equilibrium condition and using some national income accounting identities for **Y** and **AE**, the equilibrium condition may be expanded on the right-hand and left-hand sides of the equals sign by substituting the right-hand side of each identity. The resulting expression may then be simplified by subtracting **C** from both sides of the equals sign. Include the assumption that exports equal imports. What remains after these algebraic steps is the subsidiary equilibrium condition (**S+T=I+G**).

The *active learning simulation* of the macro equilibrium model shows how expenditure injections and expenditure leakages are related within the equilibrium concept and to the macroeconomy. The subsidiary equilibrium condition is important because it provides an understanding of the inventory adjustment process that ensures the macroeconomy returns to equilibrium if it is perturbed from it. The inventory adjustment (realized vs. planned investment) is

the pivotal process that creates changes in income that move the economy toward equilibrium income.

The Macro Equilibrium Parameter Selection
A full set of macroeconomic and fiscal policy parameters are provided to specify both a baseline and alternative scenario. The macroeconomic parameters include: those from the consumption function, the marginal propensity to consume (**MPC**) and autonomous consumption ($\mathbf{C_a}$), as well as; investment (**I**). Fiscal policy parameters include government expenditures (**G**) and capitation taxes (**T**).

The parameter selections allow both the baseline and the alternative scenarios to reflect a wide range of macroeconomic conditions. Government spending in the alternative scenario is expressed in terms of the change in expenditure relative to the baseline. All other parameters are expressed as discrete values.

Scenario definition using the parameter set is designed to explore the impacts of changes of fiscal policy parameters, given the other macroeconomic parameters. The role of the subsidiary equilibrium condition is important and provides a benchmark to compare and contrast scenarios. Also, attention should be given to the role of changes autonomous expenditures (**ΔAEXP**), since this term is the primary right-hand side term in the income expansion equation.

THE *ACTIVE LEARNING SIMULATIONS* OF THE MACRO EQUILIBRIUM MODEL

The *active learning simulations* of the macro equilibrium model provide detailed graphical depictions and include more information about the macroeconomic adjustments, compared to the simple macro model in Chapter 7. Greater emphasis is placed on explaining the role of the subsidiary equilibrium condition and the importance of the income expansion equation. The graphical model shows both the primary and subsidiary equilibrium conditions and the text engine explains the adjustments using embedded numerical values in the narrative describing the solutions using the equations.

The income expansion equation and the impact of autonomous expenditures (**AEXP**) are explained in detail with narrative and embedded solution values from the graphical illustrations. Changes in equilibrium income are analyzed using the income expansion equation and the terms of the equation are shown with numerical values filled-in from the parameter set selected on the *frontpage.* Graphical illustrations provide simultaneous depiction of both equilibrium conditions with important points that are color coded to match the text. The algebraic results and the quantitative methods are emphasized to improve understanding of their use in the model.

Macro Equilibrium

The Parameter Set

The parameter selection from the *frontpage* of the macro equilibrium model appears in a table in the upper right-hand portion of the *active learning simulation.* The parameter selections are restated and color-coded to reference the baseline scenario in black and the alternative scenario in red. The expression for autonomous expenditure (**AEXP**) is calculated and displayed in the last row in the rightmost column of the table.

The table displaying the parameter selection for the baseline and alternative scenario has five columns. The first column identifies the parameter shown in each row and, the second and third columns display the parameter selections for the baseline and alternative scenarios. The fourth column shows the change in the parameters between the scenarios, while the fifth column shown the change in autonomous expenditure associated with the change in capitation taxes along with the total change in autonomous expenditure.

The row associated with the tax selected for each scenario uses the last two columns to display data about changes in taxes. The fourth column is the total change in taxes between the two scenarios (**ΔT**) and the fifth (rightmost) column shows the net change in autonomous expenditure (**ΔAEXP**) calculated from the change in taxes in the fourth column. Since the affect of a change in taxes does not affect autonomous expenditure (**AEXP**) directly, the change in autonomous expenditure (**ΔAEXP**) associated with the tax change is shown in column 5[1]. That is, the change in taxes (**ΔT**) appears in column 4 and the change in autonomous expenditure (**ΔAEXP**) associated with the change in taxes is shown in column 5.

The total change in autonomous expenditure (**ΔAEXP**) is the sum of the values in column 4 for each of the parameters, excluding the **MPC** and **T**, plus the change in autonomous expenditure associated with the change in taxes shown in column 5. That is,

$$\Delta AEXP = \Delta C_a + \Delta I + \Delta G - MPC * \Delta T$$

Where:
- ΔC_a = the change in autonomous consumption,
- ΔI = the change in investment,
- ΔG = the change in government expenditure and,
- $-MPC * \Delta T$ = the change in autonomous expenditure associated with the change in taxes

The Graphical Engine

The graphical illustration for the *active learning simulation* of the macro equilibrium model appears on the left hand-side of the page. The illustration shows the 'global' equilibrium condition (**Y=AE**) in the upper graph and, the subsidiary equilibrium condition (expenditure injections equal expenditure

[1] The change in autonomous expenditure (**ΔAEXP**) associated with the tax change may be defined as autonomous tax expenditure (**TE**) and is defined as: **TE = - MPC * Δ T**

leakages) in the lower diagram. Each graph is color-coded and shares the same horizontal axes, the level of income (**Y**).

In the upper graph of the diagram, the autonomous expenditure function for each scenario is shown. The **AE** function for the baseline scenario is in black and the alternative **AE** function is red. The 45-degree line is appears as a dashed green line and indicates where income equals expenditure (the 'global' equilibrium condition). At the point where the **AE** function intersects the green 45-degree line, the two equilibrium points are labeled as point 'B' for the baseline scenario and, point 'A' for the alternative. Horizontal and vertical dotted lines are used to show the exact numerical values attained at the solution in the graph.

The lower diagram shows the expenditure injection function in black and the expenditure leakages function in yellow. The baseline scenario shows these two functions using a solid line, whereas the alternative scenario depicts the expenditure injection function as a dashed black line and the expenditure leakage function as a dashed yellow line. Subsidiary equilibrium is attained where the expenditure injection function intersects the expenditure leakage function for the same scenario and is labeled as point 'A' for the alternative scenario and, point 'B' for the baseline scenario.

The Text Engine

The textual narrative in the *active learning simulation* of the macro equilibrium model describes the graphical results and explains the change in equilibrium income using the income expansion equation. The 'global' equilibrium condition is described first and then, the subsidiary condition is discussed. Special attention is given to the utilization of the income expansion equation.

The results from the 'global' equilibrium condition (**Y=AE**) shown in the top graph of the diagram are explained in the first two paragraphs. The use of the 45-degree line is described with embedded solution values in the text to amplify and focus attention on the points in the graphical illustration. Then, in the second paragraph, the change in equilibrium income is examined using the income expansion equation and the change in autonomous expenditure shown in the parameter table. Solution values are color coded and embedded in the text.

The subsidiary equilibrium condition shown in the bottom graph of the diagram is explained in the third, fourth and fifth paragraphs. An explanation of the graphical results appears along with narrative describing the expenditure injection and expenditure leakage functions. The color coding of each function is explained along with the use of solid (baseline scenario) and dashed (alternative scenario) lines and, the equilibrium points are labeled point 'BB' for the baseline and 'AA' for the alternative.

The last paragraphs explain the details of the subsidiary equilibrium conditions, given the changes specified in the two scenarios, based on the parameter

selections. A discussion is provided about the level of income associated with the subsidiary equilibrium condition and the numerical results. The bottom and top graphs of the diagram share the same horizontal axis (**Y**) to allow contrast and comparison of the scenarios and conditions

Macro Equilibrium

Assignment Questions

1. Formulate a baseline and alternative scenario using a change in government spending. Calculate the multiplier and the change in equilibrium income.
2. Formulate a baseline and alternative scenario using a change in taxes. Calculate the multiplier and the change in equilibrium income.
3. Let one scenario reflect a balanced budget (**G=T**). In the alternative scenario, let a deficit occur. What is the impact on equilibrium income?.
4. Let one scenario reflect a balanced budget (**G=T**). In the alternative scenario, let a surplus occur. What is the impact on equilibrium income?
5. If a surplus or deficit occurs, will there be financing effects on the money markets?

Chapter 10. The Money Market

The Supply and Demand for Money

Purpose
This module examines a macroeconomic specification for the money market as the determinant of the interest rate. It forms the conceptual foundations for the money market in the ISLM model from Chapter 11 and also helps to explain the financing effects of fiscal deficits analyzed in the simple macro model of Chapter 7 and the macro equilibrium model of Chapter 9. The demand for money is explained using the speculative and transactions motives and, the supply of money is specified as being determined by the Federal Reserve Bank (Fed) maintaining a stock target. A set of parameters may be selected for the simulations representing economic aspects of both speculative and transactions demand and, the monetary stock.

Learning Objectives
The learning objectives of the money market model identify some key aspects of the macroeconomic concepts. Interest rate determination is specified as the outcome of the interaction of the total demand for money and the supply of money.[1] The demand for money includes both the transactions demand ($\mathbf{L_t}$) and speculative demand ($\mathbf{L_s}$) motives. The supply of money ($\mathbf{M_s}$) is treated as a constant for a simulation. This assumes it is invariant with respect to the interest rate and the level of income for a simulation. The money supply is a policy parameter determined by the Federal Reserve Bank.

Algebraic specification for money market equilibrium is important ($\mathbf{M_s=M_d=L_t+L_s}$) and the equilibrium condition is shown in the graphical model as the intersection of the supply of money function and the total demand for money function. Details for the mathematical specification of the speculative demand function and the transactions demand function are suitable only for advanced classes.

Graphical properties for each separate function in the model should be understood along with depiction of the market supply and demand. It is essential to understand how the parameters shift each of the demand functions and total demand, as well as how they affect the market equilibrium. Lastly, the impact of changes in the money supply on the market equilibrium is also important.

[1] The equilibrium interest rate in the money market model is probably best defined as the short-term interest rate. In the macro models of the goods market and in the product market side of the ISLM model, investment is responsive to the long-term interest rate.

Money Market

THE MONEY MARKET FUNCTION *FRONTPAGE*

The money market *frontpage* provides background narrative about the mathematical specifications used for functions of the speculative and transactions demand for money. The model offers comparisons and contrasts of two market scenarios in the determination of the equilibrium interest rate or, the determinants of the supply of money or the demand for money. Either supply and/or demand may be changed by varying a set of parameters for each side of the market.

Discussion of the Model of the Money Market

The interactions of the supply of and the demand for money comprise the money market. Money demand is specified to include two behavioral objectives for transactions purposes and for speculative purposes. The money supply is determined by the Fed and is maintained at some specified target stock with open market operations.

The first component of the demand for money is the transactions demand ($\mathbf{L_t}$) specified to depend upon the level of income and two parameters from the equation of exchange. Transactions balances are needed to provide liquidity for purchases and as income rises, transactions balances rise also. The transactions demand for money is expressed in the equation of exchange, as being a linear function of the level of income, with no intercept and having a slope equal to the velocity of money divided by the price level. The level of income is defined as real (price adjusted) income. Transactions demand alone may be selected in the simulation view to better understand the affect of the velocity of money and the price level.

Speculative demand for money ($\mathbf{L_s}$) provides the second component as it is inversely related to the interest rate. This reflects the opportunity cost of holding cash as the interest rate rises. Speculative demand may be selected as the simulation view to inspect the effects of changing the interest elasticity of speculative demand for money.

The total demand for money ($\mathbf{M_d}$) is the summation of the transactions and the speculative components of money demand. The total demand for money may be seen in the money market simulation view and the effects of changes in any of the parameters may be seen (real income, price level, velocity, interest elasticity of speculative money demand).

The supply of money ($\mathbf{M_s}$) is constant during the simulation. It is invariant with respect to the interest rate and the real income level. This assumes the monetary stock is set by the Fed and maintained with open market operations at the target. Changing the money supply is reflected in the selection of a different scenario.

Money Market

The Money Market Parameter Selection

A set of parameters may be selected for the money market simulation to demonstrate their impacts on money demand, money supply and/or the market equilibrium. The effects of changing any parameters for a specific function may be inspected by selected the simulation view for that specific function. Market equilibrium impacts may be seen by selecting the money market simulation view.

On the demand side, the transactions demand parameters are the price level and the velocity of money. The income level appears in the transactions demand function but, the simulation view of transactions demand is with respect to the level of income so, in the simulation view of transaction demand along, the income level is treated as a variable appearing on the horizontal axis. One speculative demand parameter is offered, the interest elasticity of the demand for money. This parameter allows the imposition of classical (less elastic) versus Keynesian (more elastic) properties on the speculative demand for money.

The monetary stock is treated as a parameter and may be selected as a simulation view to inspect how changes in the money stock affect the supply of money. Money supply in this model is a vertical line with the interest rate on the vertical axis and the quantity of money appearing on the horizontal axis. Changes in the money supply move the function rightward or leftward.

The simulation view is selected using the radio buttons to identify the view. The transactions, speculative, and supply views will reflect only the effects of parameters directly related to those functions. Some changes in the reference points used in the graphical model of one simulation view in the *active learning simulation* will occur by changing parameters from another simulation view. A money market simulation view will include all the parameters, including changes in real income.

THE *ACTIVE LEARNING SIMULATIONS* OF MONEY MARKET MODEL

The *active learning simulation* of the money market model examines important parametric determinants of the supply of and, the demand for money, along with equilibrium outcomes in the market as a whole. It examines the economic specifications of the market framework and presents each element of the market separately for detailed inspection. Two simulation scenarios are used to provide comparisons and contrasts between the different views of the market, using the parametric approach to represent the different conceptual factors.

The demand for money includes both the transactions ($\mathbf{L_t}$) and speculative ($\mathbf{L_s}$) demand and each can be examined separately by clicking the radio button for the simulation view of transactions or speculative demand on the parameter selection on the *frontpage*. The total demand for money is the sum of both transactions balances speculative balances at a given level of income. Money

demand may be inspected using the market simulation view but, it will also show the money supply function.

The money supply simulation view depicts changes in the stock of money and assumes the market equilibrium condition holds. Changes in the supply of money may also be seen in the aggregate using the market simulation view. Market simulation views provide an illustration with both the total demand for money and the supply of money. The market results focus on the resulting equilibrium conditions in the money market (where $\mathbf{M_s=M_d=L_t+L_s}$)

The Parameter Set

The selection of money demand parameters for the transactions demand for money, the speculative demand for money and, the money supply appear for both the baseline and alternative scenario at the top of the *active learning simulation* page. Color-coding is used to reference the parameter selections. The baseline scenario appears in black and the alternative scenario is in green for both the values of the parameters selected as well as the pertinent points in the simulation related to each scenario.

When selecting a simulation view, such as transactions demand, speculative demand, the money supply or, the market, all the parameters will be shown. Parameters unrelated to the simulation view may affect the display of reference points but, will not otherwise be reflected in the *active learning simulation*. For example, if transactions demand is the simulation view, the level of income appears as a parameter selected from the *frontpage* but, this variable appears on the horizontal axis and is treated as an independent variable. It (the level of income parameter) will affect the display of the points in the graphical illustration depending upon the value selected in the baseline scenario.

The Graphical Engine

The graphical illustration of the money market model appears on the left-hand side of the *active learning simulation.* Different simulation views provide results for transactions demand, speculative demand, the money supply and the money market. In each case, the simulation view appears as the title of the illustration.

The spanning axes[2] for each simulation view will differ. In the transactions demand simulation view, income (**Y**) appears on the horizontal axis and transactions demand on the vertical axis. The simulation views for speculative demand, and the market simulation both show the quantity of money on the horizontal axis and the interest rate on the vertical axis. The money supply simulation view show transactions demand on the vertical axis and speculative demand on the vertical axis, assuming the market equilibrium holds. Functions for both the baseline and alternative scenarios are depicted with points

[2] The spanning variables that appear on the horizontal and vertical axis of the graph are affected by selecting the simulation view.

referencing common values on the horizontal axis for establishing comparisons and contrasts of the scenario results.

The Text Engine

The first paragraph of the *active learning simulation* of the money markets examines the baseline and alternative functions for the function or functions selected with the scenario view. For example, if the market simulation view is selected, both the money supply and total money demand are discussed (with additional paragraphs of narrative), whereas if the speculative demand simulation view is selected only the speculative demand function is described. A point on the horizontal axis of the graph for the simulation view is specified to explain and reference the values of the functions displayed for each scenario. Numerical values corresponding to the points on the graph are embedded in the text with color-coding to reference the scenario.

The second paragraph compares the two scenarios for the simulation view and explains the differences between the scenarios as a consequence of the parameter differences. For example, if the price level changes for the transactions function simulation view, the two transactions demand functions are described using a common level of income on the horizontal axis. The direction of change in the shift variable is noted and shown to cause movement in the function between the scenarios. The magnitude and direction of the change is included in the discussion.

The third paragraph explains some of the determinants of the reference points used in the graphical illustration of the simulation view. For the simulation view of the market, a description of the changes in the supply of money appear if that parameter is selected. Demand shifts are generalized for changes in any/all demand parameters. For simulation views of the speculative and transactions demand and for the simulation view of money supply, experiment with changing some of the parameters unrelated to the function in the simulation view to see the effects on the textual narrative and reference points in the graphical illustration.

Money Market

Assignment Questions

1. Using the transactions demand for money, explain what determines the increase in transactions balances as income rises. Compare the level of transactions balances for two levels of income.
2. If the velocity of money increases, say due to an increase in electronic banking, what is the affect on transactions balances. If the velocity increases by 10%, what is the impact on transactions balances?
3. Compare a speculative demand function with relatively low interest elasticity to one with relatively higher interest elasticity. Start with the same percentage change in speculative balances (say +10%), what is the percentage change in the interest rate shown for each of the two demand functions?
4. Explain why the money supply function is a vertical line in the market simulation view but, in the money supply view it is downward sloping.
5. Using the market simulation view, explain the impacts of an increase in income. How would the Fed respond if the objective were to keep the market rate of interest stable?

Chapter 11. IS-LM Model

A Simultaneous Model of the Product Market and the Money Market

Purpose
The ISLM simulation model examines the impacts of fiscal and monetary policy recognizing the simultaneous interactions between the goods and money markets. Macroeconomic policy includes both monetary and fiscal policy instruments and their interaction and effects on both markets is important to study. The money and product markets do not function in isolation and have mutual dependencies.

A range of fiscal and monetary policy instruments are available for selection using a baseline and alternative scenario to compare and contrast policy prescriptions. The results may be inspected using the money market, the goods market or the simultaneous "super-equilibrium" in both the goods and money market.

This model is important to understand how the separate equilibrium in the goods and money markets are mutually dependent. Initially, the conceptual specifications of the goods market and the money market are explained as if they function in isolation. The interest rate is determined in the money market but, is a primary determinant of the level of investment. Income levels determine the level of transactions balances needed for determining equilibrium in the money markets. In this model both the equilibrium interest rate and the equilibrium level of income are viewed as variables and are "solved" by the system of equations to show how a "super-equilibrium" for both markets may be attained in the macroeconomy.

ISLM Learning Objectives
Use the ISLM simulation to better understand several key aspects of the concept of equilibrium in the money and goods markets. The equilibrium conditions for the goods and money market are important conceptual elements within the graphical model and provide a benchmark for scenario contrasts and comparisons. Shifts in the IS and LM functions associated with the direction of movement of each policy instrument also are important in understanding their impacts on the macroeconomy and the disequilibrium adjustment process. For example, increasing the money supply shifts the LM function to the right and lowers the interest rate, stimulating investment in the product market.

IS-LM Model

Interactions between the goods and the money market are illustrated with the ISLM framework. Trace out how a shift in one market due to a policy prescription will lead to equilibrium in that market but, will cause a disequilibrium in the other market (assume the original position is a "super-equilibrium" in both markets). For example, an increase in equilibrium income associated with deficit finance of a fiscal policy stimulus will engender an increase in transactions money demand but, with the money supply fixed causes an increase in the interest rate. This result is represented by the new "super-equilibrium" and shows how the indirect impacts in the money market mitigate the expansionary effects of the fiscal stimulus.

The disequilibrium adjustments that occur in the other market due to a direct application of policy are also important. For example, after reaching a new equilibrium level of income due a fiscal policy stimulus in the goods market, the money market is in disequilibrium at the original equilibrium rate of interest because of the increase in the transactions demand for money. This rightward shift in money demand leads to an increase in the equilibrium interest rate, given the money supply is held constant.

Comparisons of alternative policy scenarios are suggested as a means to understand how alternative policy mixes can affect the economy. For example, prepare a demonstration of a Keynesian approach that emphasizes a fiscal policy stimulus versus a monetary policy approach based on 'easy' money. The parametric values that affect the slope of each of the functions will determine the effectiveness of either approach,

THE ISLM *FRONTPAGE*

The ISLM *frontpage* provides background narrative about the conceptual framework and offers the selection of the parameters representing the mix of fiscal and monetary policy instruments for the baseline and alternative scenarios. The model examines the goods market and the money market, individually and simultaneously. It assumes that the equilibrium level of income is determined in the goods market and the equilibrium interest rate is determined in the money market.

Conceptual Specifications of the Goods Market

The goods, or product, market is examined to understand how equilibrium income is determined. A Keynesian approach is used to specify the relationship between income and expenditure in the macroeconomy. The goods market is examined by assuming investment is autonomous and predetermined, essentially assuming the interest rate (determined in the money market) is fixed.

IS-LM Model

Equilibrium is identified using the “45 degree” line on a graph with income on the horizontal axis and expenditure on the vertical axis, where income equals expenditure. The conceptual importance of equilibrium in the product market allows ready comparisons of the scenarios. That is, it provides a benchmark to compare the outcomes of alternative policy prescriptions.

The fiscal parameters offered for selection represent components of autonomous expenditure in the models’ specification. Changes in autonomous expenditure and equilibrium income are related using the income expansion equation that shows changes in equilibrium income are equal to changes in autonomous expenditure multiplied by the national income expansion multiplier. The model also assumes that taxes are related to income using a flat income tax rate that may be varied as one of the fiscal policy parameters.

Autonomous Expenditure

Autonomous expenditure is defined as those components of expenditure in the national accounts that are exogenous or predetermined in the model. They are treated as constant terms or parameters and are held fixed during the simulation. The variables in the goods market model are income (**Y**) and aggregate expenditure (**AE**).

Aggregate expenditure (**AE**) is specified in functional form from the national income accounting identity:

$$\mathbf{AE = C + I + G + X\text{-}M}$$

C = consumption expenditures,
I = autonomous expenditures,
G = government expenditures and,
X-IM = net exports or exports (**X**) less imports (**IM**), assume **X-IM=0** for simplicity.

Given that consumption is a function of disposable income

$$\mathbf{C = C_a + MPC * Y_d}$$
$$\mathbf{Yd = Y\text{-}T}$$

$\mathbf{C_a}$ = autonomous consumption,
MPC= the marginal propensity to consume,
Y = income,
$\mathbf{Y_d}$=disposable income and,
T = taxes.

Let taxes be a function of income

$$\mathbf{T = t * Y}$$

Hence,

$$Y_d = Y - T = Y - t*Y = (1-t) * Y$$

And

$$C = C_a + MPC * (1-t) * Y$$

The aggregate expenditure equation may be restated as

$$AE = AE^* + MPC * (1-t)\ Y$$

Where **AE* = Ca + I + G** assuming **X-IM=0**.

Hence autonomous expenditures (**AEXP**) are defined as **AE*** or the constant term (the intercept on the vertical axis), in the AE equation. The slope is equal to **MPC * (1-t)**.

Equilibrium in the Goods Market

The equilibrium condition in the goods market specifies that income equals expenditure [**Y=AE**]. Using the circular flow diagram, this result shows that expenditures by households equal to the incomes paid by firms to factors of production (land, labor, capital and entrepreneurship). Or, the value of goods and services produced by firms equals the purchases of consumer goods.

While the national income accounting identities show there are some subsidiary line items that lead to differences between income and expenditure approach to measuring GDP, this model is an abstraction and the differences are ignored for simplicity. An alternative specification of the equilibrium condition shows that inventories are at their expected levels and (including a public sector), this subsidiary equilibrium condition may be restated as the leakages equal injections [**S+T=I+G**]

Expenditure leakages include savings plus taxes and expenditure injections are investment and government spending. Leakages are financial flows out of the circular flow and reduce spending from a given level of income. Expenditure injections increase aggregate spending at a given level of income.

Income Expansion Equation

Changes in the level of equilibrium income in the goods market may be examined for changes in the components of autonomous expenditure (**AEXP**). A change in investment is thought to shift the aggregate expenditure (**AE**) function upward or downward and lead to a change in equilibrium income. The increase or decrease in equilibrium income (Y_e) is greater than the original change in autonomous expenditure (**AEXP**) due to the multiplier effect.

The national income expansion multiplier (**MULTI**) measures the cumulative impact of changes in autonomous expenditure (**AEXP**) on the level of equilibrium income ($\mathbf{Y_e}$). The relationship is defined as the national income expansion equation:

$$\mathbf{\Delta Y_e = MULTI * \Delta\ AEXP}$$

where the multiplier (**MULTI**) is:

$$\mathbf{MULTI = 1/(1- MPC + t*MPC)}$$

Note that this form of the multiplier and income expansion equation specifies that taxes (**T**) are a function on income. If taxes are capitation taxes[1], the results differ as explained in Chapters 7 and 9.

Conceptual Specification of The Money Market

The money market is examined to explain the determinants of the equilibrium level of interest. It assumes that the equilibrium rate of interest is that rate where the supply of money and the demand for money are equal. Graphically, this is the point where the supply of money and the demand for money intersect and the quantity of money appears on the horizontal axis and the interest rate appears on the vertical axis. The focus on the money market equilibrium is provided to understand how it simultaneously adjusts to changes in the goods market. Details of the money market in isolation appear in Chapter 10.

The Demand for Money

The demand for money is specified to reflect two sources of demand: the transactions motive and the speculative motive. Each effect (transactions and speculative) may be considered in isolation but, the combined influence results in the demand for money. The demand for money is specified as a downwardly sloped function where the interest rate appears on the vertical axis and the quantity of money is shown on the horizontal axis.

Speculative Motive

The speculative demand for money is associated with the speculative motive of individuals or money managers who may or may not prefer to hold cash balances given the rate of interest. That is, there is an opportunity cost of holding cash in liquid form. The opportunity cost of holding cash is the foregone interest earnings that would otherwise accrue.

The speculative demand shows that the quantity of cash holdings will vary inversely with the rate of interest. As the interest rate increases, the opportunity cost of holding cash increases. Hence, with higher interest rates, few individuals

[1] Capitation taxes are what may be called ‘head taxes”. That is, the tax is a fixed dollar amount per tax payer.

and money managers will retain cash for speculation. Instead, the funds will be used to purchase interest bearing financial assets. To restate the relationship, as the interest rate rises, speculative demand for cash will demand.

Transactions Motive
The transactions motive arises from the use of money as a medium of exchange. As incomes rise individuals need more cash to finance their expenditures. This assumes a given level of prices and that the velocity of money[2] is constant.

This relationship may be specified as the equation of exchange:

$$\mathbf{M * v = P * Y}$$

M = transactions demand for money
V = velocity of money
P = price level
Y = real income.

Combining the Speculative and Transactions Motive
The combined effect of both the speculative and transactions motive leads to the demand for money function. The demand for money is downward sloping with respect to the interest rate and income is a shift variable.

The model treats the rate of interest and the level of cash money as variables and the other factors are treated as parameters. That is, the quantity of money demanded appears on the horizontal axis and the rate of interest appears on the vertical axis. The level of income (**Y**) is a shift variable and moves the demand for money function rightward or leftward depending on an increase or decrease in the level of income.

<u>The Supply of Money</u>
The money supply ($\mathbf{M_s}$) is assumed to be invariant with respect to the interest rate and is maintained at a quantity target by the Federal Reserve Bank (the "Fed"). The Fed maintains the quantity target. Hence, intervening open market operations are thought to shift the money supply ($\mathbf{M_s}$) directly from the original position.

Discussion of Direct and Indirect Effects of MacroPolicy in the Goods and Money Markets

The ISLM model recognizes that fiscal and monetary policy instruments affect the goods and money market simultaneously. Fiscal policy is thought to affect the goods market directly through changes in autonomous expenditure (**AEXP**), or taxes. Monetary policy changes will directly impact the money market.

[2] The velocity of money is defined as the number of times a dollar in circulation is used per year.

IS-LM Model

Indirect effects of fiscal policy are those impacts on the money market that arise due to changes in the goods market. A new equilibrium level of income in the goods market gives rise to a shift in the demand for money function, since the level of income is treated as a shift variable. The result is that a fiscal policy application will directly affect the goods market and indirectly affect the money market.

Indirect effects of monetary policy include a change in the level of investment when a new equilibrium rate of interest is attained due to a change in the money markets. As the new-targeted equilibrium rate of interest is achieved in the money market, investment decisions by business will be affected. The level of investment in the goods market is treated as autonomous or exogenous but, is dependent on the rate of interest. If the interest rate changes, it is likely investment will change and consequently, the direct impact of monetary policy will be to determine the equilibrium rate of interest. Indirectly interest rate changes will affect the level of investment in the goods market.

The ISLM framework allows for both the direct and indirect effects of fiscal and monetary policy on both the goods and money markets. As fiscal policy changes are implemented and realized in the goods market, ISLM shows how the money market will adjust to shifts in the demand for money. The resulting interest rate changes will mitigate some of the direct effects in the goods market because of effects on investment. Likewise, applications of monetary policy instruments can be seen to directly impact the money markets. The ISLM model includes the simultaneous adjustment in investment demand that arises indirectly in the goods market leading to changes in equilibrium income that moderate the effects of monetary policy.

ISLM Parameters

The ISLM model offers a selection of parameters to examine the effects of fiscal and monetary policy on the economy. Interactions between the goods and money market are recognized and the resulting “super-equilibrium” is that associated with a simultaneous equilibrium in both markets. Parameters sets may be selected to specify a baseline scenario and an alternative scenario.

Fiscal Policy Parameters

Fiscal policy parameters include the level of government expenditure (**G**) and the income tax rate (**t**). The original or baseline scenario is given and the parameters allow changes from the original position (baseline scenario). Both **G** and **t** may be increased or decreased.

government expenditure (**G**)

Government expenditures may be increased or decreased in the alternative scenario from the original level. The model is not designed to focus attention on the particulars of the solution in the goods market but, rather to describe the adjustments between the goods and money market equilibriums. Hence, the

change in government spending is of interest and not the original level of spending. Details of the goods market, including the effects of selected spending levels in the baseline and alternative scenarios, are described in Chapter 7 and Chapter 9.

flat tax rate (**t**)
Income taxes (**T**) are specified by using the flat tax rate. It assumes the tax function does not have an intercept (no negative income tax for equity or redistributional purposes). The slope of the tax function is the flat tax rate (**t**) or sometimes called the marginal propensity to tax (**mpt**). The tax rate may be increased or decreased relative to the original position or baseline scenario of 30%.

Monetary Policy Parameters
Monetary policy parameters are restricted to two stylized instruments: the velocity of money (**v**) and the money supply ($\mathbf{M_s}$).

velocity of money (**v**)
The velocity of money may be increased or decreased from the baseline (original position) of 12. The selection is limited to an increase or decrease in velocity to represent potential policy changes that affect the bank clearance process.

supply of money ($\mathbf{M_s}$)
The money supply is a monetary policy parameter that may be increased or decreased incrementally from the baseline value. Since the purpose of the ISLM model is to explain the interactions between the goods and money market, the actual values of the original monetary stock are obscured to focus on the impacts of change in the stock. Details of the money market, including the impacts of specifying the baseline value of the monetary stock may be seen in Chapter 10.

Selecting the Simulation View
The results of the ISLM simulation may be viewed from the perspective of the money market, the goods market of the "super-equilibrium", representing simultaneous equilibrium in both the goods and money markets.

the goods market
A view of the ISLM simulation from the goods market incorporates the fiscal policy parameters selected. It will not be affected by monetary policy parameters. The resulting graphic model is a four-quadrant diagram of the goods market. The four axes are the equilibrium level of income, the level of savings (**S**) plus taxes (**T**) or leakages, the level of investment (**I**) plus government expenditures (**G**) or injections and the rate of interest.

The level of leakages (**S+T**) appears in quadrant two in the lower right-hand corner of the graph. The equilibrium condition, where leakages equal injections, appears in the lower right-hand quadrant (quadrant three). In the upper right-

hand quadrant, the function specifying the level of expenditure injections (**I+G**) is shown (quadrant 4). The resulting equilibrium level of income for a given interest rate (the IS diagram) appears in quadrant 1.

the money market
The view of the ISLM simulation from the money market incorporates the monetary policy parameters selected. It will not be affected by fiscal policy parameters. The resulting graphic model is a four-quadrant diagram of the goods market. The four axes are the equilibrium level of income, the level the transactions demand for money ($\mathbf{L_t}$), the level the speculative demand for money ($\mathbf{L_s}$) and the rate of interest.

The level of the transactions demand for money appears in quadrant two in the lower right-hand corner of the graph. The equilibrium condition, where the money supply equals money demand, appears in the lower right-hand quadrant (quadrant three). In the upper right-hand quadrant, the function specifying the level of speculative demand is shown (quadrant 4). The resulting equilibrium interest rate for a given level of income (the LM diagram) appears in quadrant 1.

the "super-equilibrium" of the goods and money markets
The "super-equilibrium" of the ISLM model is that outcome where both the goods and money markets attain equilibrium simultaneously. This appears as the intersection of the IS and LM curves representing equilibrium income from the goods market at a given level of the interest rate and, the equilibrium interest rate from the money market given the level of income. The intersection point is unique and illustrates that only a single combination of the equilibrium interest rate and the level of income will realize simultaneous equilibrium in both markets.

THE *ACTIVE LEARNING SIMULATIONS* OF THE ISLM MODEL

The ISLM model provides a range of perspectives to examine the simultaneous interaction of the goods and money markets. Results may be viewed in the four-quadrant IS-system for the goods market, the four-quadrant LM-system for the money market or, the super-equilibrium of the ISLM solution. In each case the parameter selection from the *frontpage* will be reflected in the graphical solution and the narrative.

The Parameter Set
The parameters selected for the simulation appear at the top of the *active-learning simulation* page. The parameters listed are those referring to the selection from the front page. The graphical results display the baseline scenario

and the effects of a change in the parameters representing the fiscal or monetary policy instruments selected. [3]

The Graphical Engine

A graphical solution of the ISLM model depends, in part, on the display selection from the *frontpage.* Three different graphical models appear, depending on the selection of display of the goods market model (IS), the money market (LM) or, the ISLM system (the "super-equilibrium" of both equilibrium income from the goods market and the equilibrium interest rate from the money market). In each of the three graphical displays the graphics engine produces the image based on the solution of the system of equations using the parameter selection and the engine displays the results on the left-hand side of the *active-learning simulation* page.

The graphical depiction for the IS goods market model is a four quadrant diagram showing the leakages in quadrant two (lower right-hand portion of the diagram), the equilibrium condition for the goods market in the lower left-hand quadrant (where leakages equal injections), injections in the upper left-hand quadrant and the IS function in quadrant one (the upper right-hand quadrant).

The graphical depiction for the LM money market model is a four quadrant diagram showing the transactions demand for money in quadrant two (lower right-hand portion of the diagram), the equilibrium condition for the money market in the lower left-hand quadrant (where money supply equals money demand), the speculative demand for money in the upper left-hand quadrant and the LM function in quadrant one (the upper right-hand quadrant).

The graphical depiction of the super-equilibrium of the ISLM system is a combination of the results from quadrant one in the IS and LM systems taken separately. That is, the IS function from the goods market (appearing in quadrant one of the four-quadrant IS diagram) and the LM function from the money market (appearing in quadrant one of the four-quadrant LM diagram) are super-imposed on the same spanning axis (income and the interest rate) appearing in each separate market model in quadrant one.

The Text Engine

The text engine provides some descriptive narrative to explain the results. The narrative is designed to focus on the impacts of shifts in the functions associated with the parameters. An original level of income is used to trace-out the impacts of the shifts associated with the original level of income. The associated functional values from each quadrant are evaluated to explain the changes.

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[3] The exact baseline parameters may be examined by an inspection of the software code modules appearing in the open source listing on the homepage of the Economics Net-TextBook.

The hypothetical values for the original position are discussed in the first paragraph. The changes resulting from the shifts in the functions are then enumerated in the next paragraph. Compare and contrast the changes associated with differing policy prescriptions represented by using alternative parameter selections.

IS-LM Model

Assignment Questions

1. Formulate an expansionary fiscal policy including an increase in government spending and a tax cut. What is the impact on the product market and assuming the money market was initially in equilibrium, what will happen in the money market?
2. Formulate an expansionary monetary policy based on lowering interest rates to stimulate investment. What happens in the money market as a result of the monetary policy prescription? Given the money market has attained a new equilibrium and the product market was initially in equilibrium before the monetary policy change, explain what occurs in the product market.
3. Examine the impacts of the events in question 1 for a high elasticity and a low elasticity case for the speculative demand for money. Compare and contrast the two cases.

Chapter 12. Comparative Advantage

Linear Production Possibilities Frontiers (PPFs) and Relative Value

Purpose
This module analyses the concept of comparative advantage to explain the direction of international trade. It provides a graphical explanation of this pivotal concept of international economics by using a stylized expression of supply and the cost of production within a simple two-good model of production in an economy. Linear production possibilities functions (PPF) are specified for simplicity and the concept of relative value (or "opportunity cost" price) is derived based on the slope of the PPF.

The concept and measurement of comparative advantage explains the direction of international trade. After the advances of Adam Smith, comparative advantage represents one of the most important conceptual contributions to economic policy and it is usually attributed to David Ricardo. It is essentially a restatement of the supply side of Smiths' market theory of price determination and shows that the low-cost producer will have the advantage in trade. However, it focuses only on the production side and the demand side is presented in Chapter 12 to explain the volume of trade.

Learning Objectives
Each of the sections on the comparative advantage *frontpage* has a set of learning objectives enumerated below.

- Linear production possibilities frontiers (PPF). The assumptions of the model from Chapter 2 and, implications of being on or below the PPF describe the fundamentals of using the PPF to model a macroeconomy. The slope of the PPF is defined and measured as the "opportunity cost" (OC) price of the product on the horizontal axis of the PPF,
- Slope of the PPF - relative values. The algebraic derivation of the slope (the "OC" price of food) is an empirical proxy for the visual interpretation of steepness of the PPF as measured by slope. There are important implications of changes in the slope of the PPF that measure changes or differences in the "OC" price.
- Graphically defining comparative advantage using the lowest "opportunity cost" price. Two country's PPFs and the corresponding "OC" prices may be used to compare the relative efficiency of the production processes and thereby explain the direction of trade. The graphical meaning of comparative advantage is based on interpreting differences in the "OC" price and, understanding how changes in the PPF affect the "OC" price.

- Gains from trade. The assumptions of the trading model includes three trade events starting with autarky (no trade), moving to complete specialization and, then engaging in trade defined by prices reflected by the "trading vector". The slope of the "trading vector" shows the "OC" price that the nations' domestic producers can receive in the export market. One can define the trading margin based on the differences in the "OC" price. Finally, trade based on comparative advantage moves a country beyond its' PPF.

THE COMPARATIVE ADVANTAGE *FRONTPAGE*

The comparative advantage *frontpage* provides background about the concept of comparative advantage explaining the direction of international trade. A brief discussion of the history of economic thought is included to provide perspective on the topic. The *frontpage* has three sections with hypertext links to four subsidiary topics:

- linear production possibilities frontiers (PPF),
- the slope of the PPF: relative values,
- graphically defining comparative advantage using the lowest "opportunity cost" price and,
- gains from trade.

Discussion of Comparative Advantage

Ricardo developed the theory of comparative advantage a few decades after Adam Smith published the Wealth of Nations. Smiths' theory of market pricing proved to be the source of extraordinary change in economic policy amongst nations. Contrary to mercantilism, the existing school of thought that dominated economic policy of European nations in the early days of the age of discovery, the theory of market pricing suggested relying on consumers rather than the control, direction, and guidance of royalty and princely-priestly classes to determine the product mix being produced in the economy.

Economic history has shown that nations adopting Smiths' theory, namely England and later France, prospered whilst those clinging to mercantilism, such as Spain, declined. The industrial revolution soon became the engine of economic growth and English industrial trade became a source of great national wealth. This background sets the stage for Ricardos' theory of comparative advantage.

- **Linear PPFs**

The theory of comparative advantage is best illustrating using a simple form of the Production Possibilities Frontier (PPF), first introduced in Chapter 2. However, rather than using the more complicated non-linear PPF, a linear PPF can be used that depicts resources that are perfectly substitutable in an economy. All the other aspects of the PPF concept remain the same from

Chapter 2, only the PPF is now a straight line, rather than bowed outward and away from the origin.

The slope of the PPF is defined as the relative value of the products in the economy. It represents the trading rate of the two products on the production or supply side. That is, the slope of the linear PPF indicates how many of one of the products must be given up to obtain one more unit of the other. With food on the horizontal axis, and clothing on the vertical axis, the slope of the PPF represents the "opportunity cost" price of food (the good on the horizontal axis).

Recognizing relative price is important since it provides a way to compare two different nations' economies without using currency. As long as the two countries both produce the same two goods, the relative price is a simple and effective way to compare the two countries production processes. It eliminates money and shows that the "trading rate" or relative price of the goods renders an accurate measure of the value of the goods in each country.

- **The slope of the PPF: relative values,**

The slope of the PPF represents the "opportunity cost" price of the good on the horizontal axis. It is the "trading-rate" or the relative price of the two products in the country, based on the production process of each country for that product. The slope or steepness of the PPF is a visual proxy for the "OC" price, so defined. The steeper the PPF, the higher the "OC" price of the product (shown on the horizontal axis).

Changing the PPF means that the tradeoffs between the two products are affected. It reflects a difference in the rate at which one product must be given up to obtain more of the other. The relative value, or slope, may be defined algebraically (as rise over run) and this variable is graphed to illustrate the consequences of changing the PPF. Production possibilities mean that given the resource endowment, food or clothing can be produced in the volumes specified as the parameters on the *frontpage*. These volumes are the maximums.

The approach is to provide a baseline PPF and the student may change the PPF limits and create an alternative scenario for the PPF. The slope of each PPF represents the relative value and the slope is constant for the PPF for all values of food (the good on the horizontal axis). The relative values or "opportunity cost" (OC) prices may then be compared directly for two different PPFs.

- **Comparative advantage defined: a lower "OC" price**

Comparison of two PPFs using the "OC" price provides an effective and unambiguous method for economic analysis. It suggests that a PPF that is less steep than another reflects the fact that the "OC" price of production (of the good on the horizontal axis --- food) is lower for that PPF. This result is very important when the two PPFs correspond to those for two different countries.

Comparative Advantage

Two PPFs, with different slopes, yield two different "OC" prices. The PPF with the lower "OC" price of food (the good on the horizontal axis), is indicative of a production process that produces food at a relatively lower "price" than the other PPF. A lower "OC" price implies that PPF offers relatively greater efficiency in production.

The difference in the relative or "OC" price is the source of the comparative advantage in food for that nation with the less steep PPF. This means that country can produce food for comparatively less foregone in terms of the other good (cloth) than the other nation. It allows the nation with the comparative advantage to trade it to the nation where the "OC" price is higher and, profit from the trade transaction.

- **Gains from trade**

The gains from the trade resulting from comparative advantage arise from the difference in the "OC" price or relative price between the two countries. A country having a comparative advantage in the production of food (the PPF is less steep), can produce and "sell" food (by trading) to the other country and profit from the transaction. The amount of the profit, or gains from trade, depends upon the price difference and the volume of trade.

It is assumed here the country having a comparative advantage will completely specialize in the production of that good. For example, a country with having a comparative advantage in food (a less steeply sloped PPF) will specialize in food and produce nothing but food. This means the country will stop producing the other good (cloth) and devote all resources into food production.

This assumption implies the country will move to the point of the PPF where the PPF intersect the horizontal axis. This is the point of complete specialization and provides the greatest gains from trade. The horizontal intercept of the PPF is the origin of the "trading vector" which represents the transformed PPF with free trade. The gains from trade may be measured in total, given the volume of trade, and may also be measured by using the "OC" price multiplied by the trading volume, starting from the point of complete specialization.

The Parameter Selection

The selection of parameters depends upon which of the *frontpages*' four sections' hypertext links are used. The four sections are described below.

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- **Linear PPFs**

A baseline PPF is predetermined and the student may select parameters to determine a PPF for an alternative scenario. The parameter selection defines the intercepts on the horizontal and vertical axis of the PPF diagram (the maximum production of cloth or food). These values reflect the production possibilities limits of the economy's PPF, given the assumptions in Chapter 2.

Comparative Advantage

The PPF is depicted with units of food on the horizontal axis and cloth on the vertical axis. It is a linear PPF so the parameter selection refers to the vertical intercept term, and the horizontal intercept. The slope is the vertical intercept divided by the horizontal intercept term. A predetermined baseline PPF is provided for reference.

The purpose of the parameter selection is illustrated and explains changes in the slope of the PPF. The limiting values selected as the intercepts for the vertical and horizontal axis are the determinants of the slope of the PPF, defined as the relative value or the "OC" price of the product on the horizontal axis (food). Changes in either intercept or both will affect the slope.

- **The slope of the PPF: relative values**

Parameter selection for this section is identical to the previous section, except the graphical engine shows the value of the slope in a separate graph. The student should select values of the parameters with the idea that they affect the slope of the PPF. The value of the slope, or steepness, of the PPF is a direct measure of the "OC" price of food.

Compare the slope of the PPF selected to the baseline. The baseline slope may be greater or less than the slope of the alternative PPF. The difference in the slopes is important since it reflects differences in the "OC" price of food.

- **Comparative advantage defined: a lower "OC" price**

In this section, the student may select the parameters for both the baseline PPF (the US) and the alternative PPF (the UK). Two PPFs are used and each one refers to a separate country. The graphical engine shows both the PPFs and the resulting slopes for each scenario. Choosing two different PPF allows for comparisons and contrasts of the differences in the "OC" price.

Comparative advantage is ascribed to that PPF with the lower "OC" price. This means that when a PPF is less steep than another, the PPF that is less steeply sloped has a lower "OC" price of food in production. The lower "OC" price of food implies that food is produced in a manner that is relatively more efficient than that of the other countrys' PPF.

Comparing two countries PPFs, using the lower "OC" price as the benchmark, identifies the country that is able to produce food relatively more efficiently. It implies that the opportunity cost of a unit of food, in terms of the loss of production in the other product (given the assumptions of the PPF model), is lower for the country with the less steeply sloped PPF. Simply stated, the production "price" is lower and the country is relatively more efficient and will be able to export food to the other country in the model. Exporting the product defines the direction of trade but, the volume depends on demand as explained in Chapter 13.

- **Gains from trade**

Parameter selection for the gains from trade section initially appears identical to that of the previous section. However, once the graphical model is displayed in the *active learning simulation*, another set of parameters is available to re-simulate the model. The gains from trade depend on the difference in the "OC" price and the trading volumes. The trade volumes are initially predetermined but, may then be changed in the *active learning simulation* to see the effects of changing trading volumes.

THE *ACTIVE LEARNING SIMULATIONS* OF THE COMPARATIVE ADVANTAGE MODEL

The *active learning simulation* of the comparative advantage model provides analysis of the determinants of trade direction and the gains from trade. It illustrates and explains comparative advantage as arising from differences in the "OC" price or relative value of the goods. A linear PPF model is used and the slope or steepness of the PPF is shown to reflect the "OC" price of the good on the horizontal axis (food).

The PPF model, first analyzed in Chapter 2, is simplified for the analysis of comparative advantage and linear PPFs are used that have constant slopes or "OC" prices that are constant for all levels of production of the good. This implies resources are perfectly substitutable in production. Two PPFs are used to depict the production processes of two different countries (the US and the UK) and comparisons of the slope or steepness of the PPF provides a means to illustrate comparative advantage, the trading margin and gains from trade.

The Parameter Set

The four sections of the *active learning simulations* of comparative advantage each restate the parameter set selected from the *frontpage*.

- **Linear PPFs**

The parameter set appears on the right-hand side of the *active learning simulation* page. Each of the parameters for the baseline case (predetermined) and the alternative scenario (selected by the student) appears. The parameter values are the PPF boundaries, the horizontal and vertical axis intercepts, where food appears on the horizontal axis and clothing on the vertical axis.

The parameters are color coded with the baseline in black and the alternative in red. The baseline values appear as expressions (e.g. food = 10, clothing =15). The baseline values appear at the top, then the alternative values are shown below them.

- **The slope of the PPF: relative values**

Comparative Advantage

The parameter set for the relative values appears in a table on the upper right-hand side of the *active learning simulation* page. The parameters from the *frontpage* are restated and the "OC" prices of both goods are shown. The values for both the baseline and alternative appear.

In the table, there are four columns. The columns show the parameter values and the resulting slopes or "OC" prices. The rows refer to the values for each scenario. "OC" prices for both goods appear, meaning that the "OC" price of food is shown using units of cloth per unit of food (C/F) whilst, the "OC" price of cloth is expressed as units of food per unit of cloth (F/C)

The parameters are color-coded. The alternative selected by the student is red and the predetermined baseline is black. The "OC" price is the slope of the PPF for the good appearing on the horizontal axis. Only the graph for food on the horizontal axis is shown but the "OC" price of cloth is also included for completeness.

- **Comparative advantage defined: a lower "OC" price**

The parameter set for the relative values appears in a table on the upper right-hand side of the *active learning simulation* page. The display is identical to that for the previous section. The units in the table are also the same, as is the color-coding. The student can however change both the baseline as well as the alternative scenario.

- **Gains from trade**

The parameter set for the relative values appears in a table on the upper right-hand side of the *active learning simulation* page. The display is identical to that for the previous two sections except for one additional parameter. The trading margin parameter is shown and is calculated as the difference between the "OC" price of food in the US and that of the UK.

The parameters are color coded with the values of the UK appearing in red, whilst those for the US are in black. The color code of the trading margin depends upon the country with the comparative advantage in food. If the UK has a comparative advantage in food, then the trading margin value appears in red. If the US has the comparative advantage in food, then the trading margin value appears in black.

The trading volume in the initial display of the *active learning simulation* for this section is predetermined to be 5 units of food. This volume may be adjusted using a parameter selection appearing at the bottom of the *active learning simulation* page. The trade volume may be increased or decreased and the *active learning simulation* will be re-run and the new results displayed to show the effects of the change in trading volumes. Trade volumes will be explained using the international trade model in Chapter 13.

Comparative Advantage

The Graphical Engine
Each of the graphical displays for all four sections appears in the upper left-hand side of the *active learning simulation* page.

- **Linear PPFs**

The graphical depiction of the baseline and alternative scenarios for the linear PPF appears with units of food on the horizontal axis and units of clothing on the vertical axis. The functions are color-coded with the baseline PPF in black and the alternative PPF in red.

- **The slope of the PPF: relative values**

The *active learning simulation* diagram for analyzing the slope of the PPF includes two graphs both sharing the same horizontal axis for food. The upper diagram shows the PPFs and is identical to that shown in the previous section. The slope for each PPF is also calculated and appears in the lower graph of the diagram with food on the horizontal axis and the value of the slope (measured in units of cloth per unit of food --- C/F), shown on the vertical axis.

The graphical depiction of the baseline and alternative scenarios for the PPF is depicted with units of food on the horizontal axis and units of clothing on the vertical axis. The functions are color-coded with the baseline PPF in black and the alternative PPF in red. The values of the "OC" price may be compared directly using the lower graph of the diagram.

- **Comparative advantage defined: a lower "OC" price**

The graph for defining comparative advantage is identical to that of the previous section. The emphasis is the association of the steepness or slope of the PPF as a visual determinant of the "OC" price. The baseline scenario appears in black and the alternative in red and both scenarios may be changed on the *frontpage.*

- **Gains from trade**

The graphical engine for the gains from trade *active learning simulation* uses a diagram with two graphs, similar to those used in the previous two sections. The upper graph of the diagram shows the PPF and the lower graph of the diagram depicts the values of the "OC" price of food (or the slope of the PPF shown in the upper graph of the diagram) on the vertical axis and both graphs have the same horizontal axis (units of food).

The upper graph of the diagram depicts the two PPFs for the US and the UK and is color-coded, as are the "OC" prices in the lower graph. The PPF (and "OC" price of food) for the US is in black and those of the UK are red, the trading vector and the trading margin appear in green. Important reference points in both graphs are labeled with color coded characters explained in the text engine.

Point 'A' is shown to refer to the value of either a point on the PPF (in the upper graph) or the "OC" price of food (in the lower graph) for the county with

comparative advantage in food, at the trading volume shown (initially 5 units of food). Point 'S' is the point of complete specialization for the country with the comparative advantage in food. Point 'T' in the upper diagram refers to the position attained on the trading vector (the new PPF with free trade) and point 'T' in the lower diagram is the "OC" price of food in the importing country. The trading margin is the vertical difference between the "OC" price of food in the two countries and the trading margin multiplied by the trading volume equals the gains from trade (shown as the green shaded area in the lower graph of the diagram).

The Text Engine

The text engine was first developed for the comparative advantage model but, was applied only to the section on gains from trade.

- **Gains from trade**

The text engine for gains from trade develops two themes. The upper paragraph describes the results shown in the parameter table appearing in the upper right-hand portion of the *active learning simulation* page. It explains the values in the table and refers to the graphical depiction for illustration of the PPFs and the "OC" prices for the UK and the US.

The second part of the text engine appears in the next paragraph at the bottom of the *active learning simulation* page. The text explains the points in the diagrams and narrates the illustration using the calculated results from the parameter values to show the "OC" prices, the trading margin and the gains from trade.

Each of the points in the graph are explained and, the same point label (A, T and S) is used in both the upper and lower graphs of the diagram to provide comparison between the two graphs for the same value of units of food. Point 'A' refers to the country with comparative advantage given the trading volume. Point 'S' is the point of complete specialization for the country with the comparative advantage in food and represents that countries production of only food by diverting all resources into the production of food (and out of cloth). Point 'T' refers to a point on the trading vector representing the new expanded PPF for the country with the comparative advantage in food. It is determined by the value of the trading volume.

Comparative Advantage

Assignment Questions

1. If two PPFs intersect, what is the meaning of the point of intersection?
2. What changes in the vertical and horizontal intercepts are needed to create a new PPF with the same slope as the original?
3. Using a different PPF for each of two countries, suppose they both have the same intercept for clothing. Since they both can produce the same maximum quantity of cloth, given their resource endowment, which country will import cloth and why?

Chapter 13. Trade Equilibrium

International Trade Model

Purpose

This module analyses the concept of free trade using a graphical model of consumption and production to explain the direction and volume of international trade. The graphical model uses a stylized expression of supply and demand derived from the production possibilities diagram (see Chapter 2) and the community indifference curve. Non-linear production possibilities functions (PPF) are specified for greater realism (compared to linear PPFs in Chapter 12) and demand is defined using a stylized derivation of consumer preferences reflected in the slope of the community indifference curves (CIC). The measure of relative value (or "opportunity cost" price) for both sides of the market (production and consumption) is defined based on the slope of the PPF and the CIC.

The trade model is an important part of the theory of international economics. It provides an important guiding principle in the formulation of economic policy and domestic tax and investment policy as well. The model shows the efficiency gains associated with free trade but does not analyze the question of fairness in the apportionment of gains (and losses) from trade. It also does not address the question of what constitutes fair trade policy, the impacts of government market interventions and the issues of environmental protection, workplace safety and child labor that often cloud modern trade policy debates.

Learning Objectives

The graphical model of international trade provides a depiction of various aspects of production, consumption and trade of goods in the product market. Several events are important:

autarky – the condition of no trade;
specialization – the diversion of productive resources from a good with a comparative disadvantage into a good with comparative advantage;
free trade point – the outcome of free trade, allowing the country to reach beyond the PPF and realize the gains from trade.

Graphical depictions of these events are shown with the PPF, the CIC and the world price and with the graphs of the slope of the PPF and CIC and the world price. The slopes of the PPF and CIC are measured and defined (using the "OC" price concept from Chapter 2 and Chapter 12) as the stylized supply and stylized demand functions for the good depicted on the horizontal axis (food). The trading vector has a slope equal to the world price and shows how the country can export the product with comparative advantage and realize gains from trade.

Trade Equilibrium

THE TRADE EQUILIBRIUM *FRONTPAGE*

The trade equilibrium *frontpage* provides background narrative about the concepts of international trade. Hypertext links provide discussions of the PPF and comparative advantage found in Chapter 2 and Chapter 12, respectively. An international trade scenario is introduced where a country moves from autarky (no trade), to free trade and, specializes in the product in which it has comparative advantage. Both the production (supply) and consumption (demand) side of trade are defined in stylized terms using the slope of the PPF and the slope of the CIC. A single parameter is available to drive the simulation, the opportunity cost ("OC") price of food in the world market (assumed to represent the price signal to which a trading country will adjust).

Discussion of the Model of International Trade

The model of international trade uses a two good model of production and consumption for a nation. It assumes the country is initially in autarky, a no-trade position and further assumes for simplicity that the domestic relative price is equal to one. The domestic price is determined by the point of tangency between the PPF and the CIC, for the highest level of community indifference.

The initial autarky point is also represented by the intersection of the stylized supply function and the stylized demand function. These stylized demand and supply functions are the slopes of the PPF and CIC functions (respectively) and the slope is measured relative to the good on the horizontal axis. Food and clothing are the two goods in the economy and food appears on the horizontal axis.

The trade model describes the country's adjustment to free trade. It moves from the autarky point and specializes in the production of the good in which it has comparative advantage (the result of the comparative advantage model in Chapter 12). The determination of comparative advantage depends upon the world price of the food, measured as the "OC" price, selected in the simulation. That is, the world price is compared relative to the predetermined domestic price, numerically assumed to equal 1 for convenience. If the world price is greater than one, the country has comparative advantage in food, if less than one, it has a comparative disadvantage in food.

The trading vector represents the new PPF that results from free trade and show that trade allows the country to better its domestic production possibilities in absence of trade. The trade vector emanates from the point of specialization, defined as where a line with a slope equal to the world price is tangent to the PPF.[1] Movement along the trading vector occurs along this line and beyond the

[1] The slope of the trade vector may also be seen relative to the "OC" price defined by the stylized supply and demand functions. The world price is constant, meaning the country is a "price taker" in a globally competitive market. The quantity associated with specialization is gotten by the

PPF and, continuing until a point of tangency is reached with the highest CIC that can be attained. This point of trade equilibrium is associated with the rightward shift in the stylized demand function arising from the increase in real income gotten from the gains from trade. It is also shown by the attainment of a higher CIC, tangent to the trade vector, beyond the original PPF

The International Trade Model Parameter Selection
One parameter, the opportunity cost ("OC") price of food in the global market, may be changed in the model. The "OC" price of food, is the price of food relative to cloth or, the number of units of cloth per unit of food in the world market for traded food. This parameter represents this ratio of cloth to food found in the global market, and it is assumed the global market is competitive.

See the PPF model in Chapter 2 and the model of comparative advantage in Chapter 12 to better understand the use and meaning of the "OC" price of food. It is measured both by the slope of the PPF in production and the slope of the CIC in consumption, representing the stylized supply price and demand price respectively. The steepness or slope of the PPF and CIC, with food appearing of the horizontal axis, provides a convenient visual representation of the equivalent of "OC" price.

The world price of food (measured in units of cloth per unit of food), may be increased or decreased relative to one. It is assumed the autarky point is where the domestic price of food is equal to one, a change in this parameter is relative to the original autarky position of the country in the trade model. Increasing the price parameter above one results in the country having a comparative advantage in food production whilst, reducing it below one implies the country has a comparative disadvantage in food.

THE *ACTIVE LEARNING SIMULATIONS* OF TRADE EQUILIBRIUM MODEL

The active learning simulation of the international trade equilibrium model provides a graphical depiction of important events in trade policy using points on the PPF and CIC associated with autarky, specialization and free trade. It includes the trade vector, showing the trading path and, the model also provides a separate graph depicting the stylized supply and demand functions that measure the slope of the PPF and CIC functions respectively, along with the world price. A text engine provides narrative description of the points on the graphs with embedded numerical data from the simulation and it explains the results. The graphical illustrations of the international trade model are complex and the images from the simulations may be saved and the images expanded to obtain greater resolution.

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intersection of the world "OC" price with the stylized supply function (the slope of the PPF). This reflects the quantity supplied at the world price, given comparative advantage.

Trade Equilibrium

The Parameter Set

The parameter selected for the *active learning simulations* of the international trade model represents the world price of food, expressed in relative terms to clothing (the other good in the two-good model of the nation). The "OC" price of food is the relative price, or the number of units of cloth per unit of food. This is assumed to be the competitive world price and is constant for the simulation, reflecting the assumption that the nation will be able to trade internationally as a "price-taker". Thus, the world price is a given (set as a parameter) and the model depicts the countrys' production and consumption response.

The world price of food that may be selected ranges from less than one to much greater than one. The country in the trade model is assumed to have an "OC" price of food equal to one in autarky (an assumption used to simplify the graphical model). If the world price of food selected is less than one this implies the country is relatively inefficient in the production of food, since some foreign producers of food in the world market are currently producing it as a lower "OC" price than is currently found in the country as realized by the domestic autarky price. That is, foreign producers engaged in world trade have costs of production below one, whereas some domestic producers have unit costs equal to one, the assumed equilibrium autarky price in the country in the trade model.

The value of the world price of food appears in the upper right-hand corner of the *active learning simulations* of the international trade model. It appears as an expression in bold, e.g. **World Price of Food 2.7 (C/F)**. It also appears as a parameter that may be changed at the bottom of the *active learning simulation* page. This parameter may be changed to show a different selection of the world price of food and, the model will be re-simulated and the new results displayed.

The Graphical Engine

The graphical model appears on the left hand side of the *active learning simulation* page. The illustration has two graphs, one on the top showing the PPF, the CIC and the trade vector, a second graph on the bottom is depicting the slopes (or "OC" price) of the PPF and CIC, representing the stylized supply and demand functions for the country along with the constant world price of food (the simulation parameter). Both the top and bottom graph share the same horizontal axes, showing the quantity of food.

In the top graph, the PPF and CIC appear and three points are labeled to depict the three trade events in the model. Point 'A' refers to the autarky point and represents the original position without trade. It is assumed that the original autarky position is attained at a point of tangency between the PPF and the highest CIC, where the slope at the point of tangency is assumed to equal to one. Point 'S' shows the point of specialization and represents the result of the country diverting resources from the good having a comparative disadvantage and into the good having the comparative advantage. Point 'S' also represents the origin of the 'trading vector'. Point 'T' represents the outcome of free trade

and lies on the 'trading vector' beyond the PPF. It shows that trade expands the limits of the PPF and allows the country to attain levels of both goods beyond that without trade. The points are color-coded: point 'A' is green, point 'S' is blue and, point 'T' is red.

In the bottom graph, the slopes of the PPF and CIC appear along with the world price. The slope of the PPF, or the stylized supply price of food --- the supply curve for food --- is upward sloping. The slope of the CIC, or the stylized demand price of food --- the demand curve for food --- is downward sloping. The world price of food (shown in blue) is assumed to be constant for all levels of food production and consumption in the country, since it is assumed the country is a "price-taker" in the competitive global food market.

Points 'A', 'S' and 'T' are also shown in the bottom graph with the same color-coding. Point 'A', the autarky position, is shown as the intersection of the supply and demand functions without trade or the affect of the world price. Point 'S', the point of specialization, is attained where the world price of food intersects the supply function showing domestic producers response to the world price. Point 'T' is where the new demand curve intersects the world price.[2] The world "OC" price of food is constant and is shown as a horizontal blue line. The difference between domestic production at the world price (point 'S') and domestic consumption (point 'T') is equal to the trade volume. The "OC" price of food is shown on the vertical axis and the quantity of food on the horizontal axis.

The Text Engine

The text engine for the *active learning simulations* of the international trade model provides narrative that describes the graphical illustration used to depict the trade events in the model. Three paragraphs are used to explain the results and describe the points associated with autarky, specialization and free trade. The world price of food is redisplayed as a parameter at the bottom of the simulation page that may be selected with a click to change the world food price and re-simulate the model.

The first paragraph of the text identifies the world price of food selected and describes the levels of food and clothing associated with autarky. The autarky position is entitled point 'A' in the upper graph at the point of tangency between the PPF and the highest CIC. In the top diagram point 'A' shows the volumes of food and clothing. The equilibrium "OC" price of food in autarky (assumed to equal one) appears in the lower graph of the diagram where the stylized supply and (original) demand curves intersect. The horizontal axis (food) is the same in both the upper and lower graphs of the diagram.

[2] The shift in the demand function is shown to reflect the increase in real income arising from the gains from trade. It is assumed that if it has a comparative disadvantage in food, the exporting country in food trade realizes all the gains from trade. However, the domestic country will have a comparative advantage in cloth and will realize gains from cloth trade.

Trade Equilibrium

The second paragraph describes specialization in the good having comparative advantage. Productive resources are diverted out of the good with comparative disadvantage and into the good with comparative advantage, resulting in an increase in production of the good with comparative advantage and, a decrease in the production of the good with comparative disadvantage. Point 'S' reflects the condition that the slope of the world price line (also the slope of the trade vector) is equal to the slope of the PPF. The world price line is defined as the slope of a line in the upper graph reflecting the world "OC' price of food. The same result is illustrated in the lower graph, where the world price line (shown as a horizontal line) intersects the stylized supply curve (the slope of the PPF) for food. That is, it is the quantity supplied by domestic producers at the world price.

Although comparative advantage may be realized in food or clothing, the quantity of food always appears on the horizontal axis. If the country has a comparative disadvantage in food, point 'S' refers to the results after resource diversion out of food.

The third paragraph describes the results of free trade. The country moves outward beyond the PPF along the 'trading vector' (from point 'S') until it reaches point 'T' where the full gains from trade are realized. At point 'T' the 'trading vector' (with a slope equal to the world price) is just tangent to the highest new CIC that may be attained. The new CIC is farther from the origin that the original CIC associated with autarky, meaning the country is better off, or gains from trade are realized as an increase in real income. This is shown in the lower diagram as the second stylized demand function (downward sloping function measuring the slope of the new CIC) that is shifted to the right (when the comparative advantage is realized for food) representing the increase in real income associated with the gains from trade. The new demand function intersects the world price at point 'T' and shows the consumer's quantity demanded at the world price. Trade volumes are the difference between domestic production and domestic consumption at the world price.

It is assumed the gains from trade are associated only with exports of food or cloth. The model shows that after trade, the quantity of the good with comparative advantage that is consumed domestically will decline and the quantity of the good (consumed domestically) with comparative disadvantage will increase. This result is likely but, is not the only possibility and reflects the certain assumptions about the supply and demand price elasticity's and the income elasticity that are beyond the scope of this model

Trade Equilibrium

Assignment Questions

1. Explain how the slope of the PPF and the CIC may be used to depict the autarky point.
2. As the world price declines from a relatively high level (>>1) to being less than one, explain how this affects the point of specialization.
3. Why does the trade vector lie beyond the PPF?
4. If the country does not specialize, but simply starts trading from autarky, will it realize the same benefits from a scenario arising from specialization and trade.

Chapter 14. Foreign Exchange Rate Market Model

The Role of Trade and the Product Market

Purpose
This module introduces a simple model of foreign exchange. It provides a graphical model of the supply and demand of foreign exchange derived from the repatriation of currency earnings from the sales of traded products. The model uses two countries, the US and the UK and the exchange market for pound sterling.

The model of the foreign exchange market provides a conceptual explanation of exchange rates. The international money market includes the interplay of a large number of foreign currencies and the determination of the relative value of each of these currencies is better understood with the knowledge of the supply of and the demand for each currency. Exchange market principles based on product markets explain the essential aspects of the currency markets and additional market participants, such as those in the capital markets can be added without too much additional complexity.

Learning Objectives
The learning objectives for this model include understanding the assumptions about the product and exchange market and how they affect the currency supply function. Some of the material is explained in earlier chapters (concerning comparative advantage and the trade model). The traded product price in the foreign market depends upon the exchange rate. This reflects the assumption that the trade entrepreneur is a “price taker” in the domestic market but, is shown (for simplicity) as the sole purveyor of the imported product. Sales revenues earned by the exporters’ sales in the foreign market are traded in the exchange market and appear as the supply of pounds in the case of the sterling market (on the part of Levi exporters). The supply of pounds depends upon the original domestic price of Levis, the elasticity of imported demand and the prevailing exchange rate.

THE TRADE EQUILIBRIUM *FRONTPAGE*

The foreign exchange market model *frontpage* provides background narrative about the determination of exchange rates using a supply and demand framework. The model specifies that the supply of and, the demand for, foreign exchange depend upon the currency flows arising from the international trade of goods from the product market. Important parameters are introduced that affect the results and, these include the elasticity of demand in the product market and, product prices in the domestic market.

Foreign Exchange Rate Market Model

Discussion of the Model of Foreign Exchange Market

The model of the foreign exchange market uses a two-country, two-good framework. The two countries are the US and the UK and, two goods are produced and exported by each country to the other. The US produces and exports clothing (Levi blue-jeans) and the UK produces and exports food (meat pies). The models of comparative advantage in Chapter 12 and the international trade equilibrium model in Chapter 13 may be examined for background and discussion of related concepts.

The model examines the determination of the exchange rate of the British pound sterling **($/** £) expressed in dollars. Thus, the US-UK exchange market for pound sterling is the subject of the analysis and the supply of pounds in this market is explained as being based on the exchange of sales revenue earned by US exporters of Levis. That is, their pound sterling sales revenues (arising from Levi sales to British consumers) will be traded for dollars. The Levi exporters are suppliers of pounds in the US-UK exchange market for pound sterling.

Each producing country is assumed to export the product to the other country and all foreign exchange earnings associated with sales revenue in the foreign product market will be repatriated to the country of origin. Thus, US exporters of Levis will sell their product in the UK and then seek to return (repatriate) their sales revenue, denominated in British pound sterling by exchanging the pounds for dollars and then return the dollars to the US. UK exporters of meat pies will seek to exchange their dollar sales revenue earnings for British pound sterling and appear as demanders of sterling.[1]

It is assumed for the sake of simplicity that there are no capital flows and the only participants in the exchange market are the exporters from the product market. All sales revenue will be repatriated. The domestic product markets where the exporters buy the produces are competitive (they are “price-takers”) and the demand for the imported product has an elasticity greater than one (assumed to ensure the currency markets exhibit normal properties). The exporter sells the Levis in a competitive market in the foreign country and, is also a price taker in that market but, is assumed to provide the sole source of the foreign exchange to be traded in the market.

The Foreign Exchange Market Model Parameter Selection

The parameter selection offers five different parameter choices. The first two parameters are related to the import price elasticity of demand and the second is the product price in the domestic market. The last three are different exchange rates used to map out the resulting supply of pounds in the sterling market and these rates will appear as reference points in the graphical results.

[1] The bilateral reflexive properties of exchange markets result in showing that the British exporters of meat pies are suppliers of dollars in the dollar side of the pound-dollar market, but are demanders of pounds on the pound side.

The price elasticity of demand in the import product market and is assumed to exceed one (to ensure stability in the exchange markets). The demand function used has constant price elasticity and hence price changes and revenue changes will depend on the price elasticity as explained in Chapter 4. A choice with elasticity less than one is offered to show the effects on the market. The supply of pounds in the sterling market is sensitive to the demand elasticity of Levis because of the relationship between price and sales revenue given elasticity (see Chapter 4) and the supply of sterling would be downward sloping if price elasticity is less than one.

The second parameter is that of the product price of Levis in the domestic US market. Exporters are assumed to be “price-takers” in the competitive domestic US market and, it is a price reflecting product market equilibrium. The effects of changes in the product price on the exchange market may examined but, no assumption is made about the determinants of changes in the domestic price. It is assumed the exporters sell the product (Levis) in the UK without any costs associated with transport and earn zero profit (for simplicity).

The third parameter is the exchange rate and is a set of three rates that will be used to narrate, explain and illustrate the market graphical results. Pick three different exchange rates to examine the effects of the exchange rate on the supply of pounds in the sterling market. The graphical model and text engine in the *active learning simulations* will provide details about these three parameters in the model.

THE *ACTIVE LEARNING SIMULATIONS* OF FOREIGN EXCHANGE RATE MARKET MODEL

The *active learning simulations* of the foreign exchange market model are designed to explain the determinants of the exchange rate. The model shows the market for British pound sterling and the supply of pounds in this market is specified to reflect the repatriation of sales revenues from US exports to the UK. The model examines the product market for hypothetical US exports (assumed to be reflected by one good – Levi blue-jeans) sold to consumers in the UK. Parameters include the domestic product price of Levis in the US and the elasticity of demand for imported Levis in the UK.

The analysis of the supply of pound sterling is sufficient to explain both sides the market, given the assumptions about the sales of British exports to the US. The reflexive nature of currency markets ensures that the supply of pounds in the pound market is the mirror image of the demand for pounds in the dollar market. Thus, the demand for pounds in the pound market reflects the supply of dollars in the dollar market, where the supply of dollars in the dollar market stems from the

repatriation of sales revenues (earned as dollars) from exporters of British goods (meat pies) to US consumers of this epicurean delicacy.

The responsiveness of the supply of pounds to the parameter set offered on the *frontpage* illustrates and explains the impacts of the price elasticity of import demand and the price in the exported product market. Only the supply side of the currency market is shown in the *active learning simulations.* Select the three exchange rates used to describe and narrative the results.

The Parameter Set

The parameters selected from the *frontpage* are restated in a color-coded table appearing in the upper left-hand side of the *active learning simulation* of the foreign exchange market. The first row of the table shows the domestic price of Levis in the US market and, the elasticity of demand for the imported Levis in the UK. The next three rows restate the exchange rates selected on the frontpage and these three exchange rates are color coded to enhance the analysis and improve the narrative of the text engine.

The three exchange rates are designed to focus attention on how the supply of pounds is determined. It allows the student to select specific exchange rates to illustrate the models' results and provides quantitative results for inspection. Study the impacts of changes in these three values, *vis a vis*, the other parameters.

The results in the imported product market for levis in the UK assume the exporter buys the levis as a "price taker" in the US and sells them at zero profit and without transport costs. This means the supply function for Levis in the UK is a horizontal line showing that the exporter will sell any and all Levis at a constant price (determined by the domestic price of levis divided by the exchange rate). These simplifying assumptions along with others previously mentioned allow attention to focus on the key economic principles.

The Graphical Engine

The graphical engine for the *active learning simulation* of the foreign exchange market model creates an illustration with two graphs. The two graphs are related but, do not share the same axes. The graph on the left-hand side of the illustration is that of the imported product market for Levis in the UK and the right-hand side graph is the US-UK foreign exchange market for pound sterling.

The quantitative relationship between the graphs is simple. Sales revenues earned as a result of Levi purchases by British consumers, given the demand function and unit cost shown in the left-hand side graph, appears as a single point in the horizontal axis on the right-hand side graph at the corresponding exchange rate. The reference between the graphs is the exchange rate and the color-coding allows ready identification.

Foreign Exchange Rate Market Model

Exact quantitative values obtained by the model appear on the graphs with color-coding. The color-coded values shown are those for each point referenced on the graphs. For example, in the right-hand side graph, the number of pounds sterling supplied by US exporters of Levis at the first exchange rate appears in green with a dashed vertical line extending upwards to the supply function for pounds. The corresponding exchange rate is shown on the vertical axis and is connected with a green dashed line to the supply function for pounds at that point.

The Text Engine

The textual narrative for the *active learning simulation* of the foreign exchange market model explains the results shown in the graphical illustration. It discusses the values depicted in both graphs and provides color-coding of the embedded values in the text for easy reference. The three exchange rates selected from the *frontpage* are those used for the narration.

The first paragraph of the text explains the two graphs in the illustration and discusses the economic relationship between the variables in the graphs. The next three paragraphs are used to explain the results for each of the three exchange rates. Specific numeric solution values from the economic model are embedded as color-coded text in the narratives' description.

In each of the next three paragraphs, each value selected for the exchange rate is discussed. The product market is described first and the points illustrated on the graph are embedded in the text. The numerical quantity of Levis sold at the specified imported product price appears in the text description of the product market. The imported product price depends upon the exchange rate and the domestic export product market price of Levis. Pound sterling sales revenues raised from Levis are the determined by multiplying the import product price times the quantity demanded of Levis in the import market. This volume of pounds and the corresponding exchange rate are embedded values in the narration describing the supply function for pounds in the right-hand side graph of the illustration.

Foreign Exchange Rate Market Model

Assignment Questions

1. Increase the domestic product price of Levis. What happens to the supply function for sterling?.
2. At a constant domestic product price for Levis, if there is a devaluation of the pound, what is the effect on the imported product price of Levi's sold in the UK.
3. Why is it necessary to assume the elasticity of demand for the imported product is greater than 1. Suppose it is not, what is the effect and why would this condition cause problems?

Chapter 15. Currency Arbitrage Model

Currency Trading in Three Countries

Purpose

This module introduces a simple graphical model of currency arbitrage. It provides an analysis of arbitrage trading using the graphical concepts first applied to show comparative advantage. It explains arbitrage using the concept of comparative advantage to explain the direction of trade. The direction of trade differs from that of comparative advantage since the currency arbitrage is done between three countries, using either a two-country currency trade or three-country currency movement for the buy or sell decision. The equivalent decision regarding the direction of trade for the export vs. import results of comparative advantage is the decision to move currency using two alternative trading paths: a two-country trade vs. a three-country trade.

The arbitrage process is important to understand because it reflects the adjustment process that makes markets provide efficient allocations. Market efficiency is attained because participants like arbitrage traders or speculators, act to ensure market equilibriums get attained. Although their motive is one of profit and self-interest and critics of market deficiencies sometimes malign this incentive, their role in the functioning of the market is ultimately beneficial. Their actions resolve market adjustments and result in the attainment of equilibrium consistent with theoretical conceptualization.

Learning Objectives

The learning objectives for the arbitrage-trading model involve the recognition and the application of the comparative advantage concept. The graphical meaning of the trading possibilities frontier (TPF) is derived in comparison to the PPF and the slope of the TPF reflects the “OC” price of the currency on the horizontal axis (pounds) in terms of the other (dollars). The TPF for the one trade (two-currency) trade is drawn directly from the exchange rate specified on the *frontpage*, expressed per unit of one-pound sterling. The two-trade (three-currency) TPF is realized with an intermediate trade with yen between dollars and pounds.

The difference in the two exchange rates for pounds represented by the two TPFs shows the arbitrage trading gains that may be realized using the theory of comparative advantage to determine the direction of trading (the buy or sell choice between the two alternative trading paths). Potential arbitrage profits per unit are measured using the trading margin from the theory of comparative advantage measures the. Trading volumes determine the total gains.

Currency Arbitrage Model

THE CURRENCY ARBITRAGE *FRONTPAGE*

The currency arbitrage *frontpage* provides background narrative about the currency arbitrage process. A model is specified using a framework where the buy and sell decision in the currency markets is dependent upon the direction of trade necessary to realize a gain from the trade. The alternatives are a two-currency trade path or three-currency trade path where the two different paths may lead to different outcomes due to the difference in the realized exchange rate between the two trade paths. The model is designed to apply the theory of comparative advantage, described in Chapter 12, to the trading of foreign exchange.

Discussion of the Model of Currency Arbitrage

In Chapter 12, the theory of comparative advantage was introduced to explain the direction of trade. The comparative advantage model showed when that two countries PPFs have different slopes, one country will specialize and export the good having a comparative advantage. Comparative advantage in the good appearing on the horizontal axis of the PPF (food) was visually characterized by the PPF with the lesser slope. The model of currency arbitrage uses the comparative advantage framework to explain currency arbitrage trading using a three-currency model. It defines two trading paths between the three currencies and shows how the theory of comparative advantage may be used to explain arbitrage trading.

The trading possibilities frontier (TPF) is defined as the trading rate between any two currencies but, is shown as the exchange rate of pound sterling in terms of dollars (**$/£)**. Introducing a third currency leads to a second TPF since the three-currency path may realize another possibly different exchange rate between the two currencies but, involves an extra trade. Arbitrage trading is designed to take advantage of small differences in the realized exchange rate that may arise between the two-path and three-path currency trades. The two PPFs correspond to these two different trading paths.

Comparative advantage in Chapter 12 was illustrated by showing that the PPF with the lower slope, of “OC” price of the good on the horizontal axis, meant that product was relatively less expensive and could be exported profitably. The PPF with the lower “OC” price would be exporting the good on the horizontal axis or, more directly one buys at the lower “OC” price, exports it to the other country and then sells at the higher “OC” price. The slopes of TPFs illustrate the direction of arbitrage trading since the realized exchange rate provides two TPFs (one for the two-currency path trade and the other for the three-currency path trade). The TPF with the lower slope represents the arbitrage ‘export’ of currency. This means, the currency-trading path with the lower “OC” price (similar to

comparative advantage) may be profitably traded by purchasing it and then selling it at the other (higher) "OC" price..

The Arbitrage Trading Parameter Selection
Three currency exchange rates are specified as parameters in the arbitrage-trading model, representing the three countries in the model, the US, the UK and Japan. The three parameters are: the exchange rate of the pound sterling (**$/£**) in the UK-US exchange market, the exchange rate of the dollar (**¥/$**) in the US-Japan exchange market and, the exchange rate for the yen (**£/¥**) in the Japan-UK exchange market. The default selection is that combination where arbitrage profits are zero and represents a global equilibrium in the currency markets. Arbitrage trading occurs however, when small fluctuations in the separate markets arise and traders take advantage of these differences but, the market is expected to return to the equilibrium, as the actions of arbitrage trading will move the market back to the equilibrium.

The model shows how the sale and purchase of pound sterling, using dollars can lead to arbitrage trading profits. The model is essentially that of comparative advantage in Chapter 12, except instead of 2 goods (food and clothing), two currencies are used (pounds dollars). The third currency (yen) is introduced to provide a second realized exchange rate between dollars and pounds (the realized rate between dollars and pounds in the alternative exchange rate is expressed with an intermediate trade in the yen market between dollars and pounds). Thus two TPFs are selected by specifying the three exchange rates, one for the two-currency path (one trade) and the other for the three-currency path (two trades). The direction of trade question relates whether to buy at the two-currency rate and sell at the three-currency rate or, the other way around.

For any combination of arbitrage rates different from the global equilibrium, an arbitrage-trading scenario will be shown. The realized rate from the three-currency (two trade) path will appear along with the TPF for the two-currency (one trade) path. The market shown will be for the pound sterling and the scenario depicts the sale or purchase of pounds using the two TPFs represented by the alternative trading paths.

THE *ACTIVE LEARNING SIMULATIONS* OF THE CURRENCY ARBITRAGE MODEL

The *active learning simulations* of the currency arbitrage model show how the concept of comparative advantage may be applied to explain currency arbitrage trading. Arbitrage trading arises because changes in currency markets will lead to adjustments in exchange rates that do not immediately equalize with a global equilibrium condition. Currency movements associated with arbitrage lead to the

global equilibrium condition but, arbitrage traders can earn short-tem profits before the equilibrium is re-attained.

The global equilibrium may be stated for three currencies using equivalence between the exchange rate for the one-trade (two-currency) path and realized exchange rate for the two-trade (three-currency) path. That is using three numerical values (**a, b** and **c**) to represent the numerical values of the exchange rates:

$$\mathbf{a\ (\$/£) = \{\ 1\ /\ [\ b\ (¥/\$)\ *\ c\ (£/¥)\ ]\ =\ A\ (\$/£)\ \}} \qquad \mathbf{[1]}$$

Where **a** (**$/£**) is the exchange rate of the pound sterling in the UK-US exchange market, **b** (**¥/$**) is the exchange rate of the dollar in the US-Japan exchange market and, the exchange rate for the yen **c** (**£/¥**) is attained in the Japan- UK exchange market. The left-hand side of the expression is the exchange rate for pounds using the one-trade (two-currency path). The right-hand side of the expression (the term in curly brackets) is the realized exchange rate for pounds two-trade (three-currency) path. When the one-trade path exchange rate for pounds, **a** (**$/£**), equals the two-trade path exchange rate for pounds, **A** (**$/£**), the global equilibrium condition holds and, no arbitrage profits arise.

As currency markets fluctuate on a daily basis, the markets move from the global equilibrium condition and arbitrage trading commences. Currency movements occur associated with the buy and sell decisions illustrated in model, the demand and supply of currency shifts (see Chapter 14 on foreign exchange markets) due to these financial flows. These shifts bring the markets back to the global equilibrium.

The Parameter Set

The parameters selected from the *frontpage* appear in a table in the upper right-hand side of the *active learning simulation* page. There are four columns in the table and the four columns correspond to the values in expression **[1]** above. That is the first column shows the value of the pound exchange rate in the UK-US exchange market [**a** (**$/£**)] or the one-trade (two currency path), the second column shows the exchange rate of the dollar in the US-Japan exchange market [**b** (**¥/$**)] and, the third columns shows the exchange rate of the yen in the Japan-UK exchange market [**c** (**£/¥**)]. The fourth column shows the realized exchange rate for the pound [**A** (**$/£**)] using the two-trade (three currency) path.

The values are color-coded to provide reference between the parameter set, the graphical simulation and the textual narrative. The exchange rate for the one-trade (two-currency) path is shown in black and, exchange rate(s) for the two-trade (three-currency) path appears in red. The last row in the table shows the trading margin defined as the difference between the two alternative exchange rate paths.

Currency Arbitrage Model

The values shown are expressed relative to the pound market. That is, the pound market appears in the graphical illustration and the parameters are expressed per unit of pound sterling.

The Graphical Engine

The graphical illustration shows two graphs. In the upper graph of the diagram, the pound – dollar trading possibilities frontier (TPF) appears. The parameter values are expressed per unit of pound sterling. This leads to an intersection on the horizontal axis at 1 pound, since pounds are depicted on the horizontal axis of the TPF and the slope of the TPF is the exchange rate. The TPF is linear showing the TPF remains constant during the trading scenario for all volumes.

The lower graph is the diagram depicts the "OC" price of pounds measured as the slope of the TPF. This is essentially the same result gotten from comparative advantage and is an important result since, lower "OC" price defines comparative advantage and determines the direction of trade. The same result holds for arbitrage, the currency path with the lower "OC" price is the one where the currency "buy" takes place, the other path is the "sell". Total arbitrage profits will depend on volume.

The color-coding of the graphical depiction provides ready reference to the parameter set selected. The one trade path is black and the two-trade path appears in red. The trading margin is the vertical distance between to "OC" price of the alternative exchange rate paths depicted in the lower graph of the diagram.

The Text Engine

Textual description for the arbitrage-trading model is limited. A brief narrative is provided to explain the graphical illustration and to define some of the measures. The embedded solution values for exchange rate of the one-trade (two-currency) trade appear in black and that for the exchange rate of the two-trade (three-currency) path is in red. The buy and sell decision is explained using the graphical illustration.

A buy decision means that starting with dollars the arbitrage trade would purchase using the path with the lowest "OC" price. For example, if the exchange rate for the two-trade (three-currency) path were lower, an arbitrage trader would buy yen with dollars and then buy pounds with the yen. The pounds would then be sold and converted back to dollars at the higher "OC" price reflected by the one-trade (two-currency) exchange rate.

Currency Arbitrage Model

Assignment Questions

1. Suppose the dollar-yen market is initially perturbed from the global equilibrium. Explain the difference in the direction of currency trade if the exchange rate in yen per dollar is first, 10 yen below, then 10 yen above the global equilibrium.
2. Explain why the two-trade path and the three-trade path will create different exchange rates if the global equilibrium condition does not hold.
3. Using the exchange rate model from Chapter 14, suppose the affects of arbitrage trading are included. How does this affect the supply of sterling in the model?